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SUPPORT OF AQUATIC LIFE USES
IN PAINTED ROBE CREEK
BASED ON PERIPHYTON COMPOSITION
AND COMMUNITY STRUCTURE

Prepared for:

State of Montana
Department of Environmental Quality
Monitoring and Data Management Bureau
P.O. Box 200901
Helena, Montana 59620-0901

Project Officer: Carol Endicott
DEQ Contract No. 200012

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Prepared by:

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October 1999

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October 26, 1999

RTE.	CC	DATE
	FILE	
ADM.	WTR.	AIR

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

Re: Final Painted Robe Creek Report and Invoice
Redwater River Electronic Data Report

Dear Carol,

Enclosed is the final Painted Robe Creek periphyton report printed on recycled paper.

Also enclosed is a diskette containing raw diatom data for Painted Robe Creek and the Redwater River. I have consulted with Mike Field regarding the format for electronic data reports.

The enclosed invoice includes an incentive of 2.3% for the 23 days that the final report was submitted in advance of the four-month contract deadline. I picked up the samples on July 20, so the deadline was November 20.

Thanks again for the work.

Sincerely,

Loren

Loren L. Bahls, Ph.D.
Phycologist

Enclosures: Final Painted Robe Creek Report
Diskette with raw diatom data for Painted Robe Creek
and the Redwater River (with diskette directory)
Invoice for Painted Robe Creek Report/Electronic Data
and for Redwater River Electronic Data

Frustulia bahlsii Edlund and Brant

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SUMMARY

In June 1999, composite periphyton samples were collected from natural substrates at 4 sites on Painted Robe Creek in southcentral Montana. Samples were collected following MDEQ standard operating procedures, processed and analyzed using standard methods for periphyton, and evaluated following modified USEPA rapid bioassessment protocols for wadeable streams.

The benthic algal flora at the uppermost site at **Lehfeldt (PR1-3)** indicated perennial flows and cool waters with somewhat elevated salt concentrations. An abundance of motile species here, led by *Navicula gregaria*, indicated **moderate impairment by siltation with partial support of aquatic life uses.**

The benthic algal flora at **Paulson (PR2-1)** resembled that of a mountain stream and was very different from floras upstream and downstream on Painted Robe Creek. Algae at the Paulson site indicated fresher waters and much less sedimentation than at the Lehfeldt site. The pollution index at Paulson was acceptable even for a mountain stream. Diatom metrics here indicated full support of aquatic life uses, however dominance by *Rhoicosphenia curvata* resulted in a rating of minor impairment. *R. curvata* is a common epiphyte on the filamentous green alga *Cladophora*, which was the dominant taxon at the Paulson site.

The two downstream stations on Painted Robe Creek were dominated by *Rhizoclonium* and brackish water species of *Synedra*. Although salinity levels were higher here than at the upstream sites, they were still within acceptable levels for prairie streams. Both sites also had pollution and siltation index values that were within the normal range for prairie streams. Both sites provided full support of aquatic life uses with minor impairment.

INTRODUCTION

This report evaluates the support of aquatic life uses, and probable causes of impairment to those uses, in Painted Robe Creek in southcentral Montana. This evaluation is part of a larger assessment that was conducted by Warren Kellogg of the Natural Resources Conservation Service, USDA. This assessment was performed at the request of local producers who are concerned about water quality, primarily salinity. Several bulls have died recently, potentially due to alkali poisoning (Carol Endicott, MDEQ, personal communication).

Evaluation of use support in this report is based on the species composition and community structure of periphyton (benthic algae) communities at 4 stream sites that were sampled in June of 1999. The periphyton or phytobenthos community is a basic biological component of all aquatic ecosystems. Periphyton accounts for much of the primary production and biological diversity of Montana streams (Bahls et al. 1992).

Plafkin et al. (1989) and Stevenson and Bahls (1999) list several advantages of 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 quick, easy and inexpensive, and causes minimal damage to resident biota and their habitat;
- Standard methods and criteria exist for evaluating the composition, structure, and biomass of algal associations;

- Identification to species is straightforward for the diatoms, for which there is a large body of taxonomic and ecological literature;
- Excessive algae growth in streams is often correctly perceived as a problem by the public.
- Periphyton and other biological communities reflect the *biological integrity*¹ of waterbodies; restoring and maintaining the biological integrity of waterbodies is a goal of the federal Clean Water Act;
- Periphyton and other biological communities integrate the effects of different stressors and provide a measure of their aggregate impact; and
- Periphyton and other biological communities may be the only practical means of evaluating impacts from non-point sources of pollution where specific ambient criteria do not exist (e.g., impacts that degrade habitat or increase nutrients).

Periphyton is a diverse assortment of simple photosynthetic organisms called algae, and other microorganisms that live attached to or in close proximity of the stream bottom. Most algae, such as the diatoms, are microscopic. Diatoms are distinguished by having a cell wall composed of opaline glass--hydrated amorphous silica. Diatoms often carpet a stream bottom with a slippery brown film.

Some algae, such as the filamentous greens, are conspicuous and their excessive growth may be aesthetically displeasing, deplete dissolved oxygen, interfere with fishing and fish spawning, clog irrigation intakes, and cause other problems.

The federal Clean Water Act directs states to develop water pollution control plans (Total Maximum Daily Loads or TMDLs) that

¹ *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 natural habitats within a region" (Karr and Dudley 1981).

set limits on pollution loading to water-quality limited waters. Water-quality limited waters are lakes and stream segments that do not meet water-quality standards, that is, that 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.

The purpose of this report is to provide information that will help the State of Montana to determine whether Painted Robe Creek is water-quality limited and in need of TMDLs.

PROJECT AREA AND SAMPLING SITES

The project area is in northern Stillwater County and southern Golden Valley County in southcentral Montana. Painted Robe Creek heads about 8 miles north of the town of Rapelje and flows northeasterly about 25 miles to the point where it meets the Musselshell River about 6 miles east of Lavina, Montana.

The project area is located in the Northwestern Great Plains Ecoregion (Omernik and Gallant 1987). The surface geology of the watershed consists of Cretaceous shales, sandstones, and siltstones of the Montana Group (Taylor and Ashley, undated). Vegetation is mixed grassland with some open ponderosa pine and juniper forest in the headwaters (USDA 1976). The main land uses are livestock grazing and dryland farming.

Periphyton samples were collected at 4 sites on Painted Robe Creek in June 1999 (Table 1). Elevations at the sampling sites range from about 4,500 feet at the upper site to 3,400 feet at the lowest site. Painted Robe Creek is classified C-3 in the Montana Surface Water Quality Standards.

METHODS

Periphyton samples were collected following standard operating procedures of the MDEQ Planning, Prevention, and Assistance Division. Using appropriate tools, microalgae were scraped, brushed, or sucked from natural substrates in proportion to the rank of those substrates at the study site. Macroalgae were picked by hand in proportion to their abundance at the site. All collections of microalgae and macroalgae were pooled into a common container and preserved with Lugol's solution.

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). Soft algae were identified using Prescott (1978), Smith (1950), and Whitford and Schumacher (1984). These books also served as the main references on the ecology of the soft algae.

After the identification of soft algae, raw periphyton samples were cleaned of organic matter using sulfuric acid, and permanent diatom slides were prepared in a high refractive index mounting medium following *Standard Methods for the Examination of Water and Wastewater* (APHA 1998). For each slide, between 400 and 414 diatom cells (800 to 828 valves) were counted at random and identified to species. The following were used as the main taxonomic and autecological references for the diatoms: Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b; Patrick and Reimer 1966, 1975. Lowe (1974) was also used extensively as an ecological reference for the diatoms.

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).

One additional metric was calculated for this study: percent of cells in the diatom family Epithemiaceae. This family is represented in rivers by two genera, *Epithemia* and *Rhopalodia*, that commonly harbor endosymbiotic nitrogen-fixing bluegreen algae (cyanobacteria) within their cells. A diatom association that contains a large percentage of cells in these genera may indicate nitrogen-limiting conditions, that is, low nitrogen to phosphorus ratios (Stevenson and Pan 1999).

Metric values from Painted Robe Creek were compared to numeric biocriteria developed for streams in the Great Plains Ecoregions of Montana (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 that are known to be impaired by various sources and causes of pollution (Bahls 1993).

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 with confidence to reference stream samples because metric values change seasonally and summer is the season in which reference streams and impaired streams were sampled for the purpose of biocriteria development. However, late spring is an acceptable time to sample prairie streams because flows often become depleted in summer.

Quality Assurance. Several steps were taken to assure that the study results are accurate and reproducible. Upon receipt of the samples, station and sample information were recorded in a laboratory notebook and samples were assigned a unique number

compatible with the Montana Diatom Database, e.g., 1806-01. The first part of this number (1806) designates the sampling site (Painted Robe Creek at Buffalo Highway); the second part of the number (01) designates the number of periphyton periphyton samples that have been collected at this site to date for which data have been entered into the Montana Diatom Database.

Sample observations and analyses of soft (non-diatom) algae were recorded in a lab notebook along with station and sample information provided by MDEQ. A portion of the raw sample was used to make duplicate diatom slides.

On completion of the project, station information, sample information, and diatom proportional count data will be entered into the Montana Diatom Database. One set of diatom slides will be deposited in the University of Montana Herbarium in Missoula. The other set of slides will be retained by *Hanna* in Helena.

RESULTS AND DISCUSSION

Results are presented in Tables 4 and 5, located near the end of this report following the Literature Cited section. Spreadsheets containing completed diatom proportional counts, with species pollution tolerance classes (PTC) and calculated percent abundances, are attached as Appendix A.

SAMPLE NOTES

Painted Robe Creek at Lehfeldt (PR1-3). This sample was very silty. The *Vaucheria* was covered with diatom epiphytes. About half the diatom cells were empty.

Painted Robe Creek at L. Paulson Road (PR2-1). The sample from this site contained very little silt. The *Cladophora* here was densely covered with the diatom *Rhoicosphenia curvata*. About 10% of the diatom cells were empty.

Painted Robe Creek at Buffalo Highway (PR2-3). The sample was very silty. About 20% of the diatom cells were empty.

Painted Robe Creek near mouth (PR2-14). The sample was relatively free of silt. The bulk of this sample was an unidentified macrophyte. About 10% of the diatom cells were empty.

NON-DIATOM ALGAE

The uppermost site at **Lehfelddt (PR1-3)** was dominated by the filamentous chrysophyte *Vaucheria* (Table 4). *Vaucheria* is a cool season taxon that grows on moist soil or on rocks in flowing water. The presence of this alga indicates a persistent source of water at this site.

The site at **Paulson (PR2-1)** was dominated by the filamentous green alga *Cladophora*, with a lesser amount of the filamentous red alga *Audouinella* (Table 4). Dominance by *Cladophora* and the presence of *Audouinella* indicate cool and relatively fresh water at this site.

Rhizoclonium replaced *Cladophora* as the dominant alga at the **Buffalo Highway (PR2-3)**. These are closely related genera that differ primarily in the degree of branching. *Rhizoclonium* tends to be found in slower, warmer, saltier and siltier waters than *Cladophora*. The appearance of *Oedogonium* and *Anabaena* at this site also indicate warmer water than upstream.

Painted Robe Creek **near the mouth (PR2-14)** supported an algal flora that was similar to the one at the Buffalo Highway.

DIATOMS

The diatom association at **Lehfelddt (PR1-3)** was dominated by *Navicula gregaria* (Table 5). This widely distributed diatom is motile, which allows it to live in waters that are subject to siltation. It prefers cool and somewhat brackish waters ranging from 500 to 10,000 mg/L salinity (Lowe 1974). An abundance of *Navicula gregaria* and other motile diatoms at this site resulted in a siltation index that indicated **moderate impairment and**

partial support of aquatic life uses.

The diatom association at Paulson Road (PR2-1) was very different from the diatom association upstream at Lehfeldt. The two sites had only about 15 percent of their diatom associations in common (Table 5). The dominant diatoms here--*Rhoicosphenia curvata* and *Achnanthes minutissima*--are freshwater species that do not tolerate large amounts of salt. They also prefer firm attachment sites such as bare rock or other algae (*Cladophora*). Diatom metrics at Paulson Road indicated minor impairment but full support of aquatic life uses.

The sites at the Buffalo Highway (PR2-3) and near the mouth of Painted Robe Creek (PR2-14) had similar diatom floras, both dominated by species of *Synedra* that tolerate moderate amounts of salt (Bahls and Bahls 1976). These brackish water diatoms--*Synedra famelica*, *S. fasciculata*, and *S. pulchella*--indicate increasing salt concentrations in the lower reaches of Painted Robe Creek. Nevertheless, diatom metrics at these sites indicated full support of aquatic life uses with only minor impairment (Table 5).

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Table 1. Location of periphyton sampling stations on Painted Robe Creek, MDEQ station code, sample number in the Montana Diatom Database, legal description, and sample date. Sites are listed in order from upstream to downstream.

Location	Station Code (Reach-Site)	Sample Number	Legal Description	Sample Date
Painted Robe Creek at Lehfelddt	PR1-3	1804-01	T04NR21E07C	06/10/99
Painted Robe Creek at Paulson Road	PR2-1	1805-01	T05NR22E12	06/10/99
Painted Robe Cr. at Buffalo Highway	PR2-3	1806-01	T05NR23E06AAA	06/10/99
Painted Robe Creek near mouth	PR2-14	0041-03	T06NR23E15A	06/11/99

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.

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 Wadeable Plains 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	Percent Similarity Index ¹
Excellent None/Full Support	>3.99	>2.25	<50.0	<25.0	>39	<25.0	0.0	>59.9
Good/Minor Full Support	3.00- 3.99	1.76- 2.25	50.0- 69.9	25.0- 49.9	30- 39	25.0 49.9	>0.0- <1.0	40.0- 59.9
Fair/Moderate Partial Support	2.00- 2.99	1.25- 1.75	70.0- 89.9	50.0- 74.9	20- 29	50.0- 74.9	1.0- 9.9	20.0- 39.9
Poor/Severe Nonsupport	<2.00	<1.25	>89.9	>74.9	<20	>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 gauge 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 Painted Robe Creek in June 1999. R = rare, C = common, VC = very common, A = abundant, VA = very abundant.

Taxa	PR1-3	PR2-1	PR2-3	PR2-14
Chlorophyta (green algae)				
<i>Cladophora</i>		VA (1)		
<i>Closterium</i>				C (3)
<i>Oedogonium</i>			VC (3)	C (4)
<i>Rhizoclonium</i>			VA (1)	VC (2)
<i>Ulothrix</i>			C (5)	
Chrysophyta (yellow-green algae)				
Diatoms	VC (2)	A (2)	A (2)	VA (1)
<i>Vaucheria</i>	VA (1)			
Rhodophyta (red algae)				
<i>Audouinella</i>		VC (3)		
Cyanophyta (blue-green algae)				
<i>Anabaena</i>			R (6)	
<i>Phormidium</i>			C (4)	C (5)

Table 5. Percent abundance of major diatom species¹ and values of selected diatom association metrics for periphyton samples collected from Painted Robe Creek in June 1999. Underlined values indicate full support of aquatic life uses with minor impairment; **bold values** indicate partial support of aquatic life uses with moderate impairment; underlined and bold values indicate nonsupport of aquatic life uses and severe impairment based on criteria for Wadeable prairie streams in Table 3.

Species/Metric (Pollution Tolerance Class)	Station		
	PR1-3	PR2-1	PR2-3 PR2-14
<i>Achnanthes minutissima</i> (3)	1.13	17.87	4.74 5.12
<i>Navicula gregaria</i> (2)	55.50	5.92	5.23 1.46
<i>Nitzschia frustulum</i> (2)	0.75	3.02	14.60 2.80
<i>Rhoicosphenia curvata</i> (3)	0.88	46.50	2.43 7.68
<i>Synedra famelica</i> (2)	0.50	2.66	34.18 7.68
<i>Synedra fasciculata</i> (2)	0.13	0.12	1.09 29.39
<i>Synedra pulchella</i> (2)		3.62	4.50 10.85
Number of Cells Counted	400	414	411 410
Shannon Species Diversity	<u>2.92</u>	<u>2.99</u>	3.75 3.83
Pollution Index	<u>2.00</u>	2.59	<u>1.97</u> <u>2.03</u>
Siltation Index	85.19	21.59	36.35 19.48
Disturbance Index	1.13	17.87	4.74 5.12
Number of Species Counted	49	41	43 41
Percent Dominant Species	55.50	<u>46.50</u>	<u>34.18</u> <u>29.39</u>
Percent Abnormal Cells	0.00	<u>0.24</u>	<u>0.61</u> <u>0.24</u>
Percent Epithemiaceae	0.00	0.00	1.46 0.61
Similarity Index	15.42	29.91	45.74

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

APPENDIX A: DIATOM PROPORTIONAL COUNTS

Sample	Genus/Species/Variety	PTC	Count	Percent
180401	Achnanthes lanceolata	2	7	0.88
180401	Achnanthes minutissima	3	9	1.13
180401	Amphora libyca	3	1	0.13
180401	Amphora pediculus	3	3	0.38
180401	Cocconeis pediculus	3	1	0.13
180401	Cocconeis placentula	3	10	1.25
180401	Cyclotella meneghiniana	2	33	4.13
180401	Diatoma tenue	2	0	0.00
180401	Fragilaria vaucheriae	2	0	0.00
180401	Gomphonema angustatum	2	2	0.25
180401	Gomphonema clavatum	2	4	0.50
180401	Gomphonema olivaceum	3	11	1.38
180401	Gomphonema parvulum	1	15	1.88
180401	Gomphonema truncatum	3	1	0.13
180401	Gyrosigma spencerii	2	5	0.63
180401	Navicula atomus	1	2	0.25
180401	Navicula bacilloides	2	2	0.25
180401	Navicula capitata	2	4	0.50
180401	Navicula capitatoradiata	2	1	0.13
180401	Navicula cincta	1	3	0.38
180401	Navicula erifuga	2	14	1.75
180401	Navicula gregaria	2	444	55.50
180401	Navicula integra	2	1	0.13
180401	Navicula lanceolata (Ag.) Ehr.	2	53	6.63
180401	Navicula odiosa	1	2	0.25
180401	Navicula peregrina	2	0	0.00
180401	Navicula pupula	2	1	0.13
180401	Navicula slesvicensis	2	6	0.75
180401	Navicula trivialis	2	1	0.13
180401	Navicula veneta	1	14	1.75
180401	Nitzschia acicularis	2	1	0.13
180401	Nitzschia angustatula	2	4	0.50
180401	Nitzschia apiculata	2	2	0.25
180401	Nitzschia debilis	2	2	0.25
180401	Nitzschia dissipata	3	10	1.25
180401	Nitzschia frustulum	2	6	0.75
180401	Nitzschia gracilis	2	1	0.13
180401	Nitzschia hungarica	2	0	0.00
180401	Nitzschia linearis	2	2	0.25
180401	Nitzschia microcephala	1	0	0.00
180401	Nitzschia palea	1	13	1.63
180401	Nitzschia paleacea	2	1	0.13
180401	Nitzschia perspicua	1	1	0.13
180401	Nitzschia pusilla	1	2	0.25
180401	Nitzschia sigma	2	1	0.13
180401	Nitzschia valdecostata	2	6	0.75
180401	Rhoicosphenia curvata	3	7	0.88
180401	Stauroneis smithii	3	0	0.00
180401	Surirella brebissonii	2	2	0.25
180401	Surirella minuta	2	79	9.88
180401	Synedra delicatissima v. angustissim	2	1	0.13
180401	Synedra famelica	2	4	0.50
180401	Synedra fasciculata	2	1	0.13
180401	Synedra parasitica	2	2	0.25
180401	Synedra ulna	2	2	0.25

Sample	Genus/Species/Variety	PTC	Count	Percent
180501	Achnanthes minutissima	3	148	17.87
180501	Amphora inariensis	3	1	0.12
180501	Amphora pediculus	3	19	2.29
180501	Cocconeis placentula	3	5	0.60
180501	Cyclotella meneghiniana	2	3	0.36
180501	Cymbella cymbiformis	3	2	0.24
180501	Cymbella minuta	2	5	0.60
180501	Diatoma tenue	2	2	0.24
180501	Fragilaria vaucheriae	2	15	1.81
180501	Gomphonema olivaceum	3	2	0.24
180501	Gomphonema parvulum	1	2	0.24
180501	Gyrosigma spencerii	2	4	0.48
180501	Navicula caterva	2	2	0.24
180501	Navicula cincta	1	6	0.72
180501	Navicula erifuga	2	2	0.24
180501	Navicula gregaria	2	49	5.92
180501	Navicula halophila	1	1	0.12
180501	Navicula lanceolata (Ag.) Ehr.	2	1	0.12
180501	Navicula pygmaea	2	2	0.24
180501	Navicula salinarum	1	19	2.29
180501	Navicula tripunctata	3	2	0.24
180501	Navicula veneta	1	37	4.47
180501	Nitzschia agnita	1	2	0.24
180501	Nitzschia amphibia	2	5	0.60
180501	Nitzschia archibaldii	2	4	0.48
180501	Nitzschia clausii	2	0	0.00
180501	Nitzschia filiformis	2	2	0.24
180501	Nitzschia frustulum	2	25	3.02
180501	Nitzschia inconspicua	2	1	0.12
180501	Nitzschia palea	1	7	0.85
180501	Nitzschia perminuta	3	1	0.12
180501	Nitzschia perspicua	1	0	0.00
180501	Nitzschia sociabilis	2	1	0.12
180501	Nitzschia supralitoria	2	6	0.72
180501	Nitzschia valdecostata	2	2	0.24
180501	Pleurosigma delicatulum	2	2	0.24
180501	Rhoicosphenia curvata	3	385	46.50
180501	Surirella minuta	2	1	0.12
180501	Surirella ovalis	2	1	0.12
180501	Synedra famelica	2	22	2.66
180501	Synedra fasciculata	2	1	0.12
180501	Synedra pulchella	2	30	3.62
180501	Synedra ulna	2	1	0.12

Sample	Genus/Species/Variety	PTC	Count	Percent
180601	Achnanthes minutissima	3	39	4.74
180601	Amphora coffeaeformis	1	14	1.70
180601	Caloneis amphisbaena	2	0	0.00
180601	Cocconeis placentula	3	2	0.24
180601	Cyclotella meneghiniana	2	7	0.85
180601	Cymbella affinis	3	0	0.00
180601	Cymbella minuta	2	1	0.12
180601	Cymbella pusilla	1	14	1.70
180601	Denticula subtilis	2	2	0.24
180601	Diatoma tenue	2	42	5.11
180601	Entomoneis paludosa	2	1	0.12
180601	Gomphonema olivaceum	3	1	0.12
180601	Mastogloia elliptica	2	3	0.36
180601	Mastogloia smithii	2	11	1.34
180601	Navicula capitata	2	2	0.24
180601	Navicula caterva	2	4	0.49
180601	Navicula cincta	1	6	0.73
180601	Navicula durrenbergiana	1	0	0.00
180601	Navicula erifuga	2	2	0.24
180601	Navicula gregaria	2	43	5.23
180601	Navicula peregrina	2	3	0.36
180601	Navicula salinarum	1	9	1.09
180601	Navicula tripunctata	3	1	0.12
180601	Navicula veneta	1	27	3.28
180601	Nitzschia amphibia	2	0	0.00
180601	Nitzschia apiculata	2	6	0.73
180601	Nitzschia archibaldii	2	7	0.85
180601	Nitzschia bergii	1	0	0.00
180601	Nitzschia clausii	2	0	0.00
180601	Nitzschia frustulum	2	120	14.60
180601	Nitzschia incognita	2	0	0.00
180601	Nitzschia leistikowii	2	6	0.73
180601	Nitzschia liebetruthii	3	14	1.70
180601	Nitzschia microcephala	1	24	2.92
180601	Nitzschia palea	1	2	0.24
180601	Nitzschia paleacea	2	4	0.49
180601	Nitzschia perminuta	3	4	0.49
180601	Nitzschia perspicua	1	1	0.12
180601	Nitzschia sociabilis	2	11	1.34
180601	Nitzschia valdestriata	2	2	0.24
180601	Plagiotropis arizonica	2	1	0.12
180601	Pleurosigma delicatulum	2	27	3.28
180601	Rhoicosphenia curvata	3	20	2.43
180601	Rhopalodia brebissonii	1	5	0.61
180601	Rhopalodia gibba	2	1	0.12
180601	Rhopalodia operculata	1	4	0.49
180601	Surirella brebissonii	2	0	0.00
180601	Surirella ovalis	2	1	0.12
180601	Synedra famelica	2	281	34.18
180601	Synedra fasciculata	2	9	1.09
180601	Synedra pulchella	2	37	4.50
180601	Thalassiosira weissflogii	2	0	0.00

Sample	Genus/Species/Variety	PTC	Count	Percent
004103	Achnanthes minutissima	3	42	5.12
004103	Amphipleura pellucida	2	5	0.61
004103	Amphora coffeaeformis	1	4	0.49
004103	Amphora libyca	3	5	0.61
004103	Bacillaria paradoxa	2	2	0.24
004103	Cocconeis placentula	3	3	0.37
004103	Cyclotella meneghiniana	2	18	2.20
004103	Cymbella affinis	3	2	0.24
004103	Cymbella pusilla	1	11	1.34
004103	Diatoma tenue	2	74	9.02
004103	Gomphonema clavatum	2	14	1.71
004103	Mastogloia elliptica	2	3	0.37
004103	Mastogloia smithii	2	7	0.85
004103	Navicula capitata	2	1	0.12
004103	Navicula caterva	2	12	1.46
004103	Navicula circumtexta	1	2	0.24
004103	Navicula erifuga	2	5	0.61
004103	Navicula goersii	2	2	0.24
004103	Navicula gregaria	2	12	1.46
004103	Navicula mutica	2	0	0.00
004103	Navicula ommissa	1	2	0.24
004103	Navicula peregrina	2	3	0.37
004103	Navicula salinarum	1	7	0.85
004103	Navicula sp.	2	2	0.24
004103	Navicula veneta	1	44	5.37
004103	Nitzschia apiculata	2	6	0.73
004103	Nitzschia frustulum	2	23	2.80
004103	Nitzschia liebetruthii	3	7	0.85
004103	Nitzschia microcephala	1	17	2.07
004103	Nitzschia palea	1	3	0.37
004103	Nitzschia perminuta	3	0	0.00
004103	Nitzschia perspicua	1	1	0.12
004103	Nitzschia pusilla	1	1	0.12
004103	Nitzschia sociabilis	2	9	1.10
004103	Nitzschia valdestriata	2	0	0.00
004103	Nitzschia vitrea	1	1	0.12
004103	Plagiotropis arizonica	2	0	0.00
004103	Pleurosigma delicatulum	2	8	0.98
004103	Rhoicosphenia curvata	3	63	7.68
004103	Rhopalodia brebissonii	1	2	0.24
004103	Rhopalodia operculata	1	3	0.37
004103	Synedra famelica	2	63	7.68
004103	Synedra fasciculata	2	241	29.39
004103	Synedra pulchella	2	89	10.85
004103	Thalassiosira weissflogii	2	1	0.12

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..	Parent	<Dir>	
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LDRYCRK .200	8,881	10-22-99	12:16a
PROBECRK.1-3	6,827	10-22-99	12:06a
PROBECRK.2-1	5,538	10-22-99	12:07a
PROBECRK.2-3	6,523	10-22-99	12:07a
PROBECRK.214	5,749	10-22-99	12:08a
REDWATER.1-3	4,057	10-22-99	12:17a
REDWATER.1-9	6,633	10-22-99	12:19a
REDWATER.2-B	11,975	10-22-99	12:21a
REDWATER.2-D	6,866	10-22-99	12:19a
REDWATER.2-F	8,333	10-22-99	12:20a
REDWATER.3-A	10,708	10-22-99	12:22a
REDWATER.3-D	8,676	10-22-99	12:24a
REDWATER.3-F	10,068	10-22-99	12:23a