A COMPARISON OF THE BENTHIC DIATOM ASSOCIATIONS
INHABITING THE MPC COLSTRIP UNITS 3 & 4 EFFLUENT
HOLDING PONDS WITH THOSE IN COW CREEK,
ROSEBUD COUNTY, MONTANA

DURING JUNE 1985

Loren L. Bahls
Water Quality Specialist

September 1985

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Abstract: Composite periphyton samples were collected in June 1985 from the MPC units 3 and 4 effluent holding ponds and from five locations along Cow Creek near Colstrip in Rosebud County, Montana. Diatom indicators and a relatively small number of diatom species show that the active cell, the flyash pond and the decant pond are stressed by dissolved solids, settleable solids and/or oxygen-demanding organic wastes. The large differences between the diatom flora of Cow Creek and those of the effluent holding ponds, together with the homogeneous and healthy diatom associations of Cow Creek, indicate little or no effect from the ponds on water quality and biota in the creek.

A COMPARISON OF THE BENTHIC DIATOM ASSOCIATIONS

INTRODUCTION

On May 7, 1985, the author proposed to compare associations of benthic diatoms living in the Montana Power Company (MPC) Colstrip Units 3 & 4 effluent holding ponds with those living in nearby Cow Creek, a tributary of Rosebud Creek in Rosebud County, Montana (Appendix A). Such comparison was intended as an additional tool to help determine whether there is a hydrologic connection between the ponds and the creek and, if there is, what effect seepage from the ponds might have on the biology of the creek. Using 1985 data as baseline, annual diatom monitoring may help to elucidate any long-term changes in Cow Creek biology that may be due to progressive salinization of and seepage from the effluent holding ponds.

STATIONS

Personnel from Hydrometrics collected samples on June 13, 1985, from the following holding pond locations:

1. Active Cell	T01N	R42E	Section 6 DC
2. Southeast Pond	T01N	R42E	Section 5 CC - <i>blowdown?</i>
3. Flyash Pond	T01N	R42E	Section 6 DA
4. Decant Pond	T01N	R42E	Section 6 AD

Effluent is discharged to the active cell, from which it flows to the flyash pond and thence to the decant pond. The southeast pond has not been used for effluent disposal and the other three ponds had not been dosed for about four weeks prior to sampling (Dan Shaffer, per. comm. 1985).

Personnel from the MSU Reclamation Research Unit collected samples June

3-6, 1985, from the following locations along Cow Creek:

5. GSP-1 (spring)	T01N	R42E	Section 4 A
6. GSW-1-3 (creek)	T01N	R42E	Section 4 A
7. GSW-3 (creek)	T01N	R42E	Section 3 A
8. GSW-5-3 (creek)	T01N	R42E	Section 2 D
9. GSW-6 (creek)	T01N	R43E	Section 6 C

Results also are included from analysis of a sample collected by Dr. Duane Klarich on May 20, 1979, at a site on lower Cow Creek:

10. Cow Creek near GSW-6	T01N	R43E	Section 6 DA

METHODS

The procedure used to collect composite periphyton samples is described in Appendix B. Portions of conspicuous soft-bodied algae and a few drops of the well mixed sample were placed on a microscope slide and scanned under low power to identify the non-diatom algae present and to ascertain their abundance relative to the diatoms. The sample was then processed and a diatom proportional count was performed according to the procedures in Standard Methods (A.P.H.A. et al., 1981).

Shannon diversity (d) was calculated using the formula presented in Weber (1973). Similarity between associations of diatoms was determined by calculating Czekanowski's coefficient, as given in Hellawell (1978):

$$Cz = \frac{2W}{A + B}$$

where W = the sum of the lesser measures of abundance of each species common to both associations.

A = the sum of measures of abundance of species in association A

B = the sum of measures of abundance of species in association B

RESULTS

Diatoms were the dominant algae in all nine of the periphyton samples collected for this study. Among samples from the MPC effluent holding ponds, only the one from the southeast pond contained any soft-bodied algae (Anabaena, Nodularia, Oscillatoria, Scenedesmus, Synechococcus). Common soft-bodied algae in the Cow Creek samples were Anabaena, Oedogonium, Oscillatoria, Phormidium, Rivularia, and Tribonema.

Eighty-nine (89) diatom species were identified in the ten samples. Duane analyzed for this study, including the sample collected in 1979 (Appendix C). Diatom associations from the effluent holding ponds tended to have fewer species and smaller diversity values than those from Cow Creek (Table 1).

Diatom species that dominate associations in the effluent holding ponds (Chaetoceros muelleri, Cylindrotheca gracilis, Nitzschia gandershiemiensis, and Nitzschia paleacea) are different from those that dominate associations in Cow Creek (Navicula cryptocephaloides and Synedra famelica). Moreover, each of the effluent holding ponds has a different dominant species, whereas all but one of the Cow Creek associations are dominated by the same species (Navicula cryptocephaloides).

Czekanowski coefficients for all station pairs (Table 2) indicate considerable dissimilarity among associations from the effluent holding ponds. Average similarity among pond samples was 0.16, compared to 0.46 among the Cow Creek samples. Average similarity between pond and Cow Creek samples was only 0.08. The association from the southeast pond was least like those of the other ponds (average similarity = 0.04) and most like those of Cow Creek (average similarity = 0.15).

Table 1. Statistics for samples of benthic diatom associations collected from the MPC effluent holding ponds and Cow Creek near Colstrip, June 1985.

Location	Cells Counted	Species Counted	Total Species*	Shannon (Species) Diversity
Active Cell Line (89)	31342	2	2	0.69
Southeast Pond	356	15	15	1.73
Flyash Pond	336	9	9	2.29
Decant Pond	348	10	10	1.23
GSP-1	364	31	38	3.22
GSW-1-3	353	31	35	2.18
GSW-3	349	37	49	3.59
GSW-5-3	350	28	38	3.62
GSW-6	380	24	30	3.02
Near_GSW-6 (5-20-79)	349	33	49	3.63

* Includes species observed during the proportional count and during a preliminary floristic scan of the diatom association.

[illegible][illegible]

DISCUSSION AND CONCLUSIONS

The relatively small number of diatom species counted in the samples from the effluent holding ponds indicates environmental stress. Bahls (1979) reported that composite periphyton samples containing fewer than 21 species were typical of waters polluted by dissolved solids, heavy metals, organic wastes or inorganic nutrients. An examination of the water quality preferences of the most abundant species in the ponds may reveal the nature of this stress.

The largest population of Chaetoceros muelleri in Montana was reported from a small pond in Cascade County having a specific conductance of 26,620 umhos, while Cylindrotheca gracilis is morphologically adapted to maneuvering on unstable, muddy bottoms in aggrading habitats (Bahls, 1982). Navicula tenelloides is a common species on saline seeps in Montana and has been found in waters having specific conductance values in excess of 40,000 umhos (Bahls and Bahls, 1978). Lange-Bertalot (1979) reports that Nitzschia gandersheimiensis develops large populations in waters subjected to very heavy loads of organic pollution. Thus, one may conclude that the active cell, the flyash pond and the decant pond are stressed by one or more of the following factors: dissolved solids, settleable solids, and oxygen-demanding organic wastes.

The active cell, flyash pond, and decant pond have specific conductance values ranging from 9,900 to 16,500 umhos; nitrite plus nitrate nitrogen measured about 0.5 mg/l in the active cell and flyash pond, but about 10 mg/l in the decant pond (Dan Shaffer, per. comm. 1985). This large concentration of inorganic nitrogen in the decant pond may indicate an organic nitrogen precursor (other forms of nitrogen were not measured) and help to explain the presence of the very pollution-tolerant species Nitzschia gandersheimiensis.

The predominance of Nitzschia paleacea in the southeast pond, along with a moderate number of Nitzschia communis, indicates less stress from dissolved solids and organic wastes. The optimum specific conductance values for these species in southeastern Montana are less than 5,000 umhos (Bahls et al., 1984). Lange-Bertalot (1979) reports that Nitzschia paleacea is less tolerant of organic pollution than Nitzschia gandersheimiensis.

Because the southeast pond has not been used for effluent disposal and contains only fresh-water runoff, it has not been sampled for water quality (Dan Shaffer, per. comm. 1985). This also explains why the algae flora of the southeast pond was more similar to that of Cow Creek than to the floras of the other three ponds. However, the smaller number of diatom species in the southeast pond (15) indicates moderate environmental stress, perhaps residual stress stemming from land disturbance at the time the pond was constructed and/or from diffuse (non-point) sources of contamination in the pond's watershed.

The number of species counted in the Cow Creek samples indicates healthy diatom associations and only weakly stressed or unstressed conditions. The two dominant species -- Navicula cryptocephaloides (synonym: Navicula cincta var. rostrata) and Synedra famelica -- are among the 68 major diatom ecotypes in the southern Fort Union Coal Region of Montana (Bahls et al., 1984); they tend to achieve their best population development at specific conductance values ranging from 5,000 to 6,000 umhos.

There appears to have been some reduction in diversity in the vicinity of GSW-6 between 1979 and 1985 (Table 1). However, a Shannon diversity value comparable to the 1979 value was recorded in 1985 at the next upstream station (GSW-5). In Cow Creek, there will be some year-to-year and station-to-station variation in diversity due to natural differences in weather, water quality substrate, and streamflow. Sampling error -- the deviation from a truly

representative sample -- is an additional and unknown variable. As with most biological systems, several years of data will be needed to ascertain trends. The very dissimilar floras of the effluent holding ponds and the Cow Creek sites together with the homogeneous and healthy Cow Creek diatom associations, indicate little or no effect from the ponds on water quality and biota in the creek.

contains only fresh-water runoff: RECOMMENDATION is sampled for water quality

Samples should be collected again in early June of 1986 to continue a program of annual biological monitoring at these same locations in order to ascertain any changes in stream biota that may result from pond operation.

ACKNOWLEDGEMENTS

Mr. Max Botz, Hydrometrics, arranged to have samples collected from the effluent holding ponds. Dan Shaffer, Hydrometrics, collected the samples. Frank Munshower, MSU Reclamation Research Unit, arranged to have samples collected from Cow Creek. Fred Shewman, Water Quality Bureau, reviewed a draft of this report. Edwina Wheat typed the report.

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DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

TED SCHWINDEN, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

HELENA, MONTANA 59620

PROPOSAL TO MONITOR BENTHIC DIATOM

ASSOCIATIONS IN COW CREEK AND THE

MPC UNIT 3 & 4 FLYASH POND AT COLSTRIP

L. L. Bahls LB

Water Quality Bureau

May 7, 1985

Background

Benthic diatoms are simple, microscopic plants (algae) that live on the bottoms of lakes, ponds and streams. A single collection of benthic diatoms may include up to 100 or more species, each with different ecological requirements. Diatoms are reliable indicators of salinity, nutrients, low dissolved oxygen, acidity, heavy metals, and other forms of pollution (Lowe, 1974). Bahls and others (1984) have described the water quality requirements of sixty-eight of the most common diatoms found in the southern Fort Union Region of Montana.

Rationale

Diatoms respond very quickly (in a matter of days or weeks) to changes in water quality. Certain groups or associations of diatoms are typical of different levels of salinity and different mixtures of ions. For example, some diatoms will live only in water dominated by calcium and bicarbonate ions; others will thrive only in waters where sulfate is the dominant anion. Minor constituents, e.g., boron, may also affect species composition of diatom associations in ways that are not yet understood.

This study proposes to use benthic diatoms to monitor water quality changes in Cow Creek and the MPC flyash pond at Colstrip. It is an additional tool to determine whether there is a hydrologic connection between the creek and the ash pond and, if there is, what effect seepage from the pond might have on the biology of the creek. The results would be interpreted in conjunction with those from hydrologic and vegetational studies. This work would complement those studies, not replace them.

Sampling Sites

A single composite periphyton sample would be collected from each of three sites:

1. MPC Unit 3-4 flyash effluent holding pond.
2. Upper Cow Creek at or near Hydrometrics' station GSW-1 (T1N R42E Sec. 4ABC).
3. Lower Cow Creek at or near Hydrometrics' station GSW-6 (T1N R43E Sec. 6CCA).

Frequency

Periphyton samples would be collected once each year in late May or early June.

Methods

The procedure for collecting a composite periphyton sample is outlined in the attached memo. Methods for processing periphyton samples are included in Standard Methods (15th Edition) and in Weber (1973). Collections from different stations will be compared using component (indicator) species and association diversity and similarity indexes.

Cost

Max Botz, Hydrometrics, has agreed to arrange for sample collection if the Technical Committee approves this proposal (telephone conversation with Loren Bahls, May 3, 1985). Loren Bahls, WQB, would process the samples and report the results at no cost.

References

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Office Memorandum .

STATE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES

TO : WATER QUALITY BUREAU FIELD PERSONNEL DATE: June 20, 1977

FROM : LOREN BAHLIS *LB*

SUBJECT : PROCEDURE FOR COLLECTING COMPOSITE PERIPHYTON SAMPLES FROM NATURAL SUBSTRATES

Periphyton consists of the assemblage of plants and animals, mostly microscopic, living attached to or immediately upon the bottom of a body of water. The plants in this community of organisms are responsible for the greater share of primary production in most Montana rivers and streams. These plants are usually algae, which often make the river or stream bottom slippery and slimy to the touch. Each kind of plant in the periphyton has specific environmental needs, allowing for their use-- singly or collectively-- as biological monitors of water quality.

The object in sampling periphyton from natural substrates is to obtain a collection of algae that is representative of the community from which it came. The algae should be present in the sample roughly in the same proportion as they exist in the stream. Different substrates-- rock, silt, logs, higher aquatic plants-- should be sampled in proportion to their importance as a substrate at a given station. Substrates exposed to different current velocities, depths, and shading should also be sampled, again roughly in proportion to the extent these conditions prevail at a site. (For example, if a section of stream to be sampled is 80 percent riffle and 20 percent pool, about 80 percent of the sample should come from riffles.)

Only a minimum of equipment is required: pocket knife, small bottles or vials with screw caps, labels, pen or pencil, and preservative. The following steps are recommended:

1. Fill sample container about half full of stream water, making sure the container is clean.
2. Collect individual filaments and colonies of macroscopic algae in proportion to their abundance relative one to another.
3. Carefully clean knife.
4. Scrape natural substrates as outlined in the previous paragraph.
5. Add preservative (to retard bacterial growths), cap, and label.

Generally, only a few milliliters of periphyton make a sufficient sample. Most any available preservative is acceptable, including formalin (10% formaldehyde), Lugol's (IKI), and ethanol. Lugol's, available from Abe Horpestad or myself, is preferred. You need add only enough to give a permanent red tint to the sample. No preservative is necessary if samples are delivered to me within 24 hours after collection.

Page 2
June 20, 1977

1. 在 1990 年 12 月 31 日，A 公司有一笔应付账款 100 万元，账龄在 1 年以内。根据历史经验，A 公司估计坏账损失率为 5%。

The sample should be labelled clearly with the date, the name of the water sampled, a general description of the sampling station, e.g., "Tenmile Creek at USGS gaging station, the county in which the station is located and/or an accurate legal description including range, township, section, and tract. Completion of a computer data card is not necessary unless water samples for chemical analyses are collected at the same time. Along with the samples, the sampler should include a note with the sampler's name, the name of the project (if any), and the desired deadline for completion of analyses and an interpretive report.

In addition to projects for which biological periphyton analyses have been budgeted, I would welcome samples from any uncollected waters in Montana. These samples will be used to determine the distribution and water quality relationships of individual diatom taxa in the state. If you are travelling, please check the map in my office. It shows where periphyton collections have already been made. If you plan on visiting an unsampled area, I will gladly furnish you with bottles, labels, and preservative. If you got the time, I've got the gear.

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Age 10 100 1000 10000 100000 1000000 10000000 100000000 1000000000

3. Controlled drug use.

Appendix C. Results of diatom proportional counts (number of cells).

Species	WATER QUALITY BUREAU FIELD PERSONNEL									near	
	Active	Southeast	Fiyash	Decant	GSP-1	GSW-1-3	GSW-3	GSW-5-3	GSW-6	GSW-6	(5-20-79)
	Cell	Pond	Pond	Pond							
<i>Achnanthes hauckiana</i>		1									
<i>Achnanthes lanceolata</i>					12						1
<i>Achnanthes minutissima</i>					5	3	5				
<i>Amphipleura pellucida</i>					1		4	6			
<i>Amphora coffeifonius</i>									21		2
<i>Amphora ovalis</i>					X						
<i>Amphora veneta</i>		5				1					
<i>Amphora species A</i>	water sampled, a general description of the sampling station, e.g.,										
<i>Anomoeoneis sphaerophora</i>					2	3	X	1	5		
<i>Caloneis amphibaena</i>							2				
<i>Caloneis lewisii</i>							X				
<i>Caloneis ventricosa</i>							6	9	X		
<i>Caloneis species A</i>					1						1
<i>Chaetoceros muelleri</i>	138										
<i>Cocconeis placentula</i>					1		2				1
<i>Cyclotella meneghiniana</i>					4		1				1
<i>Cylindrotheca gracilis</i>	28		137	3			5				1
<i>Cymbella angustata</i>						2					
<i>Cymbella pusilla</i>						6	2	3	27		2
<i>Denticula elegans</i>						2					
<i>Denticula subtilis</i>					1	1	X	1	X		1
<i>Diatoma tenue</i>					1		38	10			10
<i>Diploneis smithii</i>							X				
<i>Entomoneis alata</i>		1									
<i>Entomoneis ornata</i>							2				
<i>Entomoneis paludosa</i>	11	12	29	21	2	1	16	13	8		36
<i>Gomphonema affine</i>							X		1		
<i>Gomphonema angustatum</i>							1				
<i>Gomphonema intricatum</i>							X				X
<i>Gomphonema parvulum</i>											X
<i>Gomphonema tenellum (?)</i>							1				
<i>Gomphonema species A</i>						1					
<i>Gyrosigma spencerii</i>							X				1
<i>Hantzschia amphioxys</i>								X	1		
<i>Hantzschia elongata</i>						X					
<i>Hastogloia elliptica</i>					1	4		13	6		X
<i>Hastogloia smithii</i>											X
<i>Navicula arvensis</i>					5						
<i>Navicula capitata</i>							1				
<i>Navicula cincta</i>					15	1	15	2			6
<i>Navicula cryptocephala</i>					3						1
<i>Navicula cryptocephaloides</i>	10	1			101	247	127	95	152		37
<i>Navicula cuspidata</i>	1				1	5	X				
<i>Navicula elginensis</i>							X				
<i>Navicula goersii</i>							1				
<i>Navicula graciloides</i>							X				
<i>Navicula gregaria</i>					7				4		26

	Active Cell	Southeast Pond	Flyash Pond	Decant Pond	GSF-1	GSW-1-3	GSW-3	GSW-5-3	GSW-6	near GSW-6 (5-20-79)
<i>Navicula halophila</i>					4	12		5	6	1
<i>Navicula insociabilis</i>									X	X
<i>Navicula oblonga</i>					1	2			X	X
<i>Navicula pelliculosa</i>			1	10	2			1		1
<i>Navicula peregrina</i>								3	6	6
<i>Navicula perpusilla</i> (?)					1					
<i>Navicula pygmaea</i>						2	1	X	1	X
<i>Navicula salinarum</i>					1	1		21	12	5
<i>Navicula tenelloides</i>	98		44	34	2	5	2	5	1	1
<i>Navicula species A</i>	4			1		6	X	X		X
<i>Navicula species B</i>					1		X			
<i>Nitzschia acicularis</i>							2	6		29
<i>Nitzschia amphibia</i>					5				1	
<i>Nitzschia apiculata</i>		5			X	1	7	X	X	5
<i>Nitzschia communis</i>		28								
<i>Nitzschia elliptica</i>	12		74	3	X		1	X	1	1
<i>Nitzschia frustulum</i>		12		2	45	2	28	5	69	21
<i>Nitzschia gandershiemiensis</i>	20		39	272						
<i>Nitzschia gracilis</i>							15	4		5
<i>Nitzschia hungarica</i>		11				X	1	X		1
<i>Nitzschia linearis</i>					X					X
<i>Nitzschia microcephala</i>					14	1	4	1	1	
<i>Nitzschia obtusa</i>						15	1		18	X
<i>Nitzschia palea</i>	30		2	1	1	1	7	1		15
<i>Nitzschia paleacea</i>	1	257	9	1	23	3	26	68	6	3
<i>Nitzschia pusilla</i>						3	1	7	1	
<i>Nitzschia signa</i>		2								
<i>Nitzschia tryblionella</i>					1		X			
<i>Nitzschia vitrea</i>								2	1	X
<i>Pinnularia microstauron</i>		1					2			
<i>Plaurosigma delicatulum</i>							1			9
<i>Rhopalodia gibba</i>						X		X	X	X
<i>Rhopalodia musculus</i>		2			X	1	1	X		4
<i>Surirella ovalis</i>					X	X	3			X
<i>Surirella ovata</i>		8								2
<i>Synedra acus</i>								X		
<i>Synedra delicatissima</i>						4		15	X	
<i>Synedra famelica</i>					100	14	15	34	29	108
<i>Synedra fasciculata</i>							1	15	2	5
<i>Synedra filiformis</i> (?)								1		
<i>Synedra pulchella</i>										X
<i>Synedra ulna</i>					X	2	1	3		

Note: An "X" denotes a species that was encountered during a floristic scan of the diatom slide but not during the proportional count.

Office Memorandum .

STATE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES

TO : Fred Schuman?

DATE: 9/20/85

FROM :

SUBJECT: Cow Creek Samples Field 9-13-85

Lab
T.D. #1Cow Creek
J. T. #Specific
conductivity
corrected from 25°C

SD4, arg/2.

85 W 2123	GKW 4-4B	558	97
85 W 2124	GKW 2-4B	2	0.5
85 W 2125	GKW 1-4B	3820	2179
85 W 2126	GSP-3-4B	1938	887?
85 W 2127	GSP-2-4B	4780	2987 ✓
85 W 2128	GSP-1-4B	2807	1450 ✓
85 W 2129	GKW 11-4B ^{so flk} _{cow}	3884	2398 ✓
85 W 2130	GKW-1-4 ^{incl 2,4,5}	4336	2579 ✓
85 W 2132	G 11 6 4	5795	3749
85 W 2133	G 11 5 4 ^{34 dry}	5117	3196
85 W 2134	G 11-2-4B	3841	2283
85 W 2135	G 11-4B	3201	1761 ✓

85 W 2123

85 W 2135

Coe Creek T.T. #

Specific
conductivity
measured at
25°CSO₄, mg/l.

85 W 2136

GNW-9-4

4320

2633

85 W 2137

GNW-8-4

2709

1360

85 W 2138

GNW-7-4B

1903

763

85 W 2139

GNW-6-4B

3536

2131

85 W 2140

GNW-5-4

4337

2607

85 W 2141

GNW-4-4B

4059

2473

85 W 2142

GNW-3-4B

3680

2137

85 W 2143

GNW-2-4B

3569

2032

85 W 2144

GNW-1-4B

2767

1579