Macroinvertebrate Survey of Arrastra Creek, 2002

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For the Animas River Stakeholders Group, Silverton Colorado

Table of contents

Purpose **2**
Field Sampling **2**
Sample Processing **3**
Sample Site Descriptions **4**
Silver Lake Inlet 4
Silver Lake 5
Below Silver Lake 5
Above Drop to Mayflower 6
Above Quonset 7
Below Quonset 7
Flume 8
Below Flume 8
@ Confluence 9
Results **10**
Sample Site Characteristics 10
Macroinvertebrate Data 10
Water Chemistry Data 15
Relationship Between Macroinvertebrate and Water Chemistry Data 16
Conclusions **16**
Reference **21**

Purpose

The purpose of this survey had 4 components:

1. to identify the quality of macroinvertebrate communities throughout Arrastra Creek,
2. to determine if there was a food source for trout,
3. to identify changes in community composition of macroinvertebrates from above Silver Lake to the Confluence with the Animas and,
4. to relate the changes in macroinvertebrate community composition to changes in water quality parameters.

Arrastra Creek is a tributary of the Upper Animas River above Silverton Colorado. There have been significant amounts of mining activity in the watershed as indicated by numerous tailing piles, abandoned tramlines and mine shafts visible from the stream. Although the Animas River supports trout where Arrastra Creek enters the River, Arrastra Creek itself does not contain trout. There are no natural barriers within Arrastra Creek that would prevent trout from migrating upstream. Cunningham Creek, the next tributary to the Animas upstream from Arrastra does support trout.

A reconnaissance of macroinvertebrate communities was conducted in June 2002. The purpose of the reconnaissance was to identify and narrow the scope of potential sample sites where more rigorous sampling of macroinvertebrates and collection of water quality samples would take place. The reconnaissance began at the Above Quonset sample site (fig. 1, table 1) and proceeded to the confluence of Arrastra Creek with the Animas. Macroinvertebrates were collected with a Surber net and placed in a white pan with water. Macroinvertebrates were identified in the field and a rough estimate of relative density was obtained. Substrate quality was also noted.

The reconnaissance identified large changes in macroinvertebrate communities from the Above Quonset sample site to the Below Flume sample site (fig. 1, table 1). At the Above Quonset sample site, the community was dominated by mature larvae of the predatory, Perlodid Stonefly, *Megarcys.* Downstream, 0.5 kilometers at the Below Quonset sample site, large, grazing mayflies from the family Heptageniidae dominated the community and no *Megarcys* were present. Another 0.5 km downstream the community became more diverse with only immature larvae of *Megarcys* and Heptageniidaes. In this reach, the stream also changed from a mossy bottom stream with some adnate algae to a stream composed only of adnate algae and then back to a stream dominated by moss. At the confluence with the Animas River, the cobble substrate of Arrastra Creek was covered with adnate algae without any noticeable quantities of moss. The macroinvertebrate community did not appear to be significantly different from the community at the Below Flume site.

This reconnaissance revealed that there were significant changes in macroinvertebrate communities and therefore in water quality within the reach from Above Quonset to Below Flume sample sites and little if any significant changes in water quality from Below Flume to the confluence. Downstream from the Below Quonset sample site there existed an old diversion that was diverting some stream water. On the west slope approximately 100 meters above and away from the stream a mine shaft and tailings pile could be seen. Above the diversion near the Below Quonset sample site were remnants of mine tailings adjacent to the creek.

It was also known that Silver Lake, 1.5 miles upstream from the Above Quonset sample site, contained large quantities of tailings and had several mine sites within a mile of the water. Because the lake was a relatively difficult drive and hike it was decided that sampling would be a 1-time event without the reconnaissance. Sample sites would be selected based on observations at the time of sampling.

Field Sampling

The more rigorous macroinvertebrate sampling and water chemistry sampling occurred on July 28^{th,}, 2002 at 9 sites from above Silver Lake to the Confluence with Arrastra Gulch (fig. 1, table 1). Riffles were sampled for macroinvertebrates with a Surber sampler. Samples consisted of 3 composited surber samples taken from the same riffle; 1 from the near edge of the stream, 1 from the middle and 1 from the far edge beginning at the bottom of the riffle and working diagonally across and upstream. Water chemistry samples were obtained upstream from the macroinvertebrate samples. Macroinvertebrate samples were composited, labeled and preserved in 90% ethanol. Photographs of each sample site was taken. Flow was estimated based on data collected in 1991 at 2 sites, A59 near the Above Quonset sample site and A58 near the @ Confluence site.

Table 1. Station number, name, elevation and estimated flows that were sampled July 28th, 2002 for macroinvertebrates and water chemistry.

Station Number	Station Name	Elevation	Surface flow (estimated)
3603.001	Silver Lake Inlet	12190	0.5
	Silver Lake	12185	
3604.001	Below Sliver Lake	12180	0.5
	Above Drop to Mayflower (only macros sampled)	11900	0.1
3608.001	Above Quonset	10000	8.26
3607.001	Below Quonset	9920	9
	Rock Flume (only water chemistry sampled)		
3606.001	Below Flume	9800	10
3605.001	@ Confluence	9540	13.19

Sample Processing

Prior to processing the macroinvertebrate samples, large woody debris was rinsed and removed from the samples and the remaining material and macroinvertebrates were evenly distributed in a white, gridded tray. Processing consisted of a 100 fixed count method from randomly selected grids. Specimens were identified to at least the taxonomic level of family. Metrics from the Rapid Bioassessment Protocols II were calculated except for community loss metric (no. 7) since no reference site was identified or sampled. Metrics calculated included 1) Taxa Richness) Family Biotic Index (FBI), 3) Ratio of Scrapers to Collector + Gatherers, 4) Ratio of Ephemerella, Plecoptera, Trichoptera (EPT) to Chironomidae, 5) Percent Dominant Taxa, 6) EPT taxa and 8) Ratio of Shredder to Total Taxa. Also calculated were the Shannon-Weiner and Simpons Diversity Indexes.

Sample Site Descriptions

Silver Lake Inlet

At this site Arrastra Creek was approximately 0.5 meters wide with less than 5cm of water flowing over pebble to boulder size substrate. Substrate was covered with adnate algae (fig. 2).

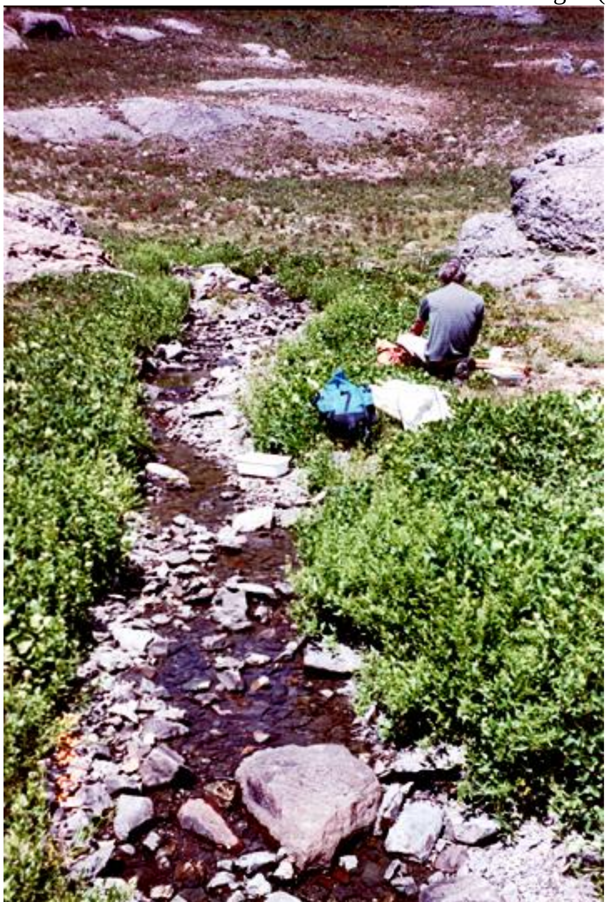


Figure 2. Silver Lake Inlet sample site.

Silver Lake

At this site the frame of the surber net was attached to a rope in 3 places and thrown into the lake and allowed to settle to the bottom. Then the net was pulled through the water to capture pelagic macro and meio invertebrates. No water chemistry data was obtained from this site (fig. 3).

Below Silver Lake

Arrastra Creek at this sample site was similar in size to the Silver Lake Inlet sample site. Water flowed over boulder and bedrock substrate that was covered with adnate algae (fig. 4).

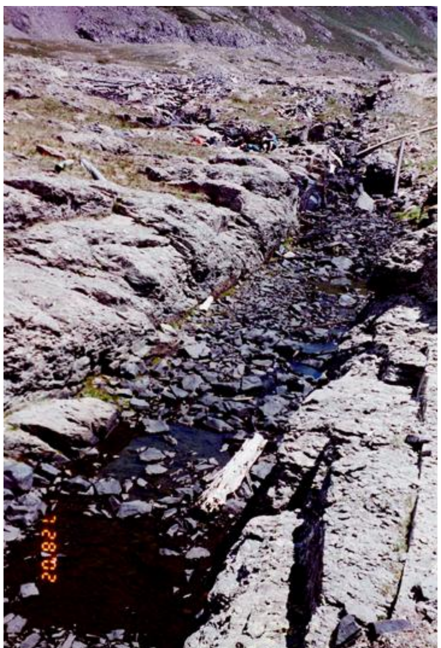


Figure 4. Below Silver Lake sample site.

Above Drop to Mayflower

At this site the creek was small and warm with very little water running over boulders and bedrock. Wet substrate was covered with a small amount of adnate algae. Only macroinvertebrates were sampled at this site (fig. 5). Below this site there was no more surface water in the creek bed to at least the drop to the Mayflower mine.

Figure 5. Above Drop to Mayflower sample site.

Above Quonset

This sample site was approximately 100 ft below the confluence with the stream that came out of Little Giant Basin. Substrate was composed of boulder and cobble and covered mostly by moss and some adnate algae. The wet width was approximately 3 feet (fig. 6).

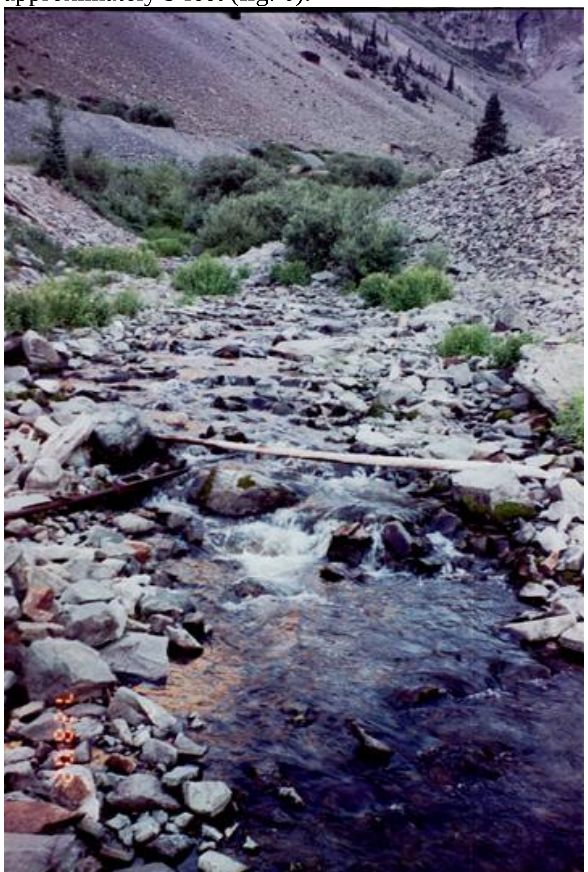


Figure 6. Above Quonset sample site.

Below Quonset

This site had no apparent difference in flow from the Above Quonset site. Moss was conspicuously absent and the boulder/cobble substrate was covered with adnate algae (fig. 7).

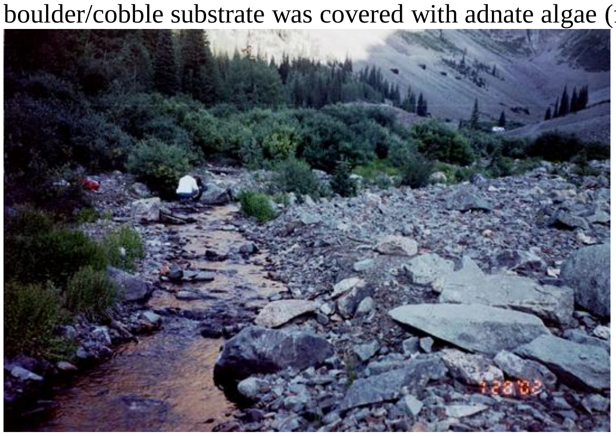


Figure 7. Below Quonset sample site.

Flume

This site was a flume that ran through the boulders approximately 30ft west of the creek and was a result of an old, dilapidated diversion approximately 200 yards upstream. Only water chemistry was sampled at this site No photograph was taken.

Below Flume

This site had no apparent difference in flow from either the Above or Below Quonset sample sites. Substrate was boulder/cobble and covered by large quantities of moss (fig. 8).

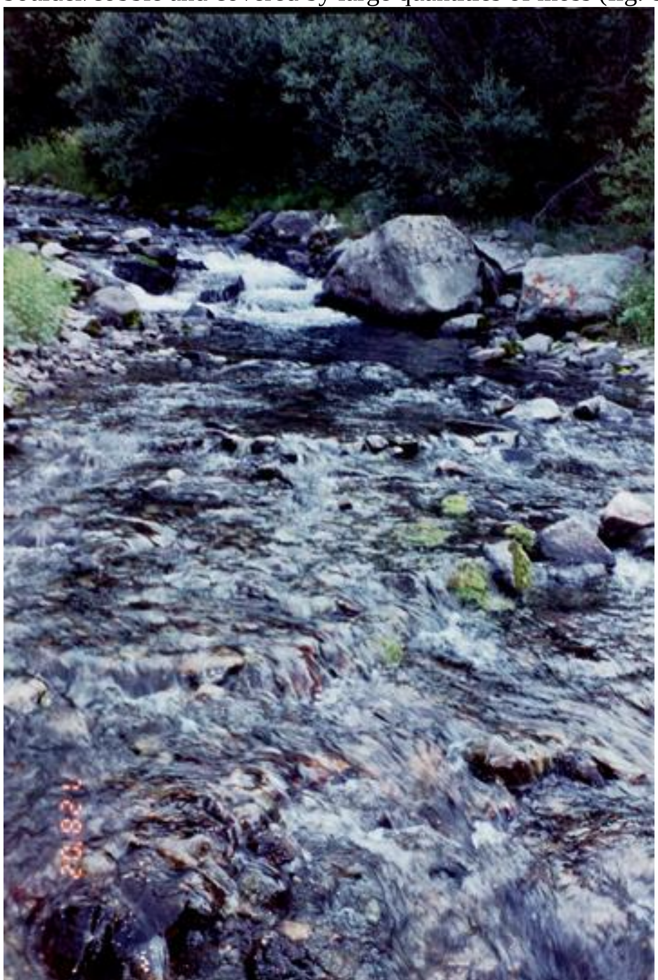


Figure 8. Below Flume sample site.

@ Confluence

Stream flow appeared to be slightly greater at this site. Gradient was also higher than at the other sample sites. Adnate algae covered the boulder/cobble substrate (fig. 9).

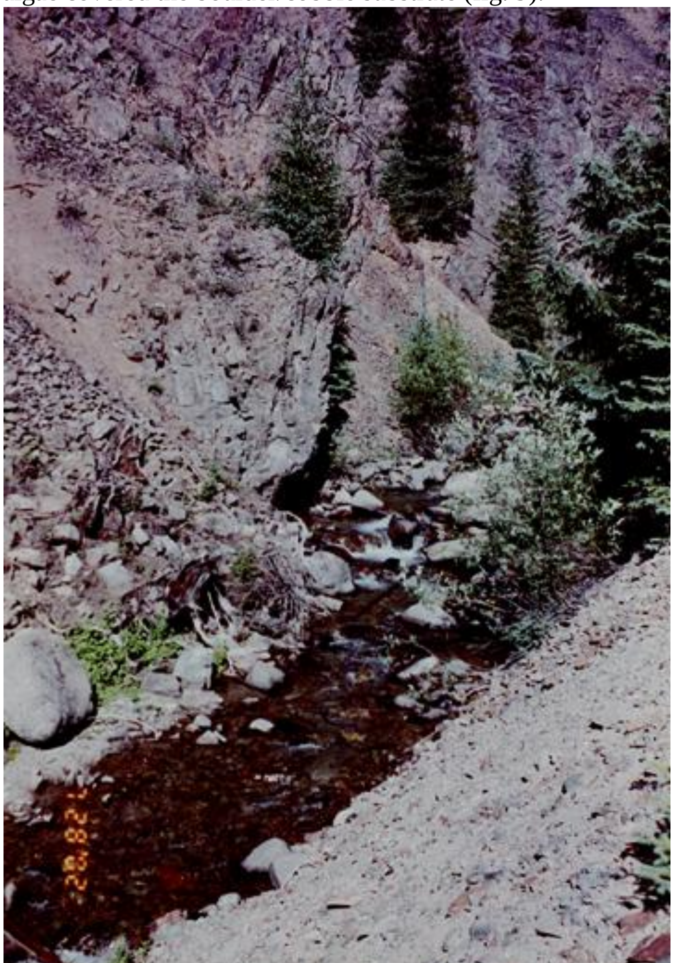


Figure 9. @ Confluence sample site.

Results

Sample Site Characteristics

Data obtained from a USGS 7.5'Quadrangle map showed stations ranging in elevation from 9,150ft at the @ Confluence sample site to 12,190ft at the Silver Lake Inlet sample site. Stream distance between the confluence and the Silver Lake Inlet sample site was 3.4 miles. The creeks from Woodchuck and Little Giant Basin appeared to be the only significant sources of water to Arrastra Creek within the stream reach that was sampled and within the time frame of sampling (figs. 1-10).

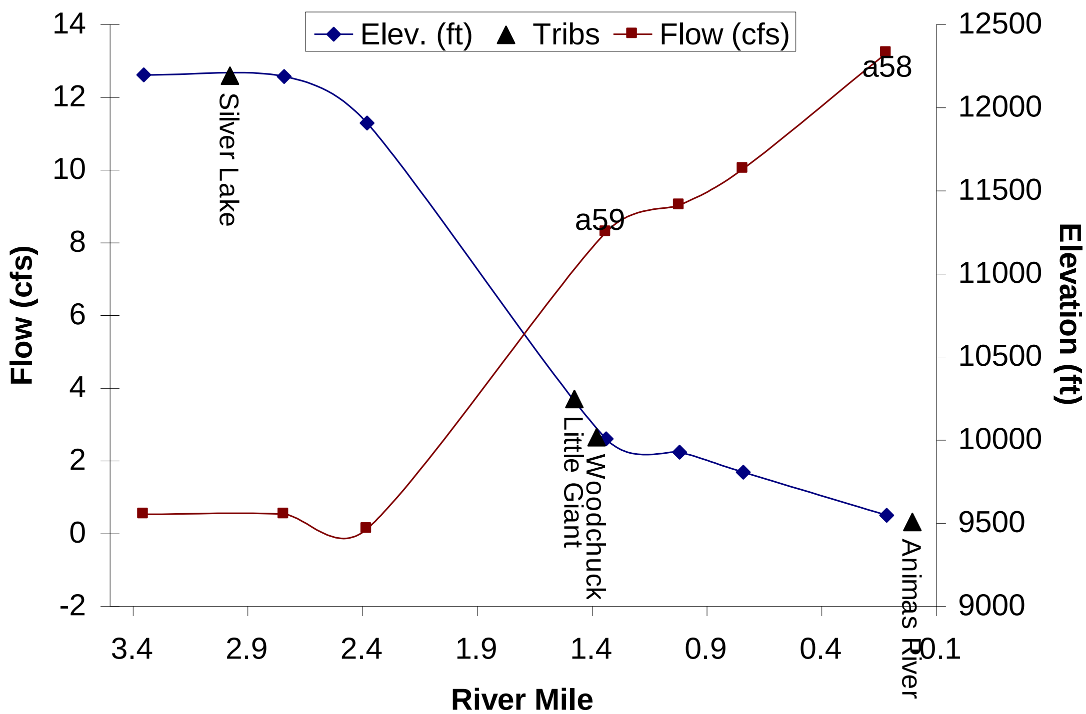


Figure 10. Station elevations, estimated flow, and location of major tributaries.

Given characteristics such as river mile, elevation and stream size (using estimated flow, see 1991 data and photos below) the stations group into 3 reaches, I) a reach above mile 2 that includes the Silver Lake Inlet, Below Silver Lake, and Above Drop to Mayflower sample sites, II) a reach below mile 2 that includes Above Quonset, Below Quonset, and Below Flume Sample Sites and III) a reach that includes the sample site at the confluence. The groupings are important when comparing macroinvertebrate communities. Therefore changes in macroinvertebrate communities are only discussed within each reach.

Macroinvertebrate Data

Within reach 1 there were important differences in macroinvertebrate communities between the Silver Lake Inlet sample site and the 2 sample sites downstream from the lake. Although Simpson's Diversity increased from upstream to downstream, RBP metrics such as FBI, EPT, and taxa richness indicated declining health in the macroinvertebrate communities below Silver Lake as well as the Shannon Wiener Diversity index (figs. 11, & 12, tables 2 & 3).

Within reach 2 there were large differences in community compositions given the relatively small changes in stream mile, elevation, and flow. RBP metrics 1, taxa richness, and 6, Ephemerella, Plecoptera, Trichoptera (EPT) index and both Simpon's and Shannon-Wiener Diversity Indeces showed a decrease in health of the macroinvertebrate community from

Above Quonset to Below Quonset and an increase in health from Below Quonset to a high point in macroinvertebrate community health at the Below Flume sample site. The FBI index indicated a general decrease in community health from the Above Quonset sample site to the Below Flume sample site. RBP metric 3, Ratio of Scrapers to Collector + Gatherers, and metric 4 Ratio of Ephemerella, Plecoptera, Trichoptera (EPT) to Chironomidae showed an increase in community health from the Above Quonset sample site to the Below Quonset sample site and a decrease to the Below Flume sample site. Courtney and Clements (2002) suggested use of Heptageniids as a metric because of their sensitivity to high concentrations of metals shows a similar but stronger trend. Regardless of the interpretation of community health from the macroinvertebrate data within reach 2, there was indication of effects of increasing concentration of metals on the macroinvertebrate communities due to the large changes in community compositions within this reach.

Data of the composition of the macroinvertebrate community at the @ Confluence sample site indicates no significant increase in toxicity of water chemistry or decline in substrate quality from the above reach. It is interesting to note that there was very little impact of precipitates to the benthos at any of the sample sites, unlike the obvious impacts found in the Animas, Mineral and Cement Creeks.

Table 2. Macroinvertebrate data.

		Silver Lake Inlet, 3603.001	**50yds Below Sliver Lake 3604.001**	**Above Drop to Mayflower 3610.001**	**Above Quonset 3608.001**	**Below Quonset 3607.001**	**Below Flume 3606.001**	**@ Confluence 3605.001**
Family	***Genus***							
Baetidae	Baetis	80	21	19	11	37	33	12
Ephemerellidae	Drunella					2		
Heptageniidae	Cinygmula					4		
Heptageniidae	Epeorus				5	35	13	9
Heptageniidae	Rhithrogena					13	7	58
Perlodidae	Megarcys				31		10	2
Siphlonuridae	Ameletus						2	
Acari				2				
Ceratopogonidae							1	
Chloroperlidae		1						
Chironimidae		11	20	62	36	9	36	
Dytiscidae			4	10				
Nemouridae					14		17	12
Planariidae		3			2	1	4	6
Ryacophilidae			6		4	2	14	8
Simulidae		3		4			1	3
Tipulidae		2						
River mile		3.35	2.74	2.38	1.33	1.01	0.74	0.11
Elev. (ft)		12190	12180	11900	10000	9920	9800	9540
Flow (cfs)		0.5	0.5	0.1	8.26	9	10	13.19

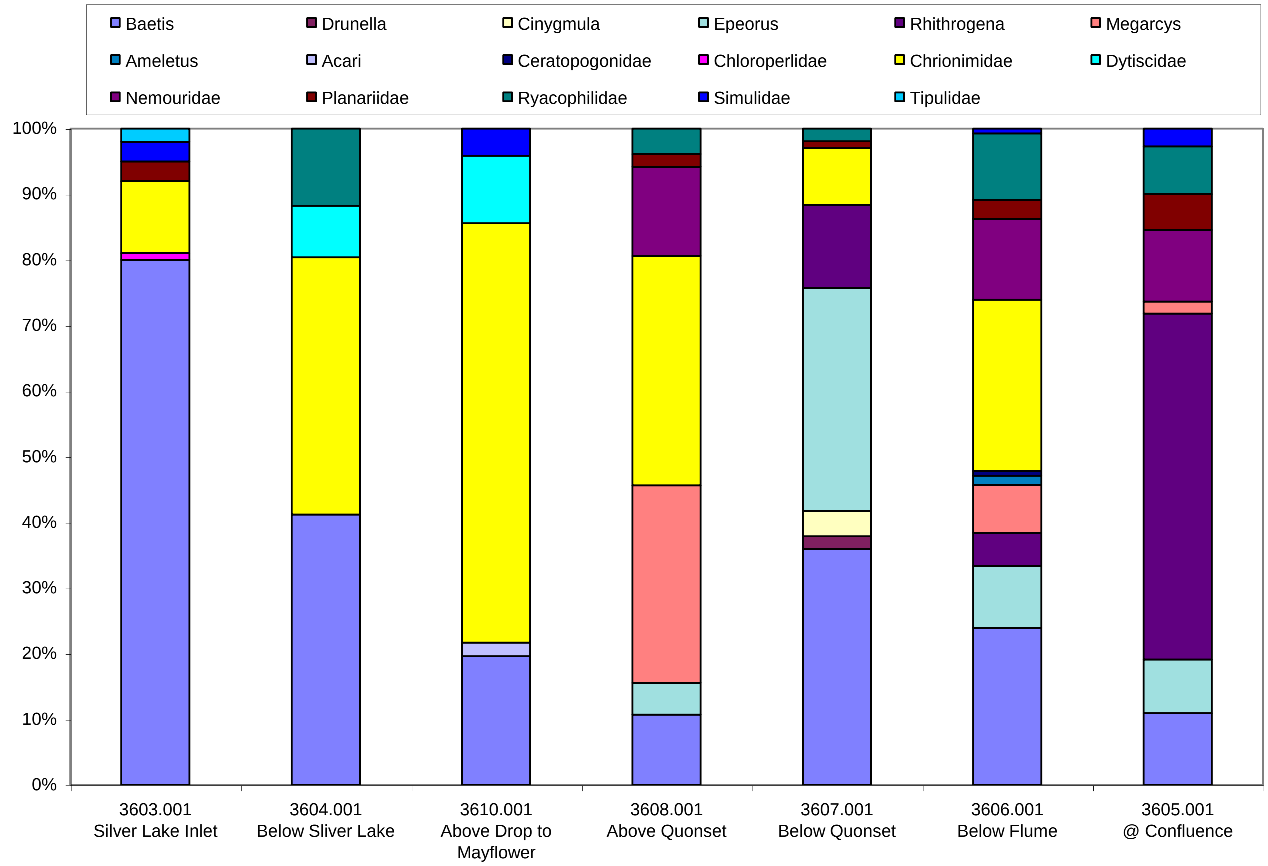


Figure 11. Composition of macroinvertebrate communities. The change in compositions from Above Quonset to Below Flume is high given the relatively small change in stream mile, elevation, and flow. Given the presence of *Megarcys* and the Heptageniid Mayflies it appears that the stretch from Above Quonset to the Confluence would support trout. The absence of Caddisflies appears to be elevational given data from streams with similar altitudes near the Rocky Mountain Biological Laboratory, Gothic, Colorado.

Table 3. Rapid Bioassessment (RPB II, EPA), metrics. No Community Loss calculated because there was no designated refernce sations. Shannon Weiner and Simpsons Diversity indeces also included.

				Metric:		1		2			3		4		5		6
Station	Coll	Det	Filt	Gath	Pred	Taxa Richness d	No. Individuals n	FBI	No. of Scraper (S)	Filt+Coll (F+C)	Ratio of S/(F+C)	No. of Chiros	Ratio of EPT/Chiro	No. Dom. Taxa	% Dom. Taxa	No. EPT	EPT Index
Silver lake inlet	91	0	3	0	6	6	100	4.11	0	94	0.00	11	7.36	80	80.00%	81	2
Below Sliver Lake	41	0	0	0	10	4	51	4.39	0	41	0	20	1.35	21	41.18%	27	2
Above Drop to Mayflower	83	0	4	0	10	5	97	5.48	0	87	0.00	62	0.31	62	63.92%	19	1
Above Quonset	47	0	0	0	51	7	103	3.59	5	47	0.1064	36	1.81	36	34.95%	65	5
Below Quonset	48	0	0	0	3	6	103	4.00	52	48	1.08	9	10.33	52	50.49%	93	4
Below Flume	71	0	1	0	46	10	138	3.68	20	72	0.2778	36	2.67	36	26.09%	96	6
@ Confluence.	12	0	3	0	28	7	110	3.29	67	15	4.4667	0	#DIV/0!	67	60.91%	101	5

		8		
Station	Shredd Abund	Ratio Shred/ Tot	Shannon Weiner Index	Simpsons Diversity
Silver lake inlet	0	0	18.96073	1.5281174
Below Sliver Lake	0	0	7.508994	2.912654
Above Drop to Mayflower	0	0	12.41995	2.1754913
Above Quonset	0	0	17.69976	4.0507827
Below Quonset	0	0	17.66269	2.5484026
Below Flume	0	0	30.34248	5.6143868
@ Confluence.	0	0	19.0659	2.4744376

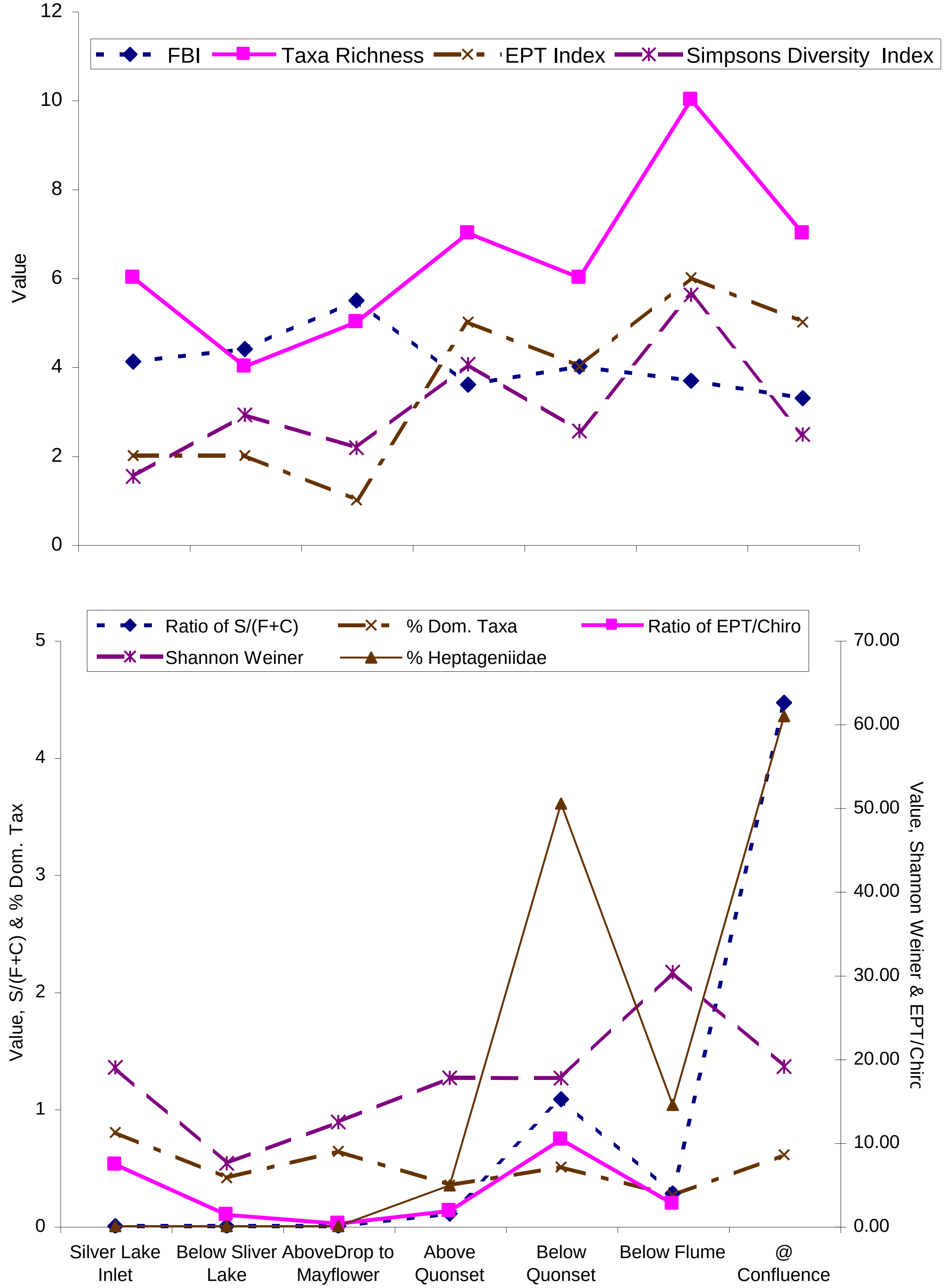


Figure 12. Graphical presentation RBPII metrics.

Water Chemistry Data

Within reach 1, the Silver Lake Inlet sample site had low hardness and low concentrations of metals (Figures 13-15). The 2 sample sites below the lake had elevated concentrations of metals and low hardness resulting in greater toxicity. Between reach 1 and reach 2 there was a substantial increase in total hardness, calcium, alkalinity and magnesium. Within reach 2, between the Below Quonset Hut sample site and the Below Flume sample site, there was an increase in concentrations of cadmium, copper, zinc and lead. Given the higher values of hardness at the Below Flume sample site the corresponding increase in metals would not result in toxicity values being as high as at the 2 sample sites below Silver Lake. But, given the size of and the fact that a large portion of the stream may be flowing through the alluvium at the Below Flume sample site, the load to the stream would be much greater within this reach than from Silver Lake where the stream was much smaller and flowed across bedrock with little alluvial material.

Relationship Between Macroinvertebrate and Water Chemistry Data

In general, macroinvertebrate communities reflected what would be expected given the concentration of metals and hardness of water found at each sample site (Tables 2, 3 & 4, Figures 11-15). Although the Silver Lake Inlet sample site had low hardness and low concentrations of metals and appeared relatively pristine, given the altitude and small stream size at this sample site a more diverse macroinvertebrate community would not be expected. The sample sites below the lake had elevated concentrations of metals and low hardness resulting in high toxicity of the metals and the macroinvertebrate communities at these sites reflected this toxicity.

Data from reach 2 were more difficult to interpret. Hardness was higher for each sample site within this reach but the concentration of metals did not increase substantially until at the Below Flume sample site (Figures 13-15). Some macroinvertebrate community metrics within reach 2 indicated increasing health, others indicated decreasing health (Table 3, Figure 12). Acute toxicity at the Below Flume Site may not have been much of a contributor to macroinvertebrate community composition due to high hardness values. Chronic toxicity, because of higher concentrations of metals, may have been more significant. Because of the relatively small distance between sample sites, downstream drift and colonization from upstream, relatively healthy macroinvertebrate communities may be masking the effects of increasing concentrations of metals.

Conclusions

Other than below Silver Lake, macroinvertebrate communities in Arrastra Creek were relatively diverse and dense and appeared to be in sufficient quantity to support trout. Calculating relative load of various metals to the Animas River and its significance to downstream recovery may be important to remediation efforts. Depending on the results of these calculations it may be important to locate the source of metals within the reach 2 (Above Quonset to Below Flume) of Arrastra Creek.

Table 4. Water chemistry values.

Station	Flow (estimated)	pH	Temp. (C°)	Phen. Alkalinity	Total Alkalinity	Total Hardness
Silver Lake Inlet	0.5	7.50	15.8	0.0	20.0	26.0
Below Sliver Lake	0.5	7.84	17.1	0.0	10.0	26.0
Above Quonset	8.26	7.87	6.2	0.0	52.0	122.0
Below Quonset	9	8.07	7.5	0.0	46.0	118.0
Rock Flume	9.5	7.60	5.1	0.0	44.0	114.0
Below Flume	10	7.72	7.3	0.0	28.0	116.0
@ Confluence	13.19	7.78	11.2	0.0	44.0	110.0

STATION	Al Diss (ug/l)	AL Tot (ug/l)	AS Diss (ug/l)	AS Tot (ug/l)	CA Diss (ug/l)	CA Tot (ug/l)	CD Diss (ug/l)	CD Tot (ug/l)	CU Diss (ug/l)	CU Tot (ug/l)	FE Diss (ug/l)	FE Tot (ug/l)	MG Diss (ug/l)	MG Tot (ug/l)	MN Diss (ug/l)	MN Tot (ug/l)
Silver Lake Inlet	0.0	0.0	0.0	0.0	12140.0	12055.0	0.00	0.00	1.1	1.0	0.0	0.0	530.0	501.0	0.0	0.0
Below Sliver Lake	0.0	81.0	0.0	0.0	8307.0	8677.0	0.59	2.89	7.7	49.6	24.0	326.0	436.0	560.0	14.9	580.7
Above Quonset	0.0	0.0	0.0	0.0	42724.0	42635.0	0.35	0.36	2.0	2.1	0.0	0.0	2280.0	2233.0	0.0	0.0
Below Quonset	0.0	0.0	0.0	0.0	41924.0	42756.0	0.37	0.35	2.3	1.7	11.0	0.0	2271.0	2267.0	0.0	0.0
Rock Flume	0.0	0.0	0.0	0.0	36673.0	36907.0	1.83	1.59	5.3	5.4	0.0	10.0	1985.0	2005.0	0.0	0.0
Below Flume	0.0	0.0	0.0	0.0	38284.0	41683.0	1.74	1.99	8.3	8.1	0.0	0.0	1938.0	2090.0	0.0	0.0
@ Confluence	0.0	0.0	0.0	0.0	39323.0	40051.0	1.64	1.61	5.9	6.1	11.0	25.0	2012.0	2025.0	0.0	0.0

STATION	PB Diss (ug/l)	PB Tot (ug/l)	Se Diss (ug/l)	Se Tot (ug/l)	Zn Diss (ug/l)	Zn Tot (ug/l)
Silver Lake Inlet	0.0	0.0	0.0	0.0	12.2	0.0
Below Sliver Lake	4.2	104.8	0.0	0.0	100.6	531.1
Above Quonset	0.0	0.0	0.0	2.5	59.3	47.2
Below Quonset	2.3	0.0	0.0	0.0	50.4	40.1
Rock Flume	3.4	3.6	0.0	3.4	197.4	197.1
Below Flume	3.5	3.0	2.3	2.9	228.7	245.9
@ Confluence	0.0	3.5	0.0	0.0	187.6	178.3

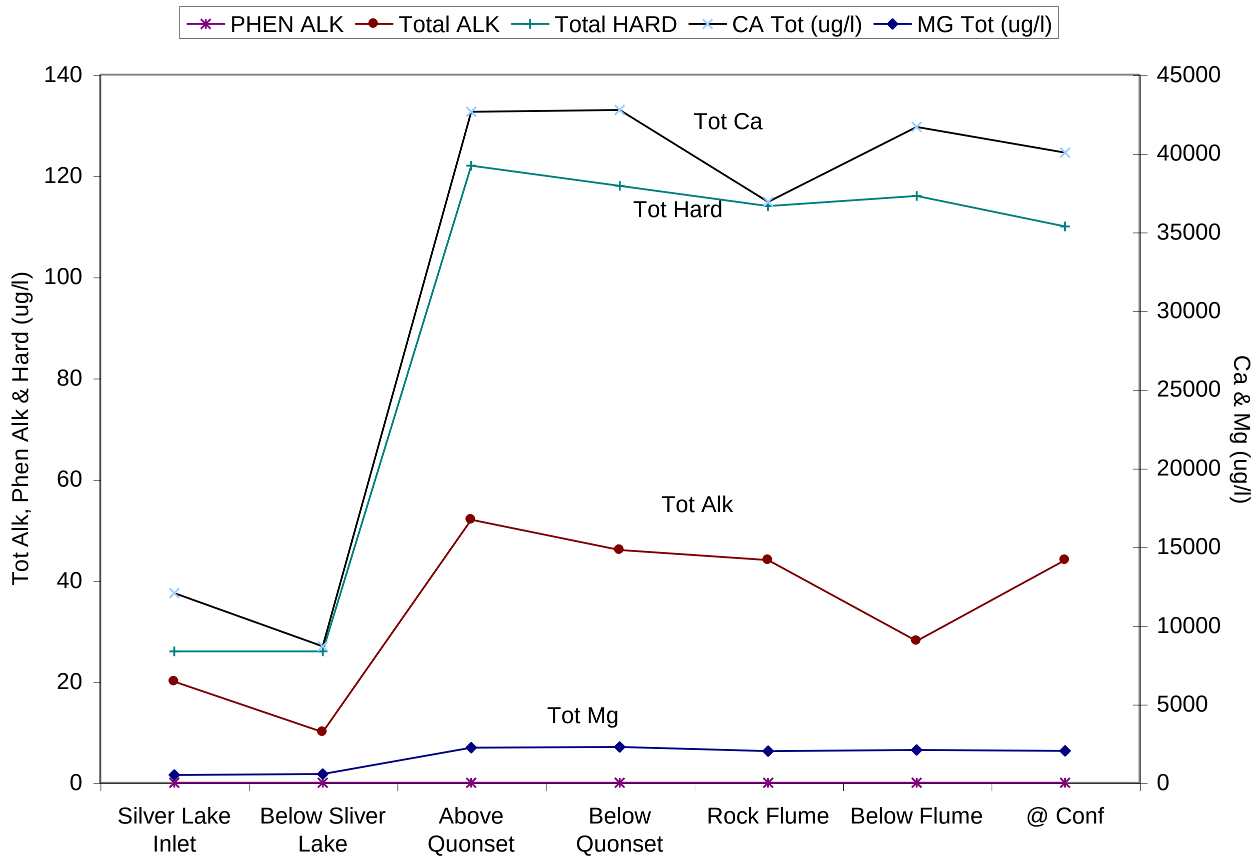


Figure 13. Concentration of total calcium, hardness, alkalinity magnesium and phenol alkalinity (ug/l).

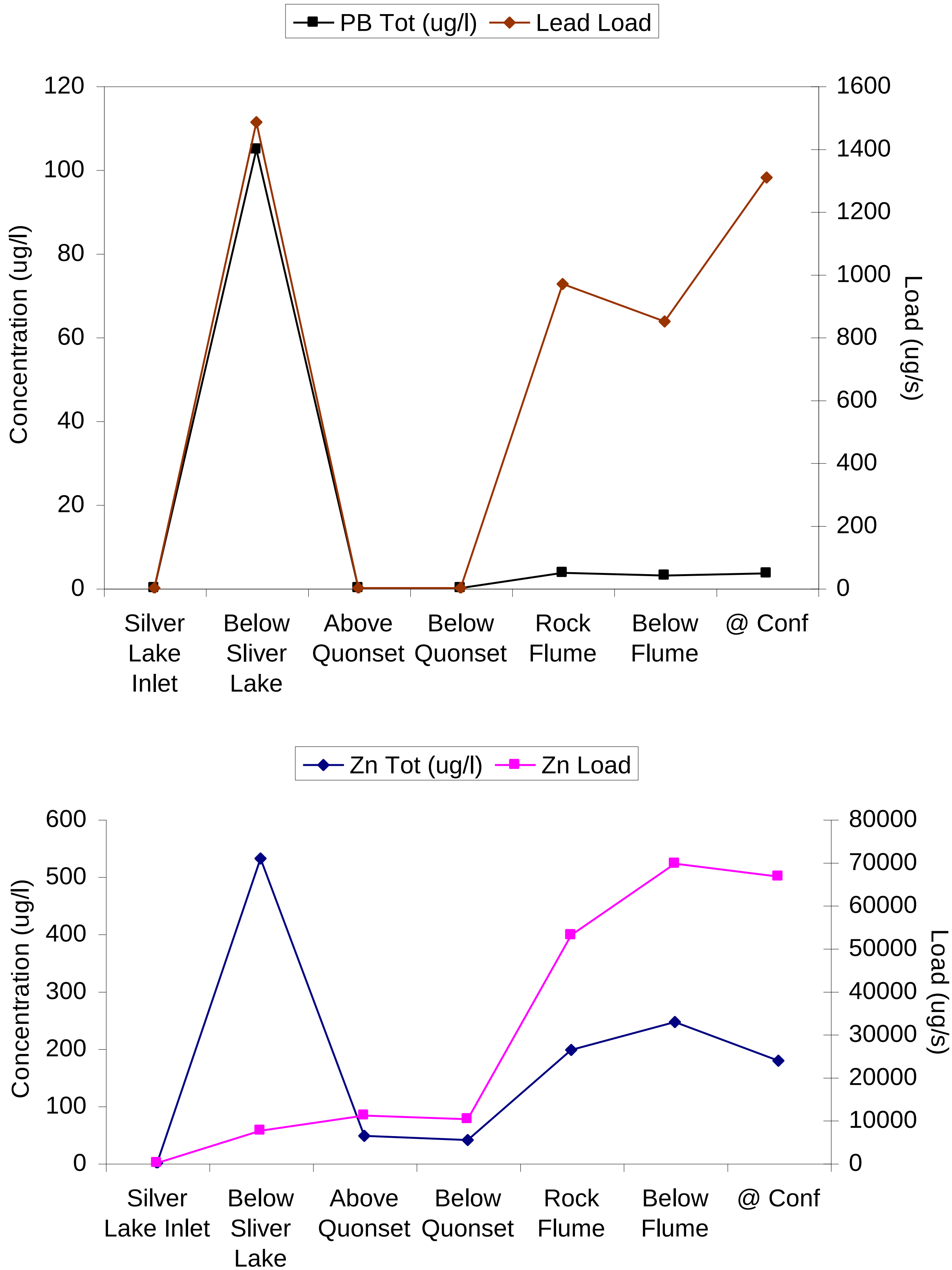
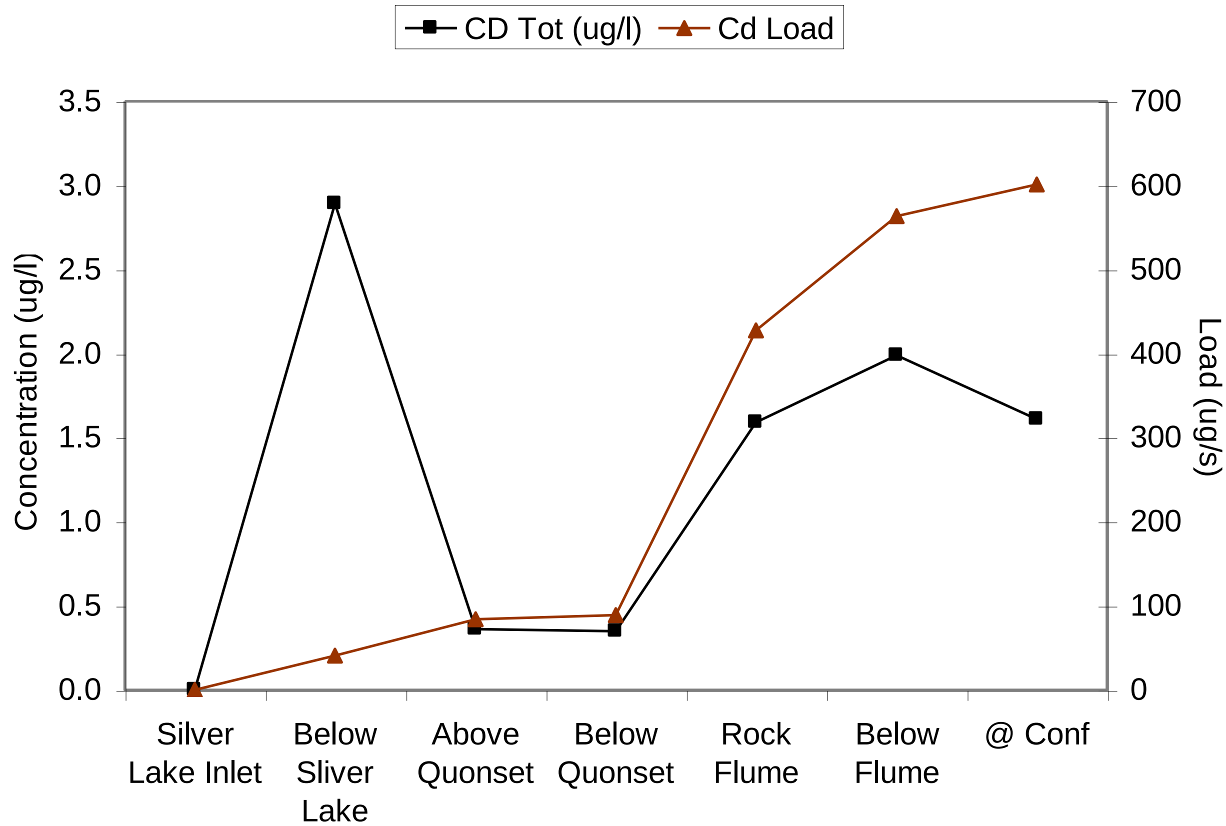


Figure 14. Concentration and estimated load of lead (upper graph) and zinc (lower graph).



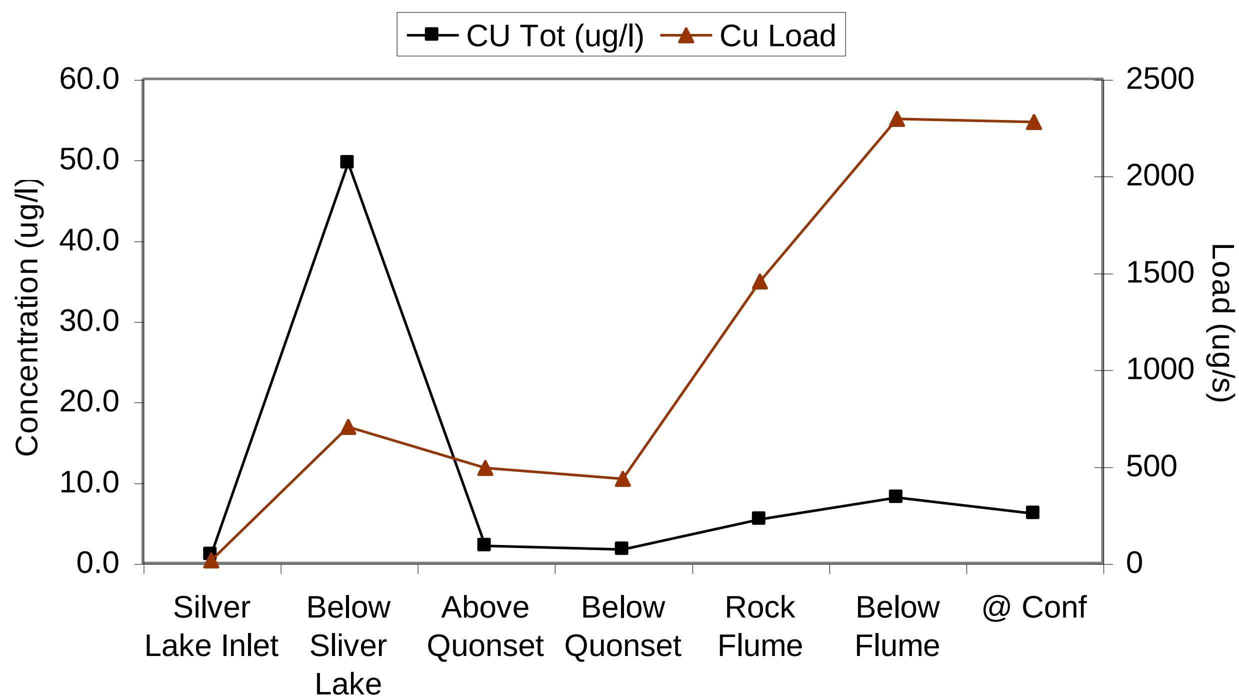


Figure 15. Concentration and estimated load of cadmium (upper graph) and copper (lower graph).

Reference

Lisa A. Courtney and William H. Clements. 2002. Assessing the influence of water and substratum quality on benthic macroinvertebrate communities in a metal-polluted stream: an experimental approach. Freshwater Biology (2002) 47, 1766–1778