

**Analysis of Metals in Stoneroller Minnows Collected
February 29 and March 1, 2000 from
the Bayou Creek System**

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DRAFT REPORT

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INTRODUCTION

This report presents the results for eight metals of concern (MOC, *i.e.* Ag, Be, Cd, Cr, Cu, Ni, Pb and Zn) analyzed in 5 stoneroller minnows (*Campostoma anomalum*) collected from Massac Creek, 55 from Big Bayou Creek, and 18 from Little Bayou Creek. Fish were collected from Massac Creek and Big Bayou Creek (BB1A-BB8) on February 29 and March 1, 2000. High waters did not allow for collections at station BB9 during this sampling event. However, stations BB9, LB2 and LB3 were sampled July 27, 2000. Sampling was conducted jointly by personnel from UK and the Division of Waste Management. The objectives were to: 1) use whole-body metal residues to identify sources, magnitude, and spatial distribution of bioavailable metals within the Bayou Creek system; 2) estimate downstream movement of metal contamination in Big Bayou Creek from upstream point-source discharges; and 3) identify stream sectors where metal stressors potentially may produce biological and/or ecological effects.

MATERIALS AND METHODS

Fish collection

Fish were collected by use of a back-pack shocker or by seining. Stoneroller minnows were placed in plastic bags, tagged, and placed on ice (4°C) for transport to the laboratory. Fish were then stored in the freezer (-15°C) until analyzed.

Fish Digestion

Stoneroller minnows selected for analysis were prepared according to modified procedures described by Shaw *et al.* (1998), Hogstrand *et al.* (1996), and U.S. EPA (1997). All chemicals used were ACS grade or better and all acids were TraceMetal grade. Stoneroller minnow samples were wet-weighed and placed in 50-mL Hot-Block® digestion tubes. The samples were digested with 3.0 mL TraceMetal grade HNO₃ per gram tissue and heated to 95° C for 10 min in the Hot-Block® digestion unit. The samples were allowed to cool to room temperature and 1.0 mL of 30% H₂O₂ per gram was added to each sample followed by heat-instilling until dry. The samples were then reconstituted with 5.0 mL of 0.5% HNO₃ and filtered through a Gelman Sciences Type A/E glass fiber filter to remove suspended particulates. The filters were rinsed with 0.5% HNO₃ prior to use and filtrates were taken to a final volume of 10 mL. Selected stonerollers were digested and analyzed with the gastrointestinal (g.i.) tract removed. The g.i. tracts removed from these specimens also were analyzed.

Metal Analyses

Analyses of stoneroller tissue samples were performed using a Varian AAS (Model Spectra AA-20) with flame or a graphite furnace equipped with a deuterium lamp for background corrections (U.S. EPA, 1997). All gases used were ultra-pure carrier grade. Calibration curves were based on five standards. The instrument was programmed to take three readings per sample and average the absorbance. Instrument blanks (0.5 % HNO₃) and check standards were processed with all samples. Sample

concentrations were then corrected for deviations from the standards, and fish wet weight was factored into the calculation of final values.

Bioavailable Metals

Body burden determinations ($\mu\text{g/g}$) obtained with the stoneroller minnow also were used to develop multipliers that were applied to total recoverable (TR) water column metal concentrations to calculate “bioavailable metal”. The formula for this conversion was as follows:

$$M_{BF} = M_{BB} / M_{RBB} * M_{TR}$$

Where

M_{BB} = Body Burden of Sentinel Organisms; M_{RBB} = Reference Body Burden;
 M_{TR} = Instream Total Recoverable Metal, and M_{BF} = Bioavailable Metal Fraction
(Birge *et al.*, 2000)

RESULTS

The weight of stoneroller minnows with gut removed; weight of the gut; and combined weights are given in Table 1. These results were necessary to determine proportional distributions of metals with and without the gut and these data also were used in evaluating metal body burden for assessing metal bioavailability in stream water. Mean values per station for whole body weight minus the gut ranged from 0.84 g to 4.43 g (Table 1). However, these values were ≥ 2.42 for most stations on Big Bayou Creek. Gut weight means per station varied from about 0.14 g to 0.46 g. Based on all of the raw data, the weight for the gut ranged from 3.33 to 15.47 percent of total body weight, with a mean percentage of 9.47 ± 3.58 . Mean percentage values per station varied from 6.1 to 13.9 % and this was due in part to differences in the size of minnows

collected at the different stations. Metal concentrations for stoneroller minnow whole body minus gut; for the gut; and for whole body plus gut are given in Table 2. Metal values and detection limits were much more variable among the gut assays. The lack of precision in metal detection was due primarily to the low weight of gut samples. Instrument method detection limits were constant for the different types of assays. Where direct comparisons were possible, concentrations for all metals most always were appreciably higher in the gut than in preparations of the whole body minus gut. Mean values for metal concentrations for whole body plus gut are summarized in Table 3. While typical trends that reveal higher metal body burden in effluent impacted stream sectors are evident for some metals (e.g. Ag), these trends were less precise or evident as compared with results obtained in assays where the gut was removed.

Based on these observations, it was determined that metal assays of whole body minus the gut would give more reliable data and greater analytical precision for assessing 1) tissue metal uptake and 2) estimating metal bioavailability. Metal concentrations in minnows with the gut removed are given in Table 4 for silver (Ag), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn).

Compared with values for minnows from the upstream “reference” areas (MC, BB1A, BB1), most metals, including Ag, Be, Cd, Pb and Ni, were detected at appreciably higher concentrations in minnows collected from the effluent receiving zone (BB3-BB6), as well as downstream stations BB7 and BB8. Cr, Cu, and Zn were elevated in stoneroller minnows taken from one or more stations in the effluent receiving zone but not at stations

BB7 and BB8. These relationships for the minnow, used as sentinel instream monitor of bioavailable metal, are evident in Table 5 that gives mean values per station.

As noted above, collections from station BB9 were not possible during the February/March collecting period. Therefore, minnows were collected in July for BB9 and from the Little Bayou Creek in areas where sediment metal loading had been observed (LB2, LB3). These results are summarized in Table 6. Metal whole body burden in the minnows was elevated as compared with those data given above. Ten minnows were analyzed from station BB9 and the results support the previous observations that metal pollution has affected the lower reaches of Big Bayou Creek. By comparison, values were particularly high for Ag. Metal contamination also was evident at stations LB2 and LB3 on Little Bayou Creek, especially for Cr.

Calculations of bioavailable metal fractions derived using the procedure given above, are shown in Table 8 and in Figures 1 through 8. The values used for total recoverable metal concentrations in the water column were averaged for three prior collections, including 10/1998, 9/1999, and 3/2000. These are given in Tables A-1 through A-3 in the Appendix. Based on these results, it is clear that both total recoverable and bioavailable metal concentrations are higher within and downstream of the effluent receiving zone for Ag, Be, Cu, Pb and Ni. Cadmium and zinc peaked at station BB7. Bioavailable Cr was elevated somewhat at BB2 – BB4 but decreased downstream.

Results obtained with the stoneroller minnow 1) support the use of sentinel monitoring with the stoneroller minnow; 2) show metal pollution in the effluent receiving zone of Big Bayou Creek; and 3) clearly demonstrate that toxic bioavailable metals have

extended down to the lower sectors of the creek. These findings underscore the need to do further, coordinated metal monitoring throughout the Bayou Creek System. In these studies water, sediment, and fish samples should be taken simultaneously for differing patterns of stream hydrology (e.g. low vs. high flow). It is likely that the Ohio River has received contaminants from the Bayou Creek System over an extended time period and that the Bayou Creek/Ohio River study proposed earlier should be undertaken.

Table 1. Results from the weights of whole body with gut removed, weight of gut, and combined weights for stoneroller minnows collected from Big Bayou Creek. Samples were collected February 29 and March 1, 2000.

Station	Date	Sample	Wt. of Whole Body - Gut (g)	Wt. of Gut (g)	Wt. of Body + Gut (g)	Percent gut out of Whole Body
MC	030100	SR1	0.709	0.113	0.822	13.75
MC	030100	SR2	0.836	0.152	0.988	15.38
MC	030100	SR3	1.090	0.150	1.240	12.10
MC	030100	SR4	1.462	0.172	1.634	10.53
MC	030100	SR5	0.652	0.094	0.746	12.60
		Mean	0.950	0.136	1.086	12.87
		±	0.332	0.032	0.360	1.82
BB1A	022900	SR1	1.168	0.125	1.293	9.67
BB1A	022900	SR2	2.451	0.224	2.675	8.37
BB1A	022900	SR3	1.544	0.060	1.604	3.74
BB1A	022900	SR4	2.156	0.245	2.401	10.20
BB1A	022900	SR5	0.938	0.096	1.034	9.28
		Mean	1.651	0.150	1.801	8.25
		±	1.271	0.143	1.412	2.33
BB1	022900	SR1	3.506	0.301	3.807	7.91
BB1	022900	SR2	2.937	0.311	3.248	9.58
BB1	022900	SR3	3.532	0.356	3.888	9.16
BB1	022900	SR4	1.255	0.102	1.357	7.52
BB1	022900	SR5	0.864	0.033	0.897	3.68
		Mean	2.419	0.221	2.639	7.57
		±	0.642	0.081	0.709	2.61
BB2	030100	SR1	5.777	0.689	6.466	10.66
BB2	030100	SR2	1.210	0.048	1.258	3.82
BB2	030100	SR3	2.078	0.052	2.130	2.44
BB2	030100	SR4	1.510	0.052	1.562	3.33
BB2	030100	SR5	1.543	0.202	1.745	11.58
		Mean	2.424	0.209	2.632	6.36
		±	1.901	0.276	2.166	4.38

Table 1, continued. Results from the weights of whole body with gut removed, weight of gut, and combined weights for stoneroller minnows collected from Big Bayou Creek. Samples were collected February 29 and March 1, 2000.

Station	Date	Sample	Wt. of Whole Body - Gut (g)	Wt. of Gut (g)	Wt. of Body + Gut (g)	Percent gut out of Whole Body
BB3	030100	SR1	0.803	0.094	0.897	10.48
BB3	030100	SR2	0.909	0.154	1.063	14.49
BB3	030100	SR3	0.644	0.080	0.724	11.05
BB3	030100	SR4	0.884	0.201	1.085	18.53
BB3	030100	SR5	0.968	0.169	1.137	14.86
		Mean	0.842	0.140	0.981	13.88
		±	0.125	0.051	0.170	3.26
BB4	030100	SR1	1.300	0.076	1.376	5.52
BB4	030100	SR2	2.736	0.180	2.916	6.17
BB4	030100	SR3	2.510	0.227	2.737	8.29
BB4	030100	SR4	1.703	0.127	1.830	6.94
BB4	030100	SR5	6.495	0.239	6.734	3.55
		Mean	2.949	0.170	3.119	6.10
		±	2.067	0.069	2.119	1.76
BB5	030100	SR1	1.251	0.229	1.480	15.47
BB5	030100	SR2	2.191	0.240	2.431	9.87
BB5	030100	SR3	0.794	0.065	0.859	7.57
BB5	030100	SR4	0.857	0.121	0.978	12.37
BB5	030100	SR5	1.758	0.270	2.028	13.31
		Mean	1.370	0.185	1.555	11.72
		±	0.599	0.088	0.673	3.07
BB6	030100	SR1	2.652	0.180	2.832	6.36
BB6	030100	SR2	2.726	0.202	2.928	6.90
BB6	030100	SR3	1.930	0.133	2.063	6.45
BB6	030100	SR4	2.380	0.207	2.587	8.00
BB6	030100	SR5	4.621	0.752	5.373	14.00
		Mean	2.862	0.295	3.157	8.34
		±	1.032	0.257	1.284	3.23

Table 1, continued. Results from the weights of whole body with gut removed, weight of gut, and combined weights for stoneroller minnows collected from Big Bayou Creek. Samples were collected February 29 and March 1, 2000.

Station	Date	Sample	Wt. of Whole Body - Gut (g)	Wt. of Gut (g)	Wt. of Body + Gut (g)	Percent gut out of Whole Body
BB7	022900	SR1	4.721	0.370	5.091	7.27
BB7	022900	SR2	4.096	0.626	4.722	13.26
BB7	022900	SR3	1.413	0.192	1.605	11.96
BB7	022900	SR4	6.356	0.536	6.892	7.78
BB7	022900	SR5	4.188	0.550	4.738	11.61
		Mean	4.155	0.455	4.610	10.37
		±	1.781	0.174	1.904	2.68
BB8	022900	SR1	7.144	0.874	8.018	10.90
BB8	022900	SR2	5.644	0.493	6.137	8.03
BB8	022900	SR3	3.607	0.335	3.942	8.50
BB8	022900	SR4	2.701	0.275	2.976	9.24
BB8	022900	SR5	3.070	0.317	3.387	9.36
		Mean	4.433	0.459	4.892	9.21
		±	1.894	0.246	2.131	1.09

Table 2. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date Sample	Ag Conc. (µg/Kg)			Be Conc. (µg/Kg)			Cd Conc. (µg/Kg)		
		Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
MC	030100 SR1	24.64	<106.20	24.64	<33.85	333.01	333.01	33.65	<212.39	33.65
MC	030100 SR2	16.00	<78.95	16.00	<28.71	227.41	227.41	<28.71	1362.29	1362.29
MC	030100 SR3	15.47	<80.00	15.47	<22.02	291.73	291.73	<22.02	1931.69	1931.69
MC	030100 SR4	13.14	<69.77	13.14	24.21	<139.54	24.21	<19.84	<139.54	N.D.
MC	030100 SR5	<18.41	<127.66	N.D.	<36.81	<255.32	N.D.	54.11	<255.32	54.11
BB1A	022900 SR1	17.48	<96.00	17.48	21.65	<192.00	21.65	<20.55	289.99	289.99
BB1A	022900 SR2	35.93	<53.57	35.93	27.60	<107.14	27.60	28.13	<107.14	28.13
BB1A	022900 SR3	21.01	<200.00	21.01	27.25	<400.00	27.25	<25.59	<400.00	N.D.
BB1A	022900 SR4	27.66	<48.98	27.66	25.69	240.66	266.34	49.59	118.94	168.53
BB1A	022900 SR5	18.70	<125.00	18.70	<25.59	<250.00	N.D.	<15.54	<250.00	N.D.
BB1	022900 SR1	30.19	<39.87	30.19	33.45	125.83	159.29	65.30	128.30	193.60
BB1	022900 SR2	32.07	47.33	79.40	33.57	160.41	193.98	38.28	615.54	653.81
BB1	022900 SR3	29.93	48.79	78.72	37.26	162.86	200.12	62.17	466.52	528.69
BB1	022900 SR4	16.67	<117.65	16.67	23.75	<235.29	23.75	<19.12	<235.29	N.D.
BB1	022900 SR5	27.98	<363.64	27.98	<27.78	<727.27	N.D.	<27.78	<727.27	N.D.
BB2	030100 SR1	46.39	89.20	135.60	25.95	458.52	484.47	19.76	159.21	178.97
BB2	030100 SR2	14.60	<250.00	14.60	21.83	<500.00	21.83	96.89	1836.13	1933.02
BB2	030100 SR3	25.92	<230.77	25.92	25.61	<461.54	25.61	48.67	2952.39	3001.06
BB2	030100 SR4	27.40	<230.77	27.40	26.49	<461.54	26.49	<15.89	<461.54	N.D.
BB2	030100 SR5	16.10	<59.41	16.10	25.80	135.65	161.45	<15.55	1213.92	1213.92

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date	Sample	Ag Conc. (µg/Kg)			Be Conc. (µg/Kg)			Cd Conc. (µg/Kg)		
			Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
BB3	030100	SR1	<18.06	<127.66	N.D.	<36.12	<255.32	N.D.	<36.11	1523.48	1523.48
BB3	030100	SR2	22.96	<77.92	22.96	<26.40	<155.84	N.D.	<26.40	542.20	542.20
BB3	030100	SR3	<18.63	<150.00	N.D.	<37.27	<300.00	N.D.	<37.27	542.27	542.27
BB3	030100	SR4	16.86	<59.70	16.86	<27.15	114.59	114.59	<27.15	169.42	169.42
BB3	030100	SR5	30.41	<71.01	30.41	<24.79	152.08	152.08	<24.79	172.51	172.51
BB4	030100	SR1	30.29	<157.90	30.29	23.18	<315.79	23.18	34.99	2304.74	2339.74
BB4	030100	SR2	61.61	101.25	162.86	42.43	<133.33	42.43	41.40	137.35	178.75
BB4	030100	SR3	55.18	<52.86	55.18	41.30	<105.73	41.30	41.80	105.83	147.63
BB4	030100	SR4	37.13	128.34	165.47	37.77	<188.98	37.77	13.77	<188.98	13.77
BB4	030100	SR5	80.28	<50.21	80.28	40.95	<100.42	40.95	23.57	171.76	195.33
BB5	030100	SR1	21.14	54.68	75.82	25.47	<104.80	25.47	<19.18	<104.80	N.D.
BB5	030100	SR2	51.59	50.10	101.69	37.17	136.78	173.95	36.27	168.10	204.38
BB5	030100	SR3	25.68	<184.62	25.68	<30.23	<369.23	N.D.	34.97	<369.23	34.97
BB5	030100	SR4	36.74	<99.17	36.74	<28.01	195.86	195.86	<28.00	<198.35	N.D.
BB5	030100	SR5	37.87	48.67	86.54	35.58	115.07	150.65	<13.65	113.98	113.98
BB6	030100	SR1	44.06	<66.67	44.06	50.63	132.92	183.56	142.43	1937.08	2079.51
BB6	030100	SR2	35.74	<59.41	35.74	50.34	119.05	169.40	186.22	6085.23	6271.46
BB6	030100	SR3	42.98	<90.22	42.98	47.75	<180.45	47.75	110.28	1272.54	1382.82
BB6	030100	SR4	53.41	<57.97	53.41	52.15	132.18	184.33	153.88	408.19	562.08
BB6	030100	SR5	38.07	25.65	63.71	42.39	126.45	168.84	22.46	238.94	261.40

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date Sample	Ag Conc. (µg/Kg)			Be Conc. (µg/Kg)			Cd Conc. (µg/Kg)		
		Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
BB7	022900 SR1	40.78	<32.43	40.78	43.97	<64.87	43.97	24.29	222.87	247.16
BB7	022900 SR2	29.45	<19.17	29.45	33.71	<38.34	33.71	100.28	2453.67	2553.96
BB7	022900 SR3	62.50	<62.50	62.50	29.95	199.60	229.55	83.96	852.76	936.72
BB7	022900 SR4	44.09	<22.39	44.09	35.80	56.07	91.88	122.81	102.67	225.48
BB7	022900 SR5	39.84	<26.36	39.84	36.80	101.63	138.43	92.57	221.75	314.31
BB8	022900 SR1	31.69	14.26	45.95	39.94	60.85	100.79	82.87	245.86	328.72
BB8	022900 SR2	36.61	76.23	112.84	45.74	116.72	162.46	27.88	316.36	344.24
BB8	022900 SR3	32.82	<43.13	32.82	41.04	<86.27	41.04	55.94	723.97	779.91
BB8	022900 SR4	38.81	<43.64	38.81	39.81	<87.27	39.81	48.30	904.70	953.00
BB8	022900 SR5	42.72	<37.86	42.72	36.39	<75.71	36.39	102.75	484.24	587.00

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date	Sample	Cr Conc. (µg/Kg)			Cu Conc. (µg/Kg)			Pb Conc. (µg/Kg)		
			Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
MC	030100	SR1	102.54	2825.70	2928.24	1793.4	2953.4	4746.7	151.90	2560.87	2712.77
MC	030100	SR2	72.15	2409.61	2481.76	1323.9	3182.8	4506.7	173.53	1956.69	2130.21
MC	030100	SR3	94.93	3074.78	3169.71	1004.9	4683.8	5688.7	228.06	2901.44	3129.50
MC	030100	SR4	59.56	954.16	1013.73	405.2	1478.2	1883.4	53.77	747.75	801.52
MC	030100	SR5	95.35	1872.50	1967.85	2198.8	2300.4	4499.2	128.52	1392.65	1521.17
BB1A	022900	SR1	46.24	2798.18	2844.41	2134.7	2857.6	4992.3	68.82	2613.07	2681.89
BB1A	022900	SR2	37.10	1308.03	1345.13	869.3	2076.4	2945.7	123.26	799.65	922.91
BB1A	022900	SR3	46.40	732.45	778.85	879.1	1594.2	2473.3	65.99	<2000.00	65.99
BB1A	022900	SR4	29.80	2007.20	2037.01	429.2	2088.8	2518.0	81.39	1476.56	1557.94
BB1A	022900	SR5	45.19	787.48	832.66	2136.5	1615.9	3752.4	109.20	<1250.00	109.20
BB1	022900	SR1	32.65	1230.68	1263.33	261.3	1448.1	1709.4	160.48	1010.98	1171.47
BB1	022900	SR2	27.17	2120.51	2147.68	525.7	1460.2	1985.9	139.35	1115.09	1254.45
BB1	022900	SR3	29.27	1793.84	1823.12	342.4	1434.2	1776.6	182.05	1222.51	1404.57
BB1	022900	SR4	46.10	1858.65	1904.75	859.5	2097.2	2956.7	73.07	1400.29	1473.36
BB1	022900	SR5	65.57	841.81	907.39	2449.1	13287.4	15736.5	370.60	<3636.36	370.60
BB2	030100	SR1	17.73	4070.90	4088.62	412.0	3949.1	4361.1	170.58	859.78	1030.36
BB2	030100	SR2	52.69	1347.25	1399.94	437.5	3768.1	4205.6	253.83	<2500.00	253.83
BB2	030100	SR3	38.42	875.78	914.20	161.1	3070.2	3231.3	80.08	<2307.69	80.08
BB2	030100	SR4	49.44	880.16	929.60	1132.9	2796.0	3928.9	94.77	<2307.69	94.77
BB2	030100	SR5	43.56	2131.62	2175.18	1048.2	2429.9	3478.1	59.15	1866.22	1925.37

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date Sample	Cr Conc. (µg/Kg)			Cu Conc. (µg/Kg)			Pb Conc. (µg/Kg)		
		Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
BB3	030100 SR1	64.09	2304.85	2368.93	2325.4	3476.9	5802.3	294.87	1724.41	2019.28
BB3	030100 SR2	64.18	1657.14	1721.33	3178.6	2173.8	5352.4	213.80	1281.02	1494.82
BB3	030100 SR3	71.93	1825.93	1897.86	3977.2	2877.9	6855.1	200.77	<1500.00	200.77
BB3	030100 SR4	85.18	1925.57	2010.75	1582.2	2305.9	3888.1	191.05	1112.76	1303.81
BB3	030100 SR5	176.66	2515.23	2691.90	2370.5	4001.8	6372.3	205.36	2111.59	2316.95
BB4	030100 SR1	439.14	818.99	1258.13	3700.9	16333.9	20034.8	470.86	<1578.95	470.86
BB4	030100 SR2	34.34	1111.43	1145.77	1833.9	9011.5	10845.4	124.38	879.58	1003.96
BB4	030100 SR3	70.69	989.75	1060.44	1793.7	6598.8	8392.5	139.92	653.18	793.10
BB4	030100 SR4	48.59	3582.09	3630.68	3785.4	19809.9	23595.3	66.83	2997.90	3064.73
BB4	030100 SR5	20.93	156.02	176.96	2277.2	3029.9	5307.1	162.89	<502.09	162.89
BB5	030100 SR1	50.40	4999.03	5049.43	1458.1	5382.3	6840.4	36.13	1246.31	1282.45
BB5	030100 SR2	45.79	2464.60	2510.39	3248.0	24203.4	27451.3	77.12	1410.81	1487.93
BB5	030100 SR3	81.69	3343.86	3425.55	2740.4	12516.3	15256.7	340.81	4031.60	4372.41
BB5	030100 SR4	61.23	3256.05	3317.28	2673.5	8471.8	11145.3	355.47	3398.70	3754.18
BB5	030100 SR5	63.84	1612.59	1676.43	1175.1	8226.0	9401.1	50.81	1340.54	1391.35
BB6	030100 SR1	20.54	1936.40	1956.94	1692.7	22333.3	24026.1	308.76	774.64	1083.40
BB6	030100 SR2	15.83	1748.32	1764.15	669.3	5297.2	5966.5	328.86	868.14	1197.00
BB6	030100 SR3	19.92	1346.23	1366.15	1142.3	21203.0	22345.3	281.99	<902.26	281.99
BB6	030100 SR4	20.04	4163.10	4183.13	1880.4	14041.0	15921.4	289.67	1076.53	1366.20
BB6	030100 SR5	23.28	3752.42	3775.70	604.9	5880.0	6484.9	302.96	663.29	966.26

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date Sample	Cr Conc. ($\mu\text{g}/\text{Kg}$)			Cu Conc. ($\mu\text{g}/\text{Kg}$)			Pb Conc. ($\mu\text{g}/\text{Kg}$)		
		Body	Gut	Body+gut	Body	Gut	Body+gut	Body	Gut	Body+gut
BB7	022900 SR1	18.90	1388.04	1406.94	1060.2	8249.0	9309.2	282.59	458.22	740.81
BB7	022900 SR2	18.56	629.05	647.61	436.2	3894.9	4331.1	271.14	789.26	1060.40
BB7	022900 SR3	<16.99	7766.27	7766.27	3774.5	18038.4	21812.9	223.14	3295.56	3518.70
BB7	022900 SR4	19.33	2143.42	2162.75	1004.1	7093.5	8097.6	296.77	963.20	1259.97
BB7	022900 SR5	23.18	3503.71	3526.89	592.2	9012.2	9604.4	316.31	787.23	1103.54
BB8	022900 SR1	16.92	2474.17	2491.09	1056.3	6803.6	7859.9	216.90	1060.89	1277.78
BB8	022900 SR2	18.59	3937.73	3956.32	703.5	7244.6	7948.1	234.29	1333.41	1567.70
BB8	022900 SR3	10.53	366.55	377.08	424.3	6961.6	7385.8	245.63	430.41	676.04
BB8	022900 SR4	11.68	1415.17	1426.85	743.3	6073.5	6816.7	240.82	795.21	1036.04
BB8	022900 SR5	11.10	1779.42	1790.53	551.8	11605.8	12157.6	239.64	809.77	1049.41

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date	Sample	Ni Conc. ($\mu\text{g}/\text{Kg}$)			Zn Conc. ($\mu\text{g}/\text{Kg}$)		
			Body	Gut	Body+gut	Body	Gut	Body+gut
MC	30100	SR1	<1015.51	1588.53	1588.53	29883.0	49778.8	79661.8
MC	30100	SR2	<861.24	1520.23	1520.23	35053.4	49506.6	84560.0
MC	30100	SR3	<660.55	2102.48	2102.48	38048.2	61583.3	99631.6
MC	30100	SR4	715.62	<697.67	715.62	27408.9	32703.5	60112.4
MC	30100	SR5	<1104.29	<1276.60	N.D.	46279.7	49601.1	95880.8
BB1	22900	SR1	950.23	767.69	1717.92	15111.6	26578.1	41689.6
BB1	22900	SR2	801.97	1680.53	2482.50	18424.7	33078.8	51503.4
BB1	22900	SR3	858.65	1571.18	2429.82	19615.8	32092.7	51708.5
BB1	22900	SR4	<573.71	<1176.47	N.D.	39509.9	50367.6	89877.5
BB1	22900	SR5	<833.33	<3636.36	N.D.	56079.7	101136.4	157216.0
BB1A	22900	SR1	<616.44	4604.27	4604.27	43809.8	60200.0	104009.8
BB1A	22900	SR2	769.79	1622.75	2392.54	23094.2	37834.8	60929.0
BB1A	22900	SR3	657.39	<2000.00	657.39	34020.9	72916.7	106937.6
BB1A	22900	SR4	705.22	6210.42	6915.65	39906.2	43520.4	83426.6
BB1A	22900	SR5	<466.32	<1250.00	N.D.	25563.2	51562.5	77125.7
BB2	30100	SR1	691.46	16157.20	16848.65	17558.2	24873.0	42431.2
BB2	30100	SR2	776.27	<2500.00	776.27	27158.7	97135.4	124294.1
BB2	30100	SR3	672.61	<2307.69	672.61	30944.1	113461.5	144405.7
BB2	30100	SR4	997.62	<2307.69	997.62	42335.9	82451.9	124787.9
BB2	30100	SR5	590.47	4683.26	5273.73	23341.3	41027.2	64368.6

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date	Sample	Ni Conc. ($\mu\text{g}/\text{Kg}$)			Zn Conc. ($\mu\text{g}/\text{Kg}$)		
			Body	Gut	Body+gut	Body	Gut	Body+gut
BB3	30100	SR1	<1083.44	<1276.60	N.D.	47397.0	62766.0	110163.0
BB3	30100	SR2	<792.08	<779.22	N.D.	38036.4	44561.7	82598.1
BB3	30100	SR3	<1118.01	<1500.00	N.D.	42014.9	63125.0	105139.9
BB3	30100	SR4	<814.48	720.37	720.37	41770.4	37437.8	79208.2
BB3	30100	SR5	<743.80	1789.82	1789.82	30235.2	40606.5	70841.7
BB4	30100	SR1	608.93	<1578.95	608.93	45986.0	81414.5	127400.5
BB4	30100	SR2	1403.76	<666.67	1403.76	28468.9	41805.6	70274.5
BB4	30100	SR3	1321.03	<528.63	1321.03	39290.1	45319.4	84609.5
BB4	30100	SR4	1028.64	1296.28	2324.93	42918.9	53248.0	96166.9
BB4	30100	SR5	831.41	<502.09	831.41	31811.9	32269.9	64081.8
BB5	30100	SR1	728.16	4898.18	5626.35	53646.0	40010.2	93656.1
BB5	30100	SR2	1236.57	2578.95	3815.52	41990.0	45440.9	87430.8
BB5	30100	SR3	<906.80	<1846.15	N.D.	49445.8	84538.3	133984.1
BB5	30100	SR4	<840.14	2254.89	2254.89	41215.1	57536.6	98751.6
BB5	30100	SR5	1157.68	1600.00	2757.68	42978.1	41059.9	84038.0
BB6	30100	SR1	1760.95	<666.67	1760.95	18209.9	45825.0	64034.9
BB6	30100	SR2	1716.56	1551.83	3268.39	18467.2	42203.2	60670.4
BB6	30100	SR3	1454.78	948.29	2403.07	20972.4	67533.6	88506.0
BB6	30100	SR4	1890.76	2289.26	4180.02	28653.4	40719.1	69372.5
BB6	30100	SR5	405.11	2388.73	2793.84	14060.9	29116.7	43177.7

Table 2, continued. Metal concentrations in whole body and gut from stoneroller minnows from Big Bayou Creek collected February 28 and March 1, 2000.

Station	Date	Sample	Ni Conc. ($\mu\text{g}/\text{Kg}$)			Zn Conc. ($\mu\text{g}/\text{Kg}$)		
			Body	Gut	Body+gut	Body	Gut	Body+gut
BB7	22900	SR1	457.53	969.66	1427.19	27212.6	34414.8	61627.4
BB7	22900	SR2	850.64	580.36	1430.99	15027.6	32057.7	47085.3
BB7	22900	SR3	1459.66	3394.50	4854.16	44760.8	56300.1	101060.9
BB7	22900	SR4	663.92	774.34	1438.26	16288.5	25977.3	42265.8
BB7	22900	SR5	521.55	1446.37	1967.93	17259.4	30590.3	47849.7
BB8	22900	SR1	775.38	1145.00	1920.39	40115.9	25162.5	65278.4
BB8	22900	SR2	561.40	1516.27	2077.67	15208.2	26755.3	41963.6
BB8	22900	SR3	1509.46	<431.34	1509.46	14246.8	28957.9	43204.7
BB8	22900	SR4	1612.06	546.91	2158.97	24252.5	33973.4	58225.9
BB8	22900	SR5	1341.48	572.03	1913.51	17566.6	34099.7	51666.3

Table 3. Mean metal concentrations \pm standard deviations in stoneroller minnows from Big Bayou Creek, collected February 28 and March 1, 2000¹.

Station	Wt. of body - gut (g)	Wt. of gut (g)	Wt. of body + gut (g)	Avg. % gut out of whole Body	Avg. whole body plus gut concentration ($\mu\text{g}/\text{Kg}$) per station ²							
					Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
MC	0.950 (0.332)	0.136 (0.032)	1.086 (0.360)	12.87 (1.82)	17.31 (5.04)	219.09 (136.99)	845.43 (954.34)	2312.26 (858.51)	4264.9 (1418.1)	2059.03 (928.57)	1481.71 (573.04)	83969.3 (15614.5)
BB1A	1.651 (0.642)	0.150 (0.081)	1.801 (0.709)	8.25 (2.61)	46.59 (30.08)	115.43 (96.17)	458.70 (237.96)	1609.25 (508.73)	4833.0 (6115.8)	1134.89 (443.58)	2210.08 (427.04)	78399.0 (47768.2)
BB1	2.419 (1.271)	0.221 (0.143)	2.639 (1.412)	7.57 (2.33)	24.15 (7.67)	68.57 (111.13)	162.22 (131.04)	1567.61 (874.98)	3336.3 (1058.6)	1067.59 (1094.19)	3642.46 (2714.88)	86485.7 (19206.0)
BB2	2.424 (1.901)	0.209 (0.276)	2.632 (2.166)	6.36 (4.38)	43.92 (51.56)	143.97 (199.36)	1581.74 (1188.97)	1901.51 (1325.64)	3841.0 (478.2)	676.88 (799.63)	4913.78 (6946.47)	100057.5 (44046.1)
BB3	0.842 (0.125)	0.140 (0.051)	0.981 (0.170)	13.88 (3.26)	23.41 (6.79)	133.34 (26.52)	589.98 (553.88)	2138.15 (389.75)	5654.0 (1139.1)	1467.13 (815.20)	1255.09 (756.22)	89590.2 (17126.1)
BB4	2.949 (2.067)	0.170 (0.069)	3.119 (2.119)	6.10 (1.76)	98.82 (62.22)	37.13 (7.98)	575.04 (989.08)	1454.39 (1290.06)	13635.0 (7822.8)	1099.11 (1144.28)	1298.01 (663.10)	88506.6 (25077.8)

¹ Standard deviations given parenthetically.

² Whole body metal concentrations including gut.

Table 3, continued. Mean metal concentrations \pm standard deviations in stoneroller minnows from Big Bayou Creek, collected February 28 and March 1, 2000¹.

Station	Wt. of body - gut (g)	Wt. of gut (g)	Wt. of body + gut (g)	Avg. % gut out of whole Body	Avg. whole body plus gut concentration ($\mu\text{g}/\text{Kg}$) per station ²							
					Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB5	1.370 (0.599)	0.185 (0.088)	1.555 (0.673)	11.72 (3.07)	65.29 (32.68)	136.48 (76.27)	117.78 (84.77)	3195.82 (1253.17)	14019.0 (8109.8)	2457.66 (1483.72)	3613.61 (1491.15)	99572.1 (20053.5)
BB6	2.862 (1.032)	0.295 (0.257)	3.157 (1.284)	8.34 (3.23)	47.98 (10.81)	150.78 (58.07)	2111.45 (2432.12)	2609.22 (1276.98)	14948.8 (8520.1)	978.97 (416.63)	2881.25 (912.15)	65152.3 (16335.7)
BB7	4.155 (1.781)	0.455 (0.174)	4.610 (1.904)	10.37 (2.68)	43.33 (12.03)	107.51 (79.97)	855.52 (993.89)	3102.09 (2815.82)	10631.0 (6594.4)	1536.69 (1123.92)	2223.71 (1488.66)	59977.8 (24070.6)
BB8	4.433 (1.894)	0.459 (0.246)	4.892 (2.131)	9.21 (1.09)	54.63 (32.91)	76.10 (55.20)	488.10 (371.82)	2008.37 (1329.87)	8433.6 (2129.8)	1121.39 (329.57)	1916.00 (250.24)	52067.8 (9915.3)

¹ Standard deviations given parenthetically.

² Whole body metal concentrations including gut.

Table 4. Metal concentrations in Stoneroller minnows (Gut removed) from Big Bayou Creek collected February 29 and March 1, 2000.

Sample Number	Whole Body - Gut Wt. (g)	Metal Concentrations ($\mu\text{g}/\text{Kg}$)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
MC-030100-SR1	0.709	24.64	<33.85	33.65	102.54	1793.36	151.90	<1015.51	29883.0
MC-030100-SR2	0.836	16.00	<28.71	<28.71	72.15	1323.93	173.53	<861.24	35053.4
MC-030100-SR3	1.090	15.47	<22.02	<22.02	94.93	1004.88	228.06	<660.55	38048.2
MC-030100-SR4	1.462	13.14	24.21	<19.84	59.56	405.16	53.77	715.62	27408.9
MC-030100-SR5	0.652	<18.41	<36.81	54.11	95.35	2198.80	128.52	<1104.29	46279.7
BB1A-022900-SR1	1.168	17.48	21.65	<20.55	46.24	2134.70	68.82	<616.44	43809.8
BB1A-022900-SR2	2.451	35.93	27.60	28.13	37.10	869.31	123.26	769.79	23094.2
BB1A-022900-SR3	1.544	21.01	27.25	<25.59	46.40	879.10	65.99	657.39	34020.9
BB1A-022900-SR4	2.156	27.66	25.69	49.59	29.80	429.19	81.39	705.22	39906.2
BB1A-022900-SR5	0.938	18.70	<25.59	<15.54	45.19	2136.46	109.20	<466.32	25563.2
BB1-022900-SR1	3.506	30.19	33.45	65.30	32.65	261.27	160.48	950.23	15111.6
BB1-022900-SR2	2.937	32.07	33.57	38.28	27.17	525.71	139.35	801.97	18424.7
BB1-022900-SR3	3.532	29.93	37.26	62.17	29.27	342.39	182.05	858.65	19615.8
BB1-022900-SR4	1.255	16.67	23.75	<19.12	46.10	859.50	73.07	<573.71	39509.9
BB1-022900-SR5	0.864	27.98	<27.78	<27.78	65.57	2449.07	370.60	<833.33	56079.7
BB2-030100-SR1	5.777	46.39	25.95	19.76	17.73	411.98	170.58	691.46	17558.2
BB2-030100-SR2	1.210	14.60	21.83	96.89	52.69	437.47	253.83	776.27	27158.7
BB2-030100-SR3	2.078	25.92	25.61	48.67	38.42	161.05	80.08	672.61	30944.1
BB2-030100-SR4	1.510	27.40	26.49	<15.89	49.44	1132.89	94.77	997.62	42335.9
BB2-030100-SR5	1.543	16.10	25.80	<15.55	43.56	1048.17	59.15	590.47	23341.3

Table 4, continued. Metal concentrations in Stoneroller minnows (Gut removed) from Big Bayou Creek collected February 29 and March 1, 2000.

Sample Number	Whole Body - Gut Wt. (g)	Metal Concentrations ($\mu\text{g}/\text{Kg}$)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB3-030100-SR1	0.803	<18.06	<36.12	<36.11	64.09	2325.38	294.87	<1083.44	47397.0
BB3-030100-SR2	0.909	22.96	<26.40	<26.40	64.18	3178.58	213.80	<792.08	38036.4
BB3-030100-SR3	0.644	<18.63	<37.27	<37.27	71.93	3977.23	200.77	<1118.01	42014.9
BB3-030100-SR4	0.884	16.86	<27.15	<27.15	85.18	1582.20	191.05	<814.48	41770.4
BB3-030100-SR5	0.968	30.41	<24.79	<24.79	176.66	2370.52	205.36	<743.80	30235.2
BB4-030100-SR1	1.300	30.29	23.18	34.99	439.14	3700.89	470.86	608.93	45986.0
BB4-030100-SR2	2.736	61.61	42.43	41.40	34.34	1833.95	124.38	1403.76	28468.9
BB4-030100-SR3	2.510	55.18	41.30	41.80	70.69	1793.65	139.92	1321.03	39290.1
BB4-030100-SR4	1.703	37.13	37.77	13.77	48.59	3785.39	66.83	1028.64	42918.9
BB4-030100-SR5	6.495	80.28	40.95	23.57	20.93	2277.24	162.89	831.41	31811.9
BB5-030100-SR1	1.251	21.14	25.47	<19.18	50.40	1458.13	36.13	728.16	53646.0
BB5-030100-SR2	2.191	51.59	37.17	36.27	45.79	3247.96	77.12	1236.57	41990.0
BB5-030100-SR3	0.794	25.68	<30.23	34.97	81.69	2740.41	340.81	<906.80	49445.8
BB5-030100-SR4	0.857	36.74	<28.01	<28.00	61.23	2673.48	355.47	<840.14	41215.1
BB5-030100-SR5	1.758	37.87	35.58	<13.65	63.84	1175.13	50.81	1157.68	42978.1
BB6-030100-SR1	2.652	44.06	50.63	142.43	20.54	1692.72	308.76	1760.95	18209.9
BB6-030100-SR2	2.726	35.74	50.34	186.22	15.83	669.31	328.86	1716.56	18467.2
BB6-030100-SR3	1.930	43.62	43.24	46.41	<218.05	863.99	179.72	1500.55	25470.7
BB6-030100-SR4	2.380	53.41	52.15	153.88	20.04	1880.44	289.67	1890.76	28653.4
BB6-030100-SR5	4.621	38.07	42.39	22.46	23.28	604.95	302.96	405.11	14060.9

Table 4, continued. Metal concentrations in Stoneroller minnows (Gut removed) from Big Bayou Creek collected February 29 and March 1, 2000.

Sample Number	Whole Body - Gut Wt. (g)	Metal Concentrations ($\mu\text{g}/\text{Kg}$)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB7-022900-SR1	4.721	40.78	43.97	24.29	18.90	1060.23	282.59	457.53	27212.6
BB7-022900-SR2	4.096	29.45	33.71	100.28	18.56	436.20	271.14	850.64	15027.6
BB7-022900-SR3	1.413	62.50	29.95	83.96	<16.99	3774.48	223.14	1459.66	44760.8
BB7-022900-SR4	6.356	44.09	35.80	122.81	19.33	1004.13	296.77	663.92	16288.5
BB7-022900-SR5	4.188	39.84	36.80	92.57	23.18	592.17	316.31	521.55	17259.4
BB8-022900-SR1	7.144	31.69	39.94	82.87	16.92	1056.33	216.90	775.38	40115.9
BB8-022900-SR2	5.644	36.61	45.74	27.88	18.59	703.52	234.29	561.40	15208.2
BB8-022900-SR3	3.607	32.82	41.04	55.94	10.53	424.27	245.63	1509.46	14246.8
BB8-022900-SR4	2.701	38.81	39.81	48.30	11.68	743.25	240.82	1612.06	24252.5
BB8-022900-SR5	3.070	42.72	36.39	102.75	11.10	551.83	239.64	1341.48	17566.6

Table 5. Mean metal concentrations \pm standard deviation in Stoneroller minnows (gut removed) from Big Bayou Creek collected February 29 and March 1, 2000¹.

Station	Avg. Whole Body - Gut Wt. (g)	Avg. Metal Concentrations ($\mu\text{g}/\text{Kg}$)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
MC	0.950	17.31 (5.04)	24.21 (0.00)	43.88 (14.47)	84.90 (18.20)	1345.23 (694.52)	147.16 (63.90)	715.62 (0.00)	35334.7 (7412.4)
BB1	2.419	27.37 (6.15)	32.01 (5.78)	55.25 (14.78)	40.15 (16.01)	887.59 (902.70)	185.11 (111.43)	870.28 (74.81)	29748.3 (17562.4)
BB1A	1.651	24.15 (7.67)	25.55 (2.73)	38.86 (15.17)	40.95 (7.32)	1289.75 (793.23)	89.73 (25.37)	710.80 (56.41)	33278.8 (8925.1)
BB2	2.424	26.08 (12.71)	25.14 (1.88)	55.11 (38.97)	40.37 (13.79)	638.31 (427.77)	131.68 (80.19)	745.68 (155.55)	28267.7 (9290.7)
BB3	0.842	23.41 (6.79)	<30.35 (---)	<30.34 (---)	92.41 (47.88)	2686.78 (916.22)	221.17 (42.01)	<910.36 (---)	39890.8 (6345.4)
BB4	2.949	52.90 (19.94)	37.13 (7.98)	31.11 (12.17)	122.74 (177.83)	2678.22 (990.92)	192.97 (159.34)	1038.75 (331.95)	37695.2 (7387.6)
BB5	1.370	34.60 (11.88)	32.74 (6.34)	35.62 (0.92)	60.59 (13.96)	2259.02 (894.11)	172.07 (161.48)	1040.81 (273.61)	45855.0 (5439.1)

¹ Standard deviations given parenthetically.

Table 5, continued. Mean metal concentrations \pm standard deviation in Stoneroller minnows (gut removed) from Big Bayou Creek collected February 29 and March 1, 2000¹.

Station	Avg. Whole Body - Gut Wt. (g)	Avg. Metal Concentrations ($\mu\text{g}/\text{Kg}$)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB6	2.862	42.98 (6.84)	47.75 (4.57)	110.28 (71.58)	19.92 (3.08)	1142.28 (599.53)	281.99 (58.89)	1454.78 (603.38)	20972.4 (5935.3)
BB7	4.155	43.33 (12.03)	36.05 (5.15)	84.78 (36.77)	19.99 (2.15)	1373.44 (1368.24)	277.99 (34.99)	790.66 (403.30)	24109.8 (12516.8)
BB8	4.433	36.53 (4.49)	40.58 (3.37)	63.55 (29.47)	13.77 (3.71)	695.84 (238.09)	235.46 (11.13)	1159.96 (465.21)	22278.0 (10709.5)

¹ Standard deviations given parenthetically.

Table 6. Mean metal concentrations in whole-body stoneroller minnows from station BB9 of Big Bayou Creek collected July 25-27, 2000.¹

Sample Number	Whole Body Wt. (g)	Metal Concentrations (µg/Kg)							
		Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB9-072500-SR1	0.606	43.32	46.36	60.75	379.37	1717.59	114.43	1043.76	31402.6
BB9-072500-SR2	0.762	154.29	30.95	102.44	288.75	1275.65	136.63	1002.92	38950.1
BB9-072500-SR3	0.861	99.10	46.26	60.65	621.71	1925.74	136.73	1541.03	35307.8
BB9-072500-SR4	2.460	36.02	26.59	47.55	12083.53	1095.38	210.95	786.18	49654.5
BB9-072500-SR5	0.361	34.19	<27.70	112.32	293.14	2398.64	284.17	866.54	20387.8
BB9-072500-SR6	0.982	45.16	15.92	34.71	415.24	1027.59	178.82	674.97	33645.6
BB9-072500-SR7	1.238	182.17	14.71	62.33	461.13	934.43	156.45	929.95	42665.6
BB9-072500-SR8	0.817	204.85	12.91	37.33	82.00	831.76	310.25	794.02	45140.8
BB9-072500-SR9	0.767	19.91	30.77	49.02	875.94	1579.35	187.46	1191.79	37575.0
BB9-072500-SR10	1.745	37.17	19.23	21.85	362.20	950.77	180.36	1012.42	34464.2
Average	1.060	85.62	27.08	58.89	1586.30	1373.69	189.63	984.36	36919.4
Std. Dev.	0.618	69.63	12.79	28.71	3694.41	515.13	63.69	246.22	8099.5

¹ Whole body weight included gut intact.

Table 7. Metal concentrations in whole-body stoneroller minnows from Little Big Bayou Creek collected July 25-27, 2000.¹

Sample Number	Whole Body Wt. (g)	Metal Concentrations (µg/Kg)							
		Ag	Be	Cd	Cr	Cu	Ni	Pb	Zn
LB2-072700-SR1	3.833	17.97	31.36	50.42	4194.54	3553.93	296.72	983.36	80879.2
LB2-072700-SR2	3.517	19.03	26.00	38.96	2826.77	3013.93	262.28	867.58	69764.0
LB2-072700-SR3	3.686	21.80	25.99	30.46	2755.95	2256.96	184.03	1024.90	67506.8
LB2-072700-SR5	3.698	19.44	29.54	22.52	3020.10	2899.78	159.07	1150.34	69186.0
LB2-072700-SR6	3.971	16.50	26.45	25.01	2947.11	2979.04	185.32	987.32	65066.7
LB2-072700-SR7	6.192	17.41	25.65	59.18	2296.16	1968.91	252.86	817.75	58251.0
LB2-072700-SR8	3.688	16.34	27.11	32.12	2131.61	1846.13	198.19	753.19	61469.6
LB2-072700-SR9	4.495	16.46	30.29	68.62	1189.44	582.21	313.80	1062.91	28691.9
LB2-072700-SR10	4.412	19.17	26.28	65.30	1808.75	1745.72	300.69	935.40	43585.7
LB2-072700-SR11	6.736	26.05	30.94	118.69	2069.57	2991.23	209.50	1237.13	50858.1
Average	4.423	19.02	27.96	51.13	2524.00	2383.78	236.25	981.99	59525.9
Std. Dev.	1.129	3.00	2.29	29.01	821.00	874.71	55.99	147.74	15032.8

¹ Whole body weight included gut intact.

Table 7, continued. Metal concentrations in whole-body stoneroller minnows from Little Big Bayou Creek collected July 25-27, 2000.¹

Sample Number	Whole Body Wt. (g)	Metal Concentrations (µg/Kg)							
		Ag	Be	Cd	Cr	Cu	Ni	Pb	Zn
LB3-072700-SR1	5.647	70.94	35.52	44.30	2434.49	1353.72	227.72	903.59	46931.1
LB3-072700-SR2	8.137	52.50	40.89	58.97	3192.89	1579.62	244.68	1106.06	52573.2
LB3-072700-SR3	13.437	15.74	17.51	66.64	978.32	456.45	179.06	1009.46	30520.2
LB3-072700-SR4	12.883	17.69	22.27	79.97	1673.01	1271.27	100.87	783.18	33703.3
LB3-072700-SR5	6.095	25.14	34.60	62.95	2472.18	1403.70	296.07	797.21	50316.7
LB3-072700-SR6	6.769	16.91	30.51	72.26	1942.03	1073.52	298.57	727.30	47040.9
LB3-072700-SR7	9.430	12.75	31.67	46.58	2683.03	1279.60	208.66	932.65	35250.3
Average	8.914	30.24	30.42	61.67	2196.57	1202.55	222.23	894.21	42333.7
Std. Dev.	3.170	22.47	8.04	12.97	728.57	362.74	69.03	134.98	8907.7

¹ Whole body weight included gut intact.

Table 8. Results from the calculations of bioavailable metals in stoneroller minnows from Big Bayou Creek collected in February 28 - March 1, 2000.

Metal	Sampling Station	Body Burden (BB) (µg/Kg)	Reference BB (M_{RBB})	Total Recoverable ¹ (µg/L)	Bioavailable Fraction (µg/L)
Ag	MC	17.31	52.90	0.25	0.08
	BB1A	24.15		0.25	0.11
	BB1	27.37		0.25	0.13
	BB2	26.08		0.25	0.12
	BB3	23.41		0.25	0.11
	BB4	52.90		0.25	0.25
	BB5	34.60		0.41	0.27
	BB6	42.98		0.77	0.62
	BB7	43.33		0.51	0.42
	BB8	36.53	0.48	0.33	
Be	MC	24.21	47.75	0.10	0.05
	BB1A	25.55		0.27	0.14
	BB1	32.01		0.23	0.15
	BB2	25.14		0.24	0.13
	BB3	<30.35		0.44	N.D.
	BB4	37.13		0.57	0.44
	BB5	32.74		0.54	0.37
	BB6	47.75		0.47	0.47
	BB7	36.05		0.47	0.35
	BB8	40.58	0.44	0.37	
Cd	MC	43.88	110.28	0.25	0.10
	BB1A	38.86		0.45	0.16
	BB1	55.25		0.25	0.13
	BB2	55.11		0.27	0.13
	BB3	<30.34		0.25	N.D.
	BB4	31.11		0.25	0.07
	BB5	35.62		0.25	0.08
	BB6	110.28		0.37	0.37
	BB7	84.78		5.39	4.14
	BB8	63.55	0.22	0.13	

¹ Total recoverable numbers based on the average of three dates of collection (October 20, 1998, September 9, 1999, and March 1, 2000).

Table 8, continued. Results from the calculations of bioavailable metals in stoneroller minnows from Big Bayou Creek collected in February 28 – March 1, 2000.

Metal	Sampling Station	Body Burden (BB) (µg/Kg)	Reference BB (M _{RBB})	Total Recoverable ¹ (µg/L)	Bioavailable Fraction (µg/L)
Cr	MC	84.91	122.74	1.00	0.69
	BB1A	40.95		1.08	0.36
	BB1	40.15		1.00	0.33
	BB2	40.37		5.36	1.76
	BB3	92.41		1.79	1.35
	BB4	122.74		1.00	1.00
	BB5	60.59		0.76	0.37
	BB6	19.92		1.39	0.23
	BB7	19.99		1.52	0.25
	BB8	13.77	1.31	0.15	
Cu	MC	1345.23	2678.22	1.00	0.50
	BB1A	1289.75		1.47	0.40
	BB1	887.59		1.22	0.71
	BB2	638.31		2.55	0.61
	BB3	2686.78		1.19	1.20
	BB4	2678.22		1.56	1.56
	BB5	2259.02		2.75	2.32
	BB6	1142.28		3.23	1.38
	BB7	1373.44		5.37	2.75
	BB8	695.84	2.29	0.60	
Pb	MC	147.16	281.99	0.91	0.47
	BB1A	89.73		0.70	0.22
	BB1	185.11		0.50	0.33
	BB2	131.68		5.09	2.37
	BB3	221.17		1.21	0.95
	BB4	192.97		0.78	0.53
	BB5	172.07		2.27	1.39
	BB6	281.99		2.12	2.12
	BB7	277.99		3.17	3.12
	BB8	235.46	1.94	1.62	

¹ Total recoverable numbers based on the average of three dates of collection (October 20, 1998, September 9, 1999, and March 1, 2000).

Table 8, continued. Results from the calculations of bioavailable metals in stoneroller minnows from Big Bayou Creek collected in February 28 – March 1, 2000.

Metal	Sampling Station	Body Burden (BB) (µg/Kg)	Reference BB (M _{RBB})	Total Recoverable ¹ (µg/L)	Bioavailable Fraction (µg/L)
Ni	MC	715.62	1454.78	2.19	1.08
	BB1A	710.80		3.49	1.70
	BB1	870.28		0.50	0.30
	BB2	745.68		1.43	0.73
	BB3	<910.36		1.52	N.D.
	BB4	1038.75		0.50	0.36
	BB5	1040.81		0.51	0.36
	BB6	1454.78		6.55	6.55
	BB7	790.66		5.65	3.07
	BB8	1159.96	4.02	3.21	
Zn	MC	35334.7	45854.99	2.37	1.83
	BB1A	33278.8		2.64	1.92
	BB1	29748.3		14.25	9.25
	BB2	28267.7		2.07	1.27
	BB3	39890.8		5.53	4.81
	BB4	37695.2		4.46	3.66
	BB5	45855.0		5.25	5.25
	BB6	20972.4		6.10	2.79
	BB7	24109.8		64.90	34.12
	BB8	22278.0	4.80	2.33	

¹ Total recoverable numbers based on the average of three dates of collection (October 20, 1998, September 9, 1999, and March 1, 2000).

Figure 1. Silver Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

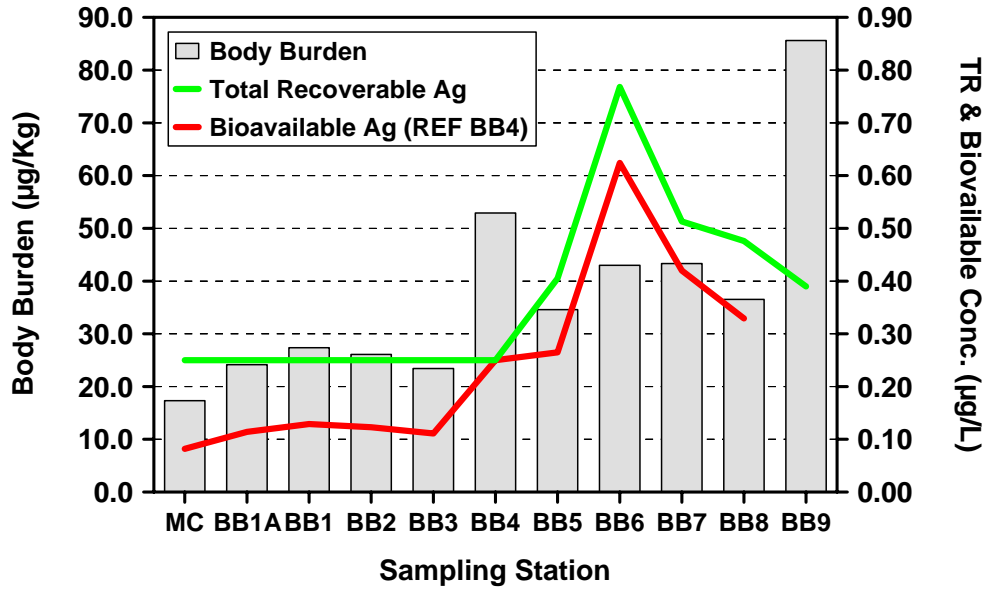


Figure 2. Beryllium Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

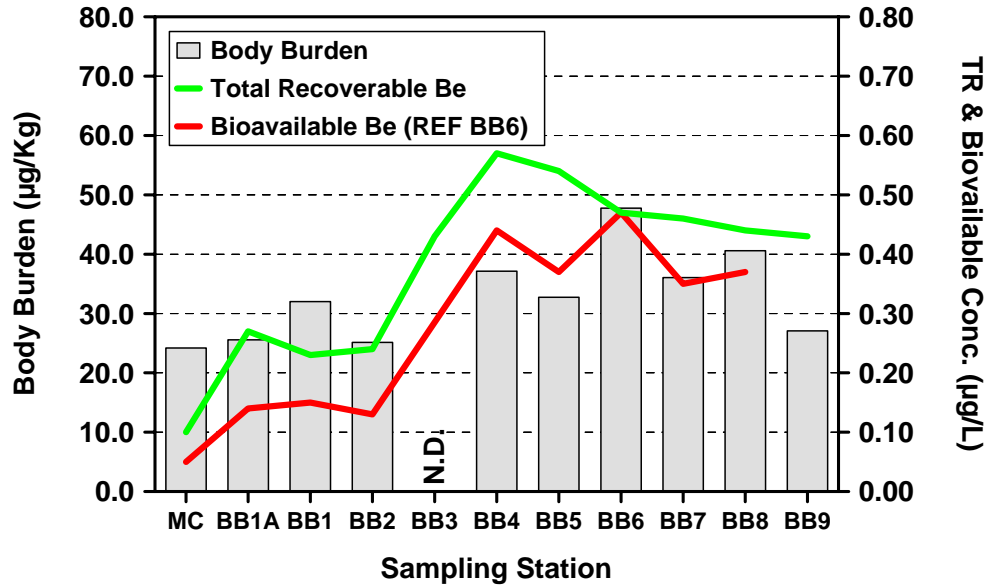


Figure 3. Cadmium Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

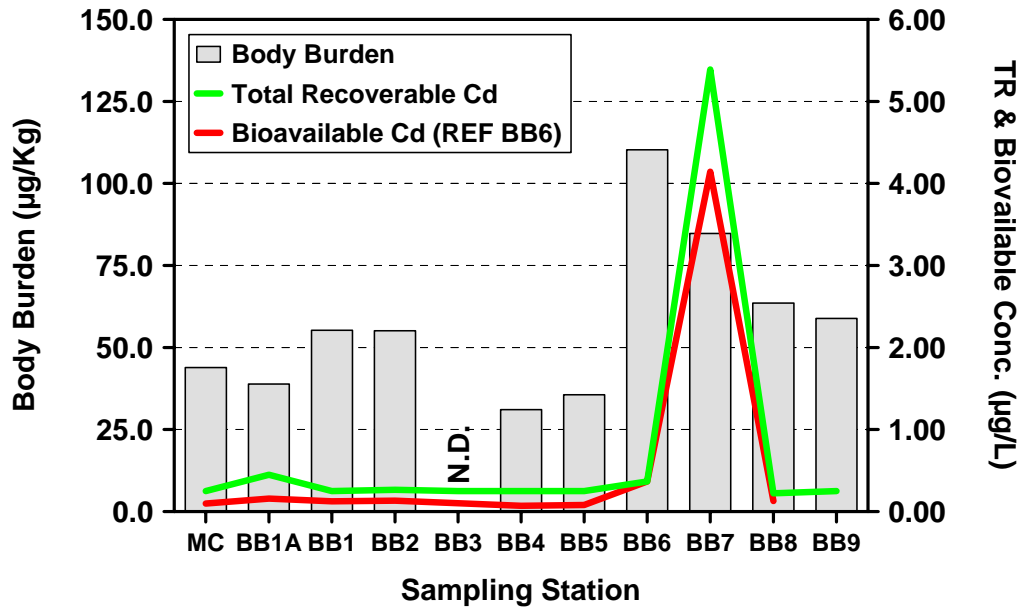


Figure 4. Chromium Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

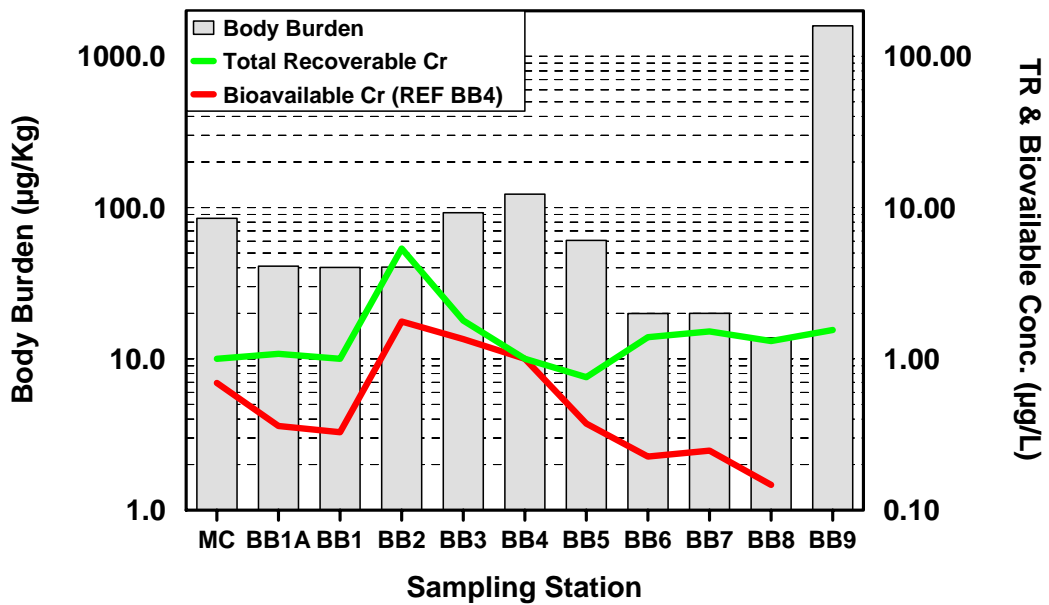


Figure 5. Copper Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

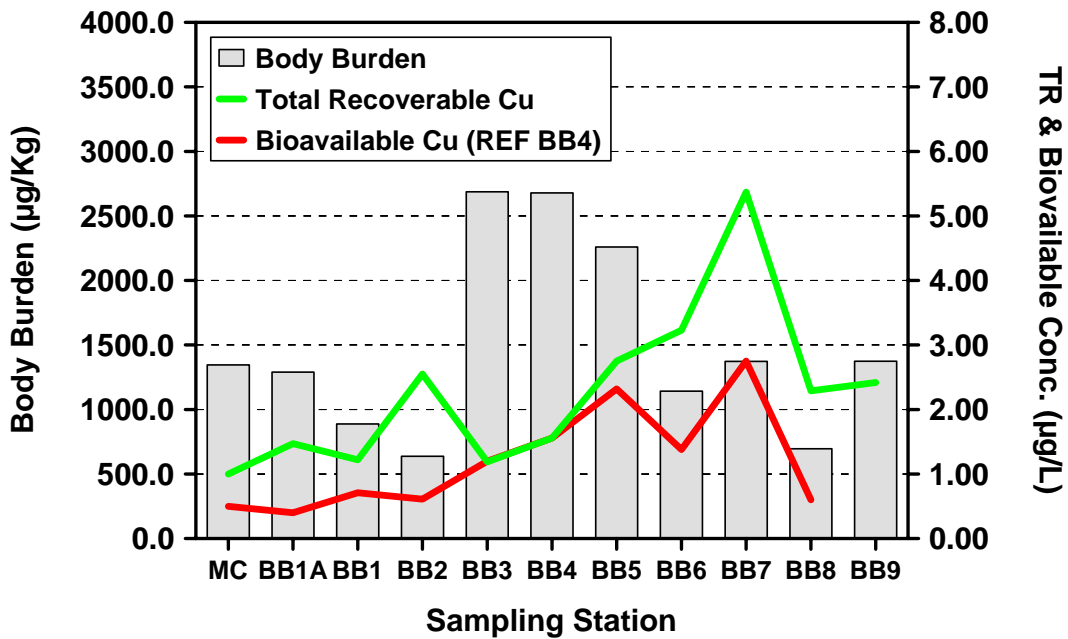


Figure 6. Lead Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

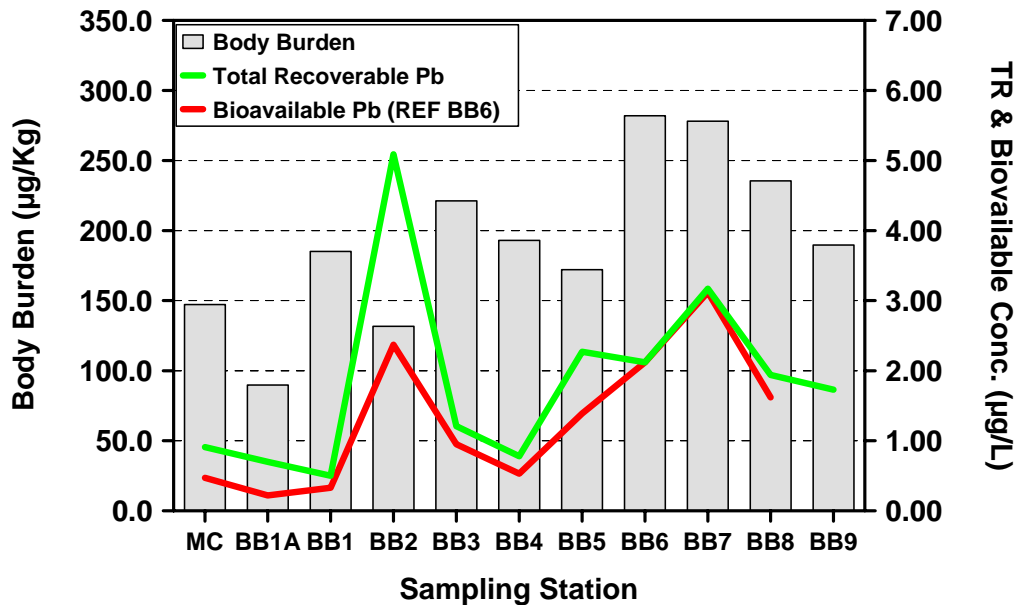


Figure 7. Nickel Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000

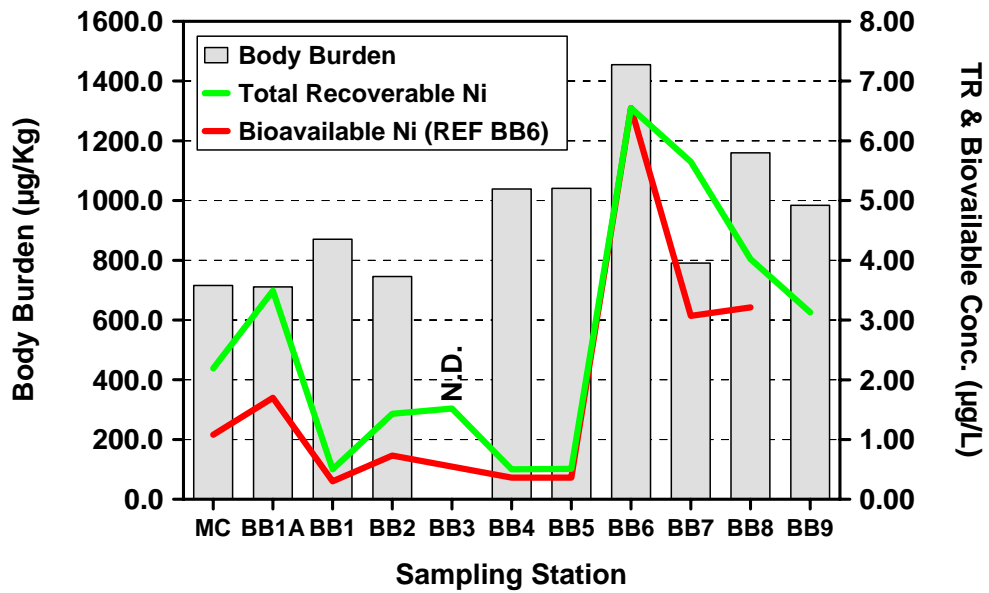
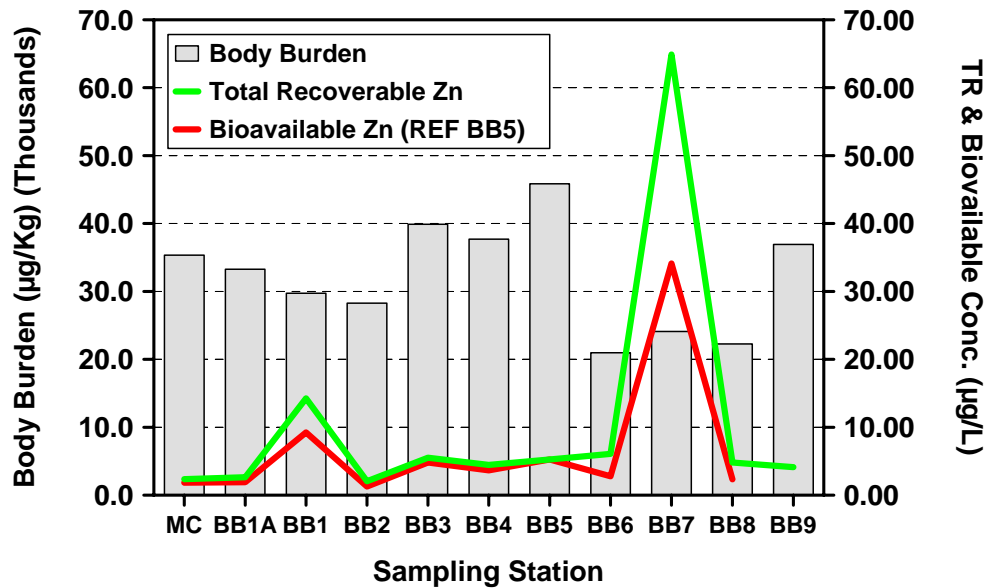


Figure 8. Zinc Concentrations in Stoneroller Minnows Collected from Big Bayou Creek, February 28-March 1 and July 27, 2000



APPENDIX

Table A-1. Metal concentrations in Stream Water from Big Bayou Creek Collected October 20, 1998.¹

			Water Metal Conc. (µg/L)							
Sample Name			Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
MC	102098	MSU1	<0.25	<0.10	<0.25	<0.50	<1.00	<0.50	2.19	2.62
BB1A	102098	MSU1	<0.25	0.10	<0.25	<0.50	<1.00	<0.50	<2.00	3.05
BB1	102098	MSU1	<0.25	<0.10	0.45	<0.50	1.80	0.70	6.30	3.52
BB2	102098	MSU1	<0.25	0.12	<0.25	<0.50	<1.00	<0.50	2.20	1.86
BB2A	102098	MSU1	<0.25	<0.10	<0.25	<0.50	<1.00	0.84	<2.00	3.50
BB3	102098	MSU1	<0.25	<0.10	<0.25	<0.50	<1.00	0.85	<2.00	5.56
BB4	102098	MSU1	0.42	0.40	<0.25	0.62	1.74	<0.50	<2.00	10.60
BB5	102098	MSU1	0.38	0.35	<0.25	0.74	1.36	1.60	<2.00	6.63
BB6	102098	MSU1	0.35	0.34	<0.25	<0.50	7.91	<0.50	3.35	6.56
BB7	102098	MSU1	0.35	0.34	<0.25	<0.50	1.36	1.72	<2.00	5.11
BB8	102098	MSU1	0.34	0.39	<0.25	<0.50	3.35	0.93	<2.00	4.16
BB9	102098	MSU1	<0.25	0.20	<0.25	<0.50	<1.00	1.11	<2.00	2.63

¹ From Birge and Price, January 26, 1999.

Table A-2. Metal concentrations in Stream Water from Big Bayou Creek Collected September 9, 1999.¹

			Water Metal Conc. (µg/L)							
Sample Name			Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
MC	090999	MSU1	<0.25	<0.25	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB1	090999	MSU1	<0.25	0.38	<0.25	<1.00	<1.00	<3.00	<0.50	12.45
BB1	090999	MSU2	<0.25	0.32	<0.25	<1.00	<1.00	<3.00	<0.50	60.96
BB1A	090999	MSU1	<0.25	0.34	<0.25	<1.00	<1.00	<3.00	0.67	<1.00
BB1A	090999	MSU2	<0.25	0.33	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB2	090999	MSU1	<0.25	0.39	0.26	<1.00	<1.00	5.50	0.65	1.44
BB2	090999	MSU2	<0.25	0.33	0.27	5.36	<1.00	4.67	<0.50	<1.00
BB2A	090999	MSU1	<0.25	<0.25	<0.25	1.79	1.37	<3.00	1.52	1.84
BB2A	090999	MSU2	<0.25	0.50	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB3	090999	MSU1	<0.25	0.83	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB3	090999	MSU2	<0.25	0.84	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB4	090999	MSU1	0.33	0.42	<0.25	<1.00	5.22	3.81	0.51	2.82
BB4	090999	MSU2	0.45	0.94	<0.25	<1.00	5.10	4.15	<0.50	1.81
BB5	090999	MSU1	<0.25	0.28	<0.25	1.74	4.72	<3.00	0.53	5.15
BB5	090999	MSU2	<0.25	0.32	<0.25	1.14	2.50	<3.00	<0.50	2.05

¹ From Birge and Price, December 3, 1999.

Table A-2, continued. Metal concentrations in Stream Water from Big Bayou Creek Collected September 9, 1999.¹

Sample Name			Water Metal Conc. (µg/L)							
			Ag	Be	Cd	Cr	Cu	Pb	Ni	Zn
BB6	090999	MSU1	0.34	0.46	<0.25	1.05	3.58	3.28	<0.50	<1.00
BB6	090999	MSU2	0.28	0.36	<0.25	1.05	2.87	<3.00	<0.50	<1.00
BB7	090999	MSU1	0.27	0.34	<0.25	1.55	2.37	<3.00	0.76	<1.00
BB7	090999	MSU2	0.31	0.36	<0.25	1.00	1.53	<3.00	0.59	<1.00
BB8	090999	MSU1	0.28	0.46	<0.25	<1.00	1.08	<3.00	0.75	2.66
BB8	090999	MSU2	0.29	0.41	<0.25	1.74	1.44	<3.00	<0.50	<1.00
BB9	090999	MSU1	0.33	0.33	<0.25	<1.00	<1.00	<3.00	<0.50	<1.00
BB9	090999	MSU2	<0.25	0.41	<0.25	<1.00	<1.00	<3.00	0.51	<1.00

¹ From Birge and Price, December 3, 1999.

Table A-3. Metal concentrations in stream water from Big Bayou Creek collected February 29 and March 1, 2000.¹

			Water Metal Conc. (µg/L)								
Sample Name			Ag	Be	Cd	Cr	Cu	Fe	Pb	Ni	Zn
MC	30100	MWS1	<0.25	<0.25	<0.25	<1.00	<1.00	<200.0	0.91	<3.00	<1.00
MC	30100	MWS2	<0.25	<0.25	<0.25	<1.00	<1.00	268.8	<0.50	<3.00	2.12
BB1A	22900	MWS1	<0.25	<0.25	<0.25	<1.00	1.07	981.1	<0.50	<3.00	3.37
BB1A	22900	MWS2	<0.25	<0.25	<0.25	<1.00	1.36	751.2	<0.50	<3.00	2.63
BB1	22900	MWS1	<0.25	<0.25	<0.25	1.10	1.15	<200.0	<0.50	<3.00	1.35
BB1	22900	MWS2	<0.25	<0.25	<0.25	1.05	1.14	405.9	<0.50	<3.00	2.16
BB2	30100	MWS1	<0.25	<0.25	<0.25	<1.00	1.31	858.2	<0.50	<3.00	1.93
BB2	30100	MWS2	<0.25	<0.25	<0.25	<1.00	3.78	930.7	<0.50	<3.00	3.88
BB3	30100	MWS1	<0.25	0.36	<0.25	<1.00	<1.00	1171.1	1.91	<3.00	6.33
BB3	30100	MWS2	<0.25	0.38	<0.25	<1.00	1.01	1192.8	1.26	<3.00	16.17
BB4	30100	MWS1	<0.25	0.31	<0.25	<1.00	1.62	856.4	0.74	<3.00	3.15
BB4	30100	MWS2	<0.25	0.30	<0.25	<1.00	1.50	704.5	0.68	<3.00	3.55
BB5	30100	MWS1	<0.25	<0.25	<0.25	0.92	1.48	1076.8	0.62	<3.00	3.35
BB5	30100	MWS2	<0.25	<0.25	<0.25	0.86	1.22	1018.9	0.51	<3.00	2.32

¹ From Birge and Price, December 14, 2000.

Table A-3, continued. Metal concentrations in stream water from Big Bayou Creek collected February 29 and March 1, 2000.¹

Sample Name			Water Metal Conc. (µg/L)								
			Ag	Be	Cd	Cr	Cu	Fe	Pb	Ni	Zn
BB6	30100	MWS1	1.17	0.74	0.38	1.95	4.80	552.3	3.03	12.28	8.34
BB6	30100	MWS2	1.14	0.80	0.35	2.03	4.66	519.3	2.24	12.85	7.81
BB7	22900	MWS1	0.87	0.64	7.00	1.88	5.56	278.9	2.99	7.84	236.40
BB7	22900	MWS2	0.89	0.65	3.78	2.09	4.37	274.2	3.12	8.04	10.08
BB8	22900	MWS1	0.78	0.63	0.22	1.34	3.41	997.4	1.77	7.53	4.57
BB8	22900	MWS2	0.80	0.61	<0.25	1.36	3.70	589.1	2.56	7.21	4.41
BB9	30100	MWS1	0.55	0.48	<0.25	1.50	2.59	768.6	<0.50	<3.00	3.27
BB9	30100	MWS2	0.56	0.48	<0.25	1.21	2.69	374.0	2.53	5.51	7.90

¹ From Birge and Price, December 14, 2000.

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