RED RIVER AQUATIC BIOLOGICAL MONITORING
2000

MARCH 2001

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Prepared for:

MOLYCORP, INC.
Questa, New Mexico

MARCH 2001

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INTRODUCTION

Biological monitoring was initiated in 1997 to evaluate the effects of open pit mining operations and waste rock dumps over a 30-year period on aquatic biota (i.e., fish and benthic invertebrate populations) in the Red River upstream, adjacent to, and downstream of the Questa Molybdenum Mine (Chadwick Ecological Consultants, Inc.[CEC] 1997, 1998). Our original report discussed the approach and scope of our evaluation in detail (CEC 1997). That discussion is not repeated here. The purpose of this report is to present data on fish and benthic invertebrate populations, and sediments collected in 2000 to further evaluate the trends identified in previous monitoring reports (CEC 1997, 1998, 1999, 2000), and to monitor the current status of aquatic biological parameters. The most recent data for 2000 are used to further assess the potential impact of open pit mining and waste rock piles on fish and benthic invertebrate populations of the Red River.

The New Mexico Environment Department (NMED) initiated a Total Maximum Daily Load (TMDL) study of the Red River in 1999. Molycorp, Inc. (Molycorp), through CEC, was responsible for collecting data on aquatic habitat in 1999, as well as the other biological parameters, to address the needs of the TMDL study. The aquatic habitat data were included in our report for last year (CEC 2000), and was provided to NMED. Aquatic habitat data were not collected in 2000.

The initial study included an analysis of historical information in addition to field sampling efforts (CEC 1997). The conclusions from the first year of the study (1997) indicated that observed negative impacts to fish and benthic invertebrates in the Red River were caused primarily by naturally occurring thermal scars downstream from the town of Red River, especially downstream of Hansen Creek. This pattern was evident during baseline (pre-1966) and present (1995-2000) periods. The open pit mine and waste rock piles did not appear to have measurably impacted the suitability of the Red River to support aquatic organisms.

Although not part of regularly scheduled annual monitoring, toxicity testing of water and sediment samples was also conducted at six sites from the Red River in October 2000. Test organisms included the zooplankter *Ceriodaphnia dubia* and fathead minnows, *Pimephales promelas*. Sampling and testing were done in conjunction with NMED, at a total of six sampling locations. NMED was responsible for lab analysis at three sites, and CEC was responsible for lab analysis at the remaining three sites. The results of the NMED and CEC tests are presented and evaluated in this report. In addition to sampling of sediment and water for toxicity testing, NMED also collected sediment and water samples for chemical analysis. The information on water quality is also presented in this report. The chemical analysis of the sediments are not yet finalized.

The Questa Molybdenum Mine began operations in 1919, using underground mining methods (Schilling 1990). Late in 1965, the mine initiated open pit mining operations that continued until 1983 (Slifer 1996). Tailings from the mill are piped down the valley to tailings ponds near the town of Questa (Fig. 1). Waste rock was deposited near the open pit on Molycorp property in areas which drain Spring Gulch, Sulphur Gulch, Goathill Gulch, and Capulin Canyon (Fig. 1).

In order to evaluate long-term trends in aquatic biological data, the historical information has been divided into three time periods: baseline (prior to open pit mining), open pit and underground mine operation, and present conditions (CEC 1997). Baseline conditions refer to the period prior to 1966. This includes fish data collected in 1960 by the New Mexico Department of Game and Fish [NMDGF] (1960) and benthic invertebrate data collected in 1965 by the U.S. Department of Health, Education, and Welfare [USDHEW] (1966). During the period of open pit and underground mine operation, benthic invertebrate data were collected from 1970 to 1992, and fish data were collected from 1974 to 1988 (CEC 1997).

Present conditions refer to the benthic invertebrate data collected in 1997, 1998, 1999, and 2000 by CEC and data collected in December 1995 by NMED and analyzed by Woodward-Clyde (1996). Present conditions for fish include data collected in 1997, 1998, 1999, and 2000 by CEC, as well as data collected in August 1997 by NMDGF. A detailed listing of all available data for baseline conditions, historic conditions in the intervening years of mine operation (data collected 1970-1992), and present conditions (through fall 1998) is contained in our previous reports (CEC 1997, 1998, 1999).

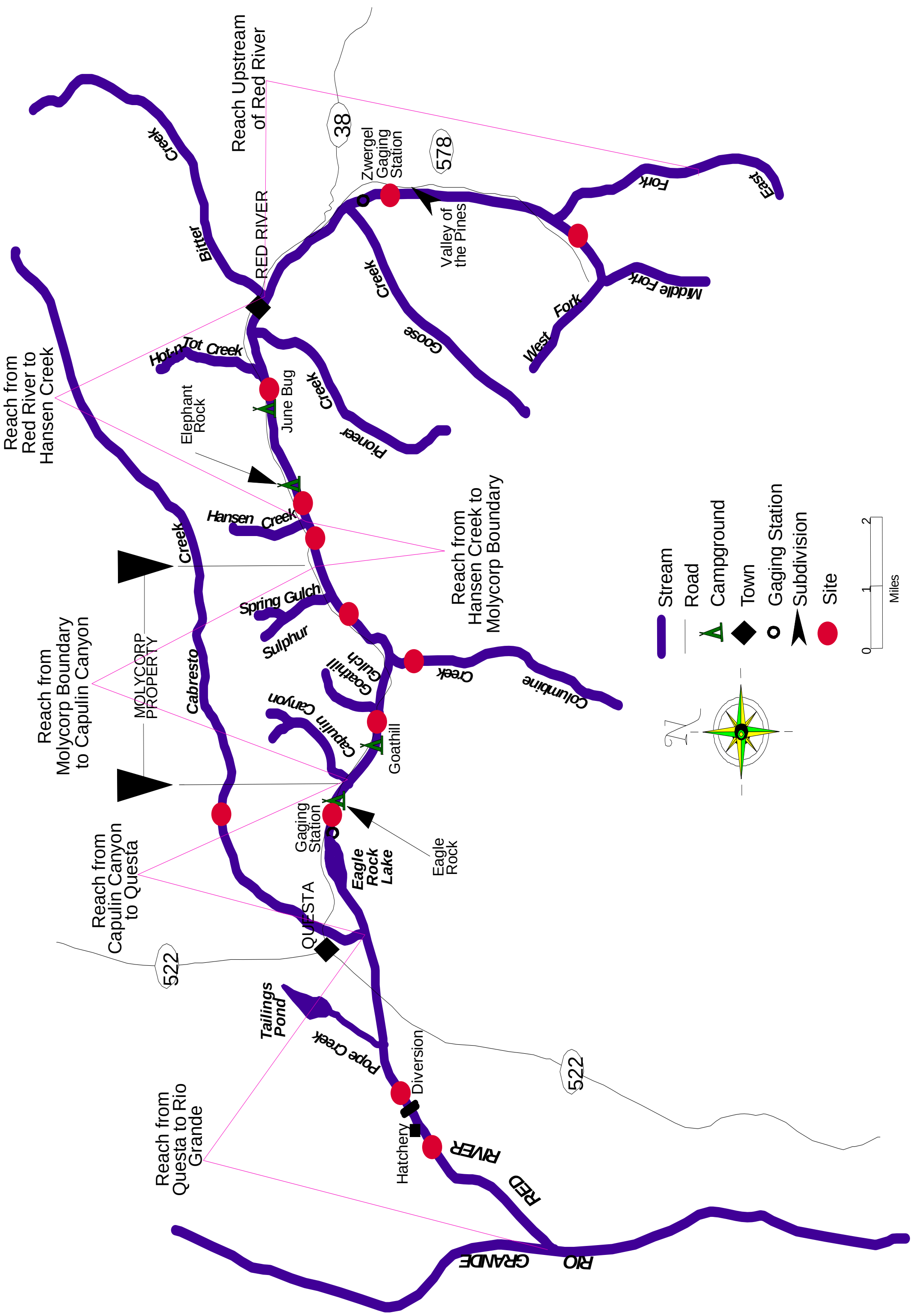


FIGURE 1: Red River study area with six river reaches and Chadwick Ecological Consultants, Inc. 1997-2000 fish, benthic invertebrate, and sediment sampling sites.

STUDY AREA

The study area includes the Red River from its headwaters to the confluence with the Rio Grande. The Molycorp Questa Molybdenum Mine is adjacent to the north bank of the Red River in its middle reaches, between the towns of Red River and Questa (Fig. 1).

Reach Descriptions

In order to organize the available historical fish and benthic invertebrate data in our previous report (CEC 1997), we segmented the Red River into six reaches (Fig. 1). These reaches are used to group data from multiple historical sampling sites into distinct, biologically significant parts of the river which contain roughly similar characteristics of channel morphology, habitat, potential impacts, etc. This allowed a more focused interpretation of the historical data. These same six reaches are also used to organize the monitoring data collected during 1997-2000. Summarized descriptions of the six reaches are presented below. More detailed descriptions were presented in our previous report (CEC 1997).

Upstream of Red River

This reach of the Red River includes its headwaters downstream to just upstream of the town of Red River. There is some residential development in this portion of the river, in the form of vacation homes (e.g., Valley of the Pines subdivision) and commercial lodges, but not to the extent present in the town of Red River. The substrate in this reach exhibited little accumulation of silt and sand, with low embeddedness. This reach provides good habitat for the different age classes of trout.

Red River to Hansen Creek

This reach extends from the town of Red River to just upstream of the confluence with Hansen Creek. Bitter Creek flows into the Red River at the town of Red River. It contains historical mining operations and natural hydrothermal scars, which apparently contribute sediment to the Red River. Potential impacts to this reach include channelization, erosion from the highway, outfall of the town of Red River's wastewater treatment plant, and runoff from natural hydrothermal scars drained by Bitter Creek and Hot-n-Tot Creek.

Hansen Creek to Molycorp Boundary

This reach extends from the confluence with Hansen Creek downstream to the eastern edge of the Molycorp property boundary. The major characteristic of this reach is the inflow of Hansen Creek, which drains a large area of hydrothermal scarring. Runoff from this scarring carries sediment into the Red River, creating a relatively large alluvial fan, as well as lower pH waters.

In addition to inputs from Hansen Creek, Hansen Spring also apparently introduces substances to the Red River in this reach. This spring is located in an overflow channel adjacent to the Red River, and appears to input directly into the Red River. Its channel contains a very evident white precipitate.

Molycorp Boundary to Capulin Canyon

Extending from the eastern Molycorp property boundary downstream to just upstream of the confluence with Capulin Canyon, this reach contains the confluence with Columbine Creek, which joins the Red River from the south side of the valley. Columbine Creek is a small, clear stream that adds diluting flows to the Red River.

Capulin Canyon to Questa

This reach extends from the confluence with Capulin Canyon downstream to just upstream of the confluence with Cabresto Creek, near the town of Questa. As with the reach from Hansen Creek to the Molycorp eastern property boundary, a major feature in this reach is a natural hydrothermal scar; in this case, the one drained by Capulin Canyon. Capulin Springs also enter the Red River in this reach. These seeps apparently introduce substances to the Red River, including those producing a white precipitate.

Questa to Rio Grande

This reach extends from the confluence with Cabresto Creek, near the town of Questa, downstream to the confluence of the Red River and the Rio Grande. At the upper end of this reach, Cabresto Creek adds clear, diluting flows to the Red River. The river valley widens at Questa, and portions of this reach through

Questa have areas of unstable stream banks, which contribute to more shallow average water depths compared to downstream portions of this reach. The river valley subsequently narrows again upstream of the state fish hatchery, and remains a narrow canyon down to the Rio Grande.

Study site locations for the twelve monitoring sites in 2000 (Fig. 1) are as follows:

Middle Fork, Red River	Located approximately 6 mi upstream of the town of Red River and approximately 0.6 mi upstream of the confluence with the East Fork, at an elevation of approximately 9,510 ft. This site was added in 1999 in conjunction with the TMDL study by the NMED.
Red River	
Upstream of town of Red River	Located approximately 0.6 mi upstream from Goose Creek and 0.2 mi upstream from the gaging station, at an elevation of approximately 8,900 ft.
June Bug Campground	Located near the upstream end of June Bug Campground at an elevation of approximately 8,530 ft.
Downstream of Elephant Rock Campground, upstream from Hansen Creek	Located 0.4 mi downstream from Elephant Rock Campground at an elevation of approximately 8,360 ft.
Downstream of Hansen Creek, upstream of mill	Located 0.8 mi upstream from the mill access road and 0.7 mi downstream from Hansen Creek, at an elevation of approximately 8,200 ft. This site corresponds to the "Bobita Campground" site of the New Mexico Game and Fish Department.
Downstream of mill, upstream of Columbine Creek	Located 1.1 mi downstream from the mill access road at an elevation of approximately 8,100 ft.
Goathill Campground	Located at the upstream end of Goathill Campground at an elevation of approximately 7,670 ft.
Upstream of Questa Ranger Station	Located 0.4 mi upstream from the ranger station access road, just upstream from where the tailings pipes cross over the Red River. The elevation of this site is approximately 7,480 ft.
Upstream of hatchery diversion	Located 0.3 mi upstream of the Red River fish hatchery diversion, at an elevation of approximately 7,120 ft.

Downstream of hatchery	Located 0.3 mi downstream of the Red River fish hatchery adjacent to the USGS gage, at an elevation of 7,070 ft. The site was added in 1999 in conjunction with the TMDL study by the NMED.
Tributaries	
Columbine Creek	Located approximately 400 yards upstream from its confluence with the Red River, at an elevation of approximately 7,880 ft.
Cabresto Creek	Located 1.6 mi upstream of the Carson National Forest boundary, at an elevation of approximately 7,640 ft.

In most cases, toxicity sampling sites from October 2000 correspond to NMED TMDL study site locations and CEC study site locations. The most upstream site was located at TMDL study Site RR-06, near the old Zweigle Dam. This site is a few hundred feet upstream of the CEC Red River sampling site (Fig. 1). The next site downstream was at TMDL location Site RR-16, which is just downstream of the CEC site at June Bug Campground. Sampling was also conducted at the CEC site downstream of Hansen Creek (corresponds to TMDL Site RR-20), at the Goathill Campground (TMDL Site RR-28), and the site upstream of the Questa Ranger Station (TMDL Site RR-29). The most downstream site was at TMDL Site RR-35, which is located just downstream of Molycorp's Outfall 001. CEC does not have a site at this location but it is just downstream from the mouth of Pope Creek, approximately 0.7 miles upstream from the CEC site upstream of the hatchery diversion.

METHODS

Fish Sampling

Fish populations were quantitatively sampled at twelve sites in September 2000, using methods nearly identical to those used in 1997, 1998, and 1999. Sampling provided data on species composition, density, biomass, and the size structure of the fish communities. The section of stream sampled at each site was chosen to be representative of the habitat present in that reach of stream, in terms of pool/riffle ratio, shading, bank stability, etc. Sites were of sufficient length to ensure a representative section of the available habitat features: 270 to 438 ft in length at the ten sites on the Red River, 282 ft in Cabresto Creek, and 284 ft in Columbine Creek.

Sampling was conducted by making two or three sampling passes through a representative section of stream using either bank or backpack electrofishing gear. Bank electrofishing equipment consisted of a 4,000-watt generator, a Coffelt voltage regulator (VVP-15), and two or three electrodes. Backpack electrofishing equipment consisted of a Coffelt BP-4 unit with one electrode. At almost all sites, sample sections were blocked with seines (⅛ inch mesh) on both the upstream and downstream ends to reduce the potential for fish to enter or leave the study section during sampling. However, in a few cases, a natural barrier to fish movement (e.g., steep riffle or plunge pool) was used as a site boundary.

Fish captured from each pass were kept separate to allow estimates of population density of each species using the maximum likelihood estimator in the "MicroFish" program developed by the U.S. Forest Service (Van Deventer and Platts 1983, 1989). All fish sampled were identified, counted, measured for length, weighed, and released. This sampling provided species lists, estimates of density (#/Mile, #/Acre), and biomass (Lbs/Acre).

Benthic Invertebrate Sampling

Benthic invertebrates were sampled in April and September 2000, at the twelve sampling locations. Sampling in September 2000 was conducted concurrently with fish sampling. Sampling methods were similar to those used in 1995 by NMED (Woodward-Clyde 1996) and by CEC in 1997, 1998, and 1999 (CEC 1997, 1998, 1999, 2000), and are briefly described below.

Benthic invertebrates were quantitatively sampled at the twelve sites by taking five replicate samples from similar riffle habitats. A modified Hess sampler, which encloses 0.1 m^2 and has a net mesh size of 500 µm (Canton and Chadwick 1984), was used to collect the invertebrate samples. Five replicate Hess samples were also collected in 1995 by NMED (Woodward-Clyde 1996). Five replicates should provide a reliable estimate of both density and species composition (Canton and Chadwick 1988).

Collected organisms were preserved in the field with 95% ethanol and returned to Chadwick & Associates, Inc. (C&A) laboratory in Littleton, Colorado, for analysis. In the lab, organisms were sorted from the debris, identified to the lowest practical taxonomic level (depending upon the age and condition of each specimen), and counted. Chironomids were mounted and cleared prior to identification and counting. Chironomids were sent to Dr. Leonard Ferrington at the University of Minnesota, St. Paul, for identification.

This analysis provided species lists, estimates of density ($\#/m^2$), and the total number of taxa present at each site. Further analysis included calculation of the Shannon-Weaver Diversity Index (H'), which the EPA recommends as a measure of the effects of stress on invertebrate communities (Klemm *et al*. 1990). This index generally has values ranging from 0 to 4, with values greater than 2.5 indicative of a healthy invertebrate community. Diversity values less than 1.0 indicate a stream community under severe stress (Wilhm 1970, Klemm *et al*. 1990).

In mountain streams, such as those near the Molycorp Molybdenum Mine, the presence of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa (collectively referred to as the EPT taxa) can be used as an indicator of water quality. These insect groups are considered to be sensitive to a wide range of pollutants (Plafkin *et al*. 1989, Wiederholm 1989, Klemm *et al*. 1990, Lenat and Penrose 1996, Wallace *et al*. 1996). Stress to aquatic systems can be evaluated by comparing the number of EPT taxa and the percent of EPT taxa (expressed as the percent of the number of EPT taxa relative to the total number of taxa) between unimpacted and potentially impacted sites. Impacted sites would be expected to have fewer EPT taxa and lower percent EPT taxa compared to unimpacted sites. These two parameters were also analyzed in this study. Clements (1991, 1994) and Clements *et al*. (1988) indicate that when specifically looking at impacts due to metals, mayflies are particularly sensitive and caddisflies are less sensitive, and this should be taken into account when interpreting EPT parameters.

To assess potential statistical differences in fish and benthic invertebrate population parameters between study sites and between population parameters and physical/chemical parameters, one-way analysis of variance (ANOVA) with Fisher's least significant difference test and/or simple regression analysis were performed (Hintze 1997). In this report, a level of 95% ($p = 0.05$) was used to indicate significance. For the parameters of invertebrate density, number of taxa, number of EPT taxa, percent EPT taxa, and diversity, ANOVA was performed using the means of the five individual sample replicates. However, benthic invertebrates are often found in "clumped" or negative binomial distributions. Therefore, in order to fulfill the assumptions needed to use ANOVA, the invertebrate density data were assessed to determine if they needed to be transformed ($\log_{10}$) prior to analysis (Elliott 1977). The statistical analysis was conducted on the mean and variance of the data for the five replicates. The summary data table in this report presents composite mean density values (untransformed). However, for the other parameters analyzed (total number of taxa, number of EPT taxa, percent EPT taxa, diversity), the summary data table presents the results of pooled numbers from the total of the five replicates.

Sediment Sampling

Sediment was sampled at all study sites in April and September 2000. Sampling in September 2000 was conducted concurrently with fish and benthic invertebrate population sampling. Sediment was collected from similar riffle habitat to where the benthic invertebrates were sampled. Sediment samples were obtained using a freeze core technique, similar to methods outlined in Grost *et al*. (1991). A stainless steel probe, with a hollow core and solid conical point at the bottom end, was driven into the substrate with a hammer, to a depth of approximately eight inches. Once the probe was in place, carbon dioxide was injected into the probe for up to one minute. The carbon dioxide was delivered to the probe by a narrow stainless steel tube placed inside the probe. The delivery tube was attached to a 20-pound cylinder of liquid carbon dioxide. After approximately 40-60 seconds, the frozen probe, along with the frozen sediment clinging to it (i.e., “freeze core”) was lifted from the substrate and placed into an enamel pan. The frozen sediment was then melted off the probe using a propane torch and placed into a plastic bag. Three or more freeze cores were taken at each site and combined into one composite sample from each site. Sediment samples were shipped to ACZ Laboratories in Steamboat Springs, Colorado, for analysis.

These sediment samples provided data on the extent of fine sediments as well as on metals concentrations in the fine particles. In the lab, the sediment samples were separated through a 2 mm sieve. The proportion of the sample passing through the sieve was used as a measure of the extent the substrate had accumulated fine sediment particles. The fines were analyzed for texture (i.e., sand, silt, clay).

The fine sediment particles passing through the sieve were also analyzed for metals concentrations by a weak acid leach process. The resulting leachate was analyzed for total concentrations of aluminum, cadmium, copper, lead, and zinc. The results were reported as the concentrations of these metals (mg/Kg) in the fine sediments.

Sediment and water samples from the six toxicity sites were tested using the two commonly used bioassay test organisms, the zooplankter *C. dubia* and fathead minnows, *P. promelas*. Samples were collected from six sites, with NMED responsible for lab analysis at the site upstream of Red River (RR-06), the site upstream of the Questa Ranger Station (RR-29), and the site upstream of the fish hatchery diversion (RR-35). Laboratory testing of these samples was conducted at the U.S. Environmental Protection Agency (USEPA) laboratory in Houston, Texas. CEC was responsible for lab analysis at the site near June Bug Campground (RR-16), the site downstream of Hansen Creek (RR-20), and the site at Goathill Campground (RR-28). Testing of these samples collected was conducted by the C&A aquatic biological laboratory.

Toxicity Testing

Water column samples were collected from each sampling site in 1-gallon polyethylene jugs. Two gallons of water sample were collected from each site. After collection, the samples were placed in a cooler, on ice, and transported to the lab at approximately 4°C.

Composite sediment samples were collected from each sampling site using a polyethylene scoop. Samples were collected from the top 3 inches of sediment in depositional areas. Areas containing fine, organic sediments were sampled whenever available. A unique scoop was used at each site, and each scoop was acid-washed before use in the field. Samples were composited in acid-washed 2-liter polyethylene bottles. A total of 2 liters (by volume) of sediment were collected at each sampling site. After collection, the samples were placed in a cooler, on ice, and transported to the lab at approximately 4°C.

Both the water column and sediment toxicity testing methods were modifications of standard USEPA seven-day *C. dubia* chronic and seven-day *P. promelas* embryo-larval toxicity testing protocols (USEPA 1994). These modified protocols were provided by Terry Hollister at USEPA, Houston, Texas. While these procedures were similar to the standard USEPA whole effluent toxicity (WET) test protocols, there were substantial departures from standard protocols. These departures included: 1) use of one water sample rather than three over the course of a seven-day test; 2) renewal of the *C. dubia* test solutions on day four and renewal of the *P. promelas* test on days four and six, rather than daily renewals of both tests; and 3) observation of *C. dubia* on days four and seven of the test and observation of *P. promelas* on days four, six, and seven of the test, rather than daily observations.

Water column testing followed standard protocols, with the exception of the deviations indicated above. The sediment toxicity tests were conducted using sediment eluate. The eluate was prepared by diluting the sediment samples at a ratio of 1:4 with moderately hard reconstituted laboratory water (USEPA 1994). The sediment-water mixture was placed in 2-liter polyethylene bottles and rotated, end-over-end, at room temperature for 24 hours. After settling for 24 hours at 4°C, the supernatant to be used in the tests was decanted. Due to excessive turbidity, and in accordance with guidance from Terry Hollister at USEPA Houston, supernatant from the Goat Hill Campground and June Bug Campground samples were passed through a 1.5µm filter before being used in testing.

Testing at the C&A laboratory was initiated on the water column samples on October 26, 2000. Testing on sediment samples was initiated on October 31, 2000, following the sediment preparation procedure listed above. All tests were conducted over a seven day period using two treatments, a moderately hard synthetic freshwater control and 100% sample concentrations. The *C. dubia* test was renewed on day four, and organisms were checked for neonate production and mortality on days four and seven of the test. The *P. promelas* test was renewed on days four and six, and checked for number alive, number hatched, and terata (collectively known as number affected) on days four, six, and seven of the test.

RESULTS AND DISCUSSION

Fish

Four different trout species were collected in the Red River and its tributaries during sampling in September 2000 (Table 1). Overall, brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) were the most common species collected. Brown trout were collected at eight of the ten sites in the Red River and in Columbine Creek and Cabresto Creek. Rainbow trout were collected at seven sites in the Red River and in Cabresto Creek. Brook trout (*Salvelinus fontinalis*) were the most abundant species at the site in the Middle Fork, and at the site in the Red River upstream of the town of Red River; they were present at one other site in the Red River (June Bug Campground) and in Cabresto Creek. Cutthroat trout (*Salmo clarki*) were present at one site in the Red River (upstream of the town of Red River) and in Columbine Creek. Hybrid rainbow/cutthroat trout were present at the site in the Red River upstream of the town of Red River, and were the most common taxa in Cabresto Creek, as was also true in 1997, 1998, and 1999 (CEC 1997, 1998, 1999, 2000). One hybrid was also collected at the site on the Red River just upstream of the hatchery diversion.

TABLE 1: Fish population parameters for study sites on the Red River and tributaries. Data collected in September 2000 by Chadwick Ecological Consultants, Inc. Data from all electrofishing passes. (CUT = cutthroat trout, BRK = brook trout, RBT = rainbow trout, BRN = brown trout, HYBRID = cutthroat/rainbow hybrid, WHS = white sucker).

			Density		Biomass
Site	Species	# Collected	#/Mile	#/Acre	Lbs/Acre
Middle Fork, Red River	BRK	67	1,372	1,750	57.9
(Reference)	RBT	2	39	50	12.2
	Total	**69**	**1,411**	**1,800**	**70.1**
Red River					
Upstream of Town of Red River	BRK	109	1,562	748	26.4
(Reference)	CUT	5	62	30	4.7
	RBT	41	512	246	141.0
	BRN	65	825	395	24.4
	HYBRID	61	762	365	4.8
	Total	**281**	**3,723**	**1,784**	**201.3**

TABLE 1: Continued.

Site	Species	# Collected	Density #/Mile	Density #/Acre	Biomass Lbs/Acre
June Bug Campground	BRK	1	16	8	1.4
	RBT	2	32	17	6.4
	BRN	30	484	250	29.2
	WHS	1	16	8	1.4
	Total	**34**	**548**	**283**	**38.4**
Downstream of Elephant Rock Campground, upstream of Hansen Creek	RBT	5	88	41	20.0
	BRN	51	895	418	95.9
	WHS	1	18	8	<0.1
	Total	**57**	**1,001**	**467**	**115.9**
Downstream of Hansen Creek, upstream of mill	RBT	1	15	9	3.6
Downstream of mill, upstream of Columbine Creek	BRN	18	353	202	68.6
Goathill Campground	BRN	50	675	287	36.1
Upstream of Questa Ranger Station	BRN	26	313	136	16.5
Upstream of hatchery diversion	RBT	33	556	246	87.3
	BRN	43	698	310	30.1
	HYBRID	1	16	7	0.2
	Total	**77**	**1,270**	**563**	**117.6**
Downstream of hatchery	RBT	13	242	75	18.4
	BRN	194	3,273	1,009	275.9
	Total	**207**	**3,515**	**1,084**	**294.3**
Tributaries					
Columbine Creek (Reference)	CUT	1	18	12	0.1
	BRN	114	2,241	1,512	63.3
	Total	**115**	**2,259**	**1,524**	**63.4**
Cabresto Creek (Reference)	BRK	17	315	254	7.8
	RBT	28	518	418	164.1
	BRN	5	93	75	3.0
	HYBRID	121	2,333	1,881	70.5
	Total	**171**	**3,259**	**2,628**	**245.4**

Multiple size-classes of cutthroat, brook, brown, and hybrid trout were collected in 2000. This indicates the presence of resident, self-sustaining populations of these species in the Red River and its tributaries. The rainbow trout collected all were 6 inches in length or greater, with most in the 8- to 11-inch size group (Appendix A). This corresponds to the lengths of fish regularly stocked by NMDGF and the town of Red River (CEC 1997). As was true in 1997, 1998, and 1999, the rainbow trout collected during sampling in fall 2000 are probably stocked fish. In order to minimize the effect of stocked fish on the interpretation of the data, the following discussions are based on trends for resident trout (defined as all trout, excluding rainbow trout).

The fish population data from fall 2000 indicate a distinct pattern of trout density in the Red River from above the town of Red River, downstream to the Red River Fish Hatchery (Fig. 2). Estimates of total number of trout and resident trout generally have been higher at sites upstream of Hansen Creek, compared to the next four sites, downstream to and including the site just upstream of the Questa Ranger Station. A similar pattern was observed in previous years (CEC 1997, 1998, 1999, 2000). Density of resident trout at the four sites upstream of Hansen Creek ranged from 500 to 3,211 trout per mile (Table 1, Fig. 2), averaging 1,495 trout per mile in 2000.

At the June Bug Campground site, the density of resident trout was lower than at the two sites upstream of Red River (Table 1, Fig. 2). There was a decrease of 62% and 84% in the density of resident trout from the two sites upstream of the town of Red River to the site at the June Bug Campground. This pattern was also observed in previous years, suggesting an impact to trout populations is occurring adjacent to or near the town of Red River.

An increase in density of resident trout was evident at the Elephant Rock Campground site, which had a 77% higher density than at June Bug Campground (Fig. 2). At the next site downstream, below Hansen Creek, there was a decrease in resident trout density of 100%. In fact, a single rainbow trout was the only fish collected at this site in 2000. Total trout density (consisting only of brown trout) at the next two sampling sites downstream increased to a high of 675 trout/mile, then decreased at the site near the Questa Ranger Station, downstream of Capulin Canyon (Table 1, Fig. 2). At the next site downstream, just upstream of the fish hatchery diversion, resident trout density increased approximately 128% to a level that is within the range of the sites upstream of Hansen Creek. An increase of 358% was measured at the next site, justdownstream of the hatchery. Resident trout density in the Red River in 2000 was the highest at the site downstream from the fish hatchery. A similar pattern was observed in 1999, and was attributed to productivity enrichment from the hatchery outflow (CEC 2000).

Trout biomass can be another useful indicator of the status of the aquatic environment. While density can be skewed by high numbers of small, young-of-the-year (YOY) fish or low numbers of older, larger fish, biomass accounts for fish size (weight) and can be a more stable and useful indicator from year to year. In past reports, trout biomass was not the focus of our evaluation because much of the historic sources reported only density data. However, the results of fish sampling by CEC in 1997, 1998, 1999, and 2000 (as well as the more recent results from NMDGF) include biomass data, allowing year-to-year comparisons using this parameter. The trend in trout biomass in 2000 was similar to that of trout density, exhibiting higher levels upstream of Hansen Creek and downstream of Questa (Fig. 3).

The patterns in both trout density and trout biomass suggest that there may be at least three sections of the Red River showing negative impacts to aquatic biota. The data from 2000 and previous years clearly indicate that Hansen Creek continues to result in a substantial impact to the aquatic biota of the Red River. Our earlier reports also suggested that there were impacts near the town of Red River and/or from Bitter Creek or Hot-n-Tot Creek that resulted in the reductions in trout populations evident at the June Bug Campground site. The data for 2000 support this. There also appears to be a third impact area downstream of Goathill Campground. In 2000, trout density and biomass levels in the Red River at the site upstream of Columbine Creek and at Goathill Campground indicated some recovery was occurring from the impacts of Hansen Creek (Figs. 2 and 3). Dilution effects from Columbine Creek and YOY brown trout spawned in Columbine Creek may contribute to this recovery. However, at the next site downstream, near the Questa Ranger Station, trout population levels decreased substantially, suggesting further impacts downstream of Goathill Campground. Capulin Canyon and Capulin Springs discharge into the Red River just upstream of the site near the Questa Ranger Station, and may be responsible for the reduction in trout populations.

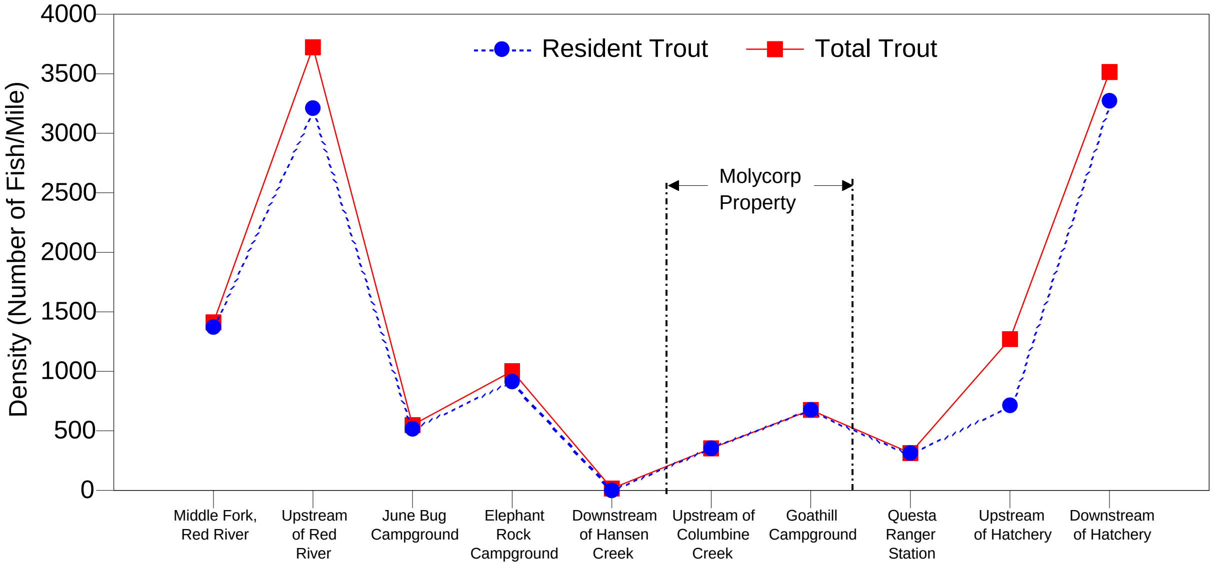


FIGURE 2: Trend in trout density (number of fish/mile) for data collected in fall 2000. Data represent results from all electrofishing passes. Resident trout excludes rainbow trout.

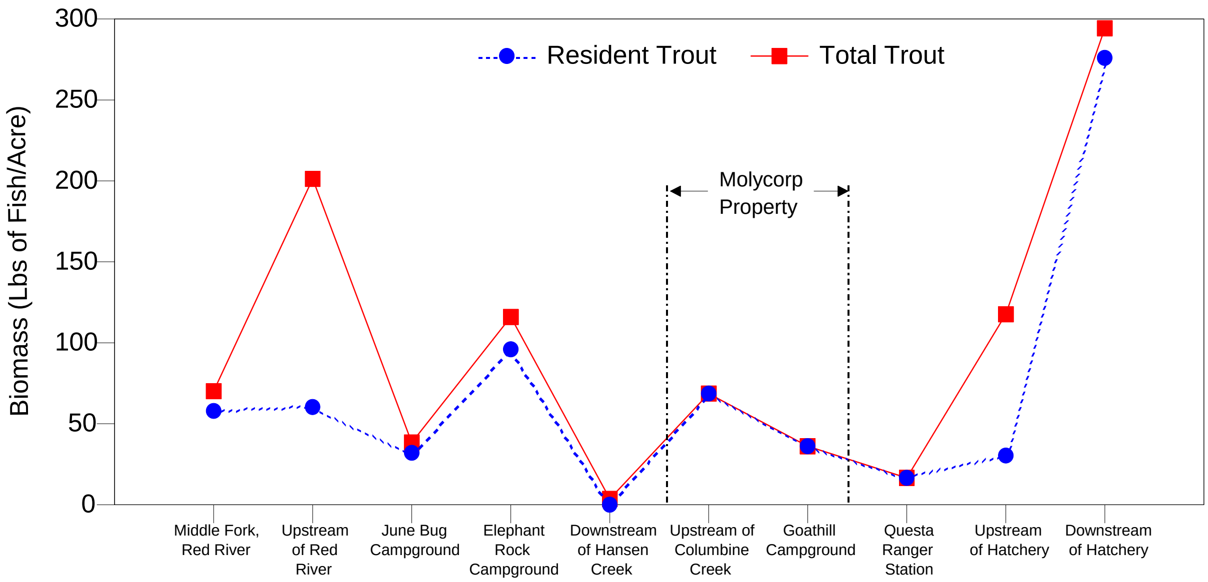


FIGURE 3: Trend in trout biomass (pounds of fish/acre) for data collected in fall 2000. Data represent results from all electrofishing passes. Resident trout excludes rainbow trout.

Cabresto and Columbine creeks represent unimpacted streams in the area. Although they are both smaller in size than the Red River, they give some suggestion of the range of trout density and biomass that may be expected in the Red River if no impacts were present. Resident trout densities in 2000 at the sites in the Red River downstream of the hatchery and upstream of the town of Red river were higher than resident trout density in Cabresto Creek (Table 1). Biomass of resident trout in Cabresto Creek was much less than found at the site downstream of the fish hatchery, reflecting the fact that resident fish are larger in the Red River. Density and biomass values for resident trout in Columbine Creek generally fall into the upper portion of the range present in the Red River in 2000. These comparisons suggest that in 2000, some sections of the Red River (the Middle Fork, upstream of Red River, near Elephant Rock Campground, downstream of the fish hatchery) compared favorably to other streams in the region, especially with respect to biomass (Table 1, Fig. 3).

Benthic Invertebrates

Columbine and Cabresto creeks represent relatively unimpacted streams in the Red River drainage. Therefore, benthic invertebrate population parameters for these two sites can be used as comparisons to evaluate the relative levels of impact in the Red River. The sites on the Middle Fork and on the Red River upstream of the town of Red River also are intended be used to represent conditions that are relatively unimpacted, at least with respect to the Molycorp mine. However, we tested this assumption by looking at the past and present data from these two sites on the Red River.

In 1999 and April 2000, population parameters were comparable between the site upstream of the town of Red River, the Middle Fork, and the two tributaries. Although some significant differences between these four sites were observed for density, number of taxa, and number of EPT taxa ($p < 0.05$), there was no clear pattern, which suggests natural variation. Although diversities in Columbine and Cabresto creeks were significantly greater ($p < 0.05$) than in the Middle Fork and in the Red River upstream of the town of Red River, they were all above the threshold value of 2.5 that generally indicates stress to benthic invertebrate communities (Wilhm 1970, Klemm *et al*. 1990).

In September 2000, an interesting pattern was observed, with values for most population parameters at the site on Columbine Creek having significantly lesser ($p < 0.05$) values than the other reference sites. However, except for a slightly reduced density compared to the other reference sites, values in Columbine Creek for the other parameters were high, indicative of a relatively unimpacted site. These results indicate that the two upstream sites on the Red River are comparable to the two unimpacted tributaries, and these four sites combined should provide suitable in-stream comparison data in order to evaluate impacts at the other Red River sites.

April 2000

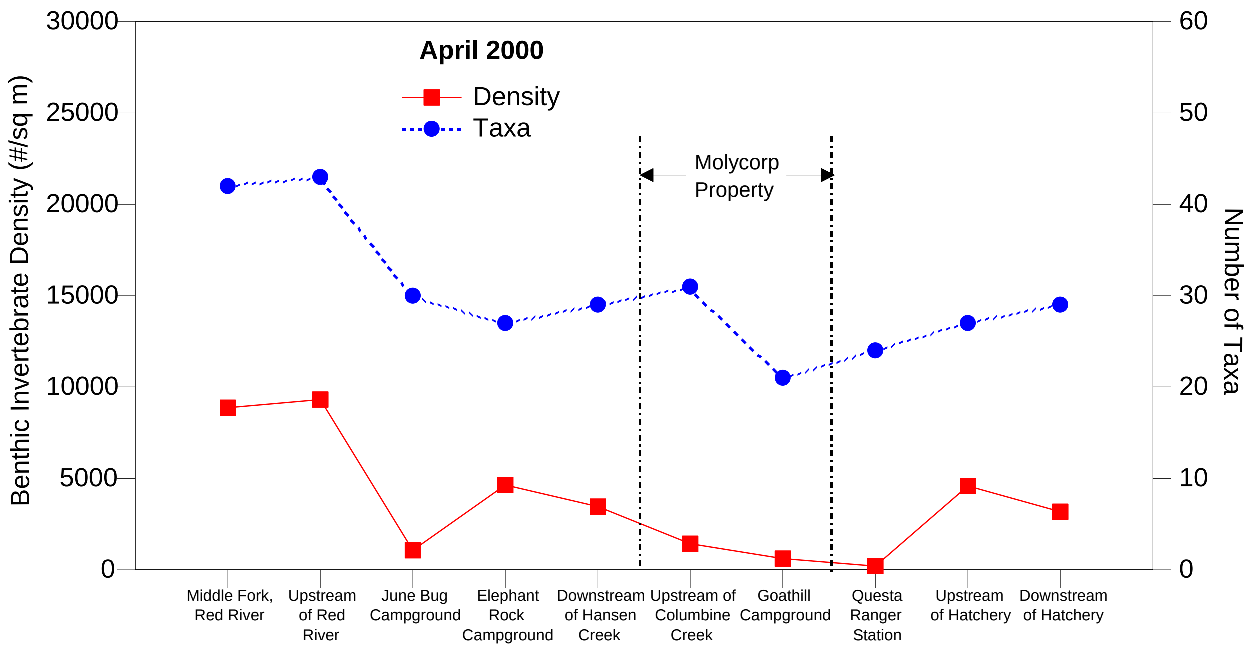
For one parameter (total number of taxa) in April 2000, the values at the four reference sites (combined) were significantly higher ($p < 0.05$) than at all the sites on the Red River from the town of Red River downstream to past the hatchery. Three other parameters (density, number of EPT taxa, and diversity) exhibited patterns in April 2000 in which three of four reference sites were significantly greater ($p < 0.05$) than most of the sites from the town of Red River to past the hatchery. This clearly indicates that there are significant impacts to benthic invertebrate populations along the length of the river downstream of the town of Red River. These parameters are commonly used to evaluate impacts due to water quality, and these significant differences imply that there are water quality impacts to the Red River along much of its length.

For the parameter of percent EPT taxa, surprisingly, the site at Goathill Campground had a significantly higher ($p < 0.05$) value than all other sites, including the reference sites. Three of the four reference sites had significantly higher values than the sites at the Questa Ranger Station, Elephant Rock Campground, and upstream of the hatchery diversion. The site below Hansen Creek was significantly less ($p < 0.05$) than only one reference site, at Columbine Creek. EPT data in metals-stressed streams can be complicated by the replacement of more sensitive Ephemeroptera (E) species by more tolerant Trichoptera (T) species (Clements 1994). However, this was not the case in the Red River in April 2000. The relative ratio of Ephemeroptera species to Trichoptera species did not change much along the length of the Red River (Appendix B). This ambiguous pattern of differences suggests there may be multiple physical and chemical impacts to benthic invertebrates along the length of the Red River, and that these impacts are not severe enough to eliminate the presence of some sensitive species.

Density was reduced in April 2000 at the first two sites downstream of the town of Red River, at June Bug and Elephant Rock campgrounds (Table 2, Fig. 4). Density at June Bug Campground was significantly less ($p < 0.05$) than at all four reference sites. Density began to recover at Elephant Rock Campground (Table 2, Fig. 4), which had a significantly higher ($p < 0.05$) density than at June Bug Campground, and which was significantly less ($p < 0.05$) than only one reference site, the Middle Fork. Other population parameters (total number of taxa, number of EPT taxa, and percent EPT taxa) also appeared reduced at these two sites compared to the reference sites (Table 2, Fig. 4). Based on replicate data, values for total number of taxa and number of EPT taxa at June Bug and Elephant Rock campgrounds in April 2000 were significantly less ($p < 0.05$) than at least three of the reference sites, although some sensitive taxa (i.e., EPT) are still able to survive at these two sites. Although mean diversity values were also significantly less ($p < 0.05$) than at least three reference sites, overall diversities were greater than 2.5, indicating balanced populations. These population data indicate that some impacts (possibly enrichment and sedimentation) are occurring between the town of Red River and Hansen Creek, but that conditions are still adequate to support sensitive forms.

TABLE 2 Benthic invertebrate population parameters for collection sites on the Red River and tributaries. Data collected in April 2000 by Chadwick Ecological Consultants, Inc.

Site	Density (#/m^2)	Total # of Taxa	# EPT Taxa	EPT Taxa as % Total Taxa	Diversity Index (H')
Middle Fork, Red River (Reference)	8,862	42	25	60	3.46
Red River					
Upstream of Town of Red River (Reference)	9,316	43	22	51	3.78
June Bug Campground	1,072	30	15	50	3.38
Downstream Elephant Rock Campground, upstream of Hansen Creek	4,640	27	12	44	2.68
Downstream of Hansen Creek, upstream of mill	3,456	29	17	59	2.72
Downstream of mill, upstream of Columbine Creek	1,422	31	18	58	3.43
Goathill Campground	616	21	14	67	2.70
Upstream of Questa Ranger Station	202	24	11	46	3.33
Upstream of hatchery diversion	4,588	27	13	48	2.85
Downstream of hatchery	3,176	29	13	45	3.00
Tributaries					
Columbine Creek (Reference)	2,520	52	34	65	4.42
Cabresto Creek (Reference)	8,318	46	26	57	4.23



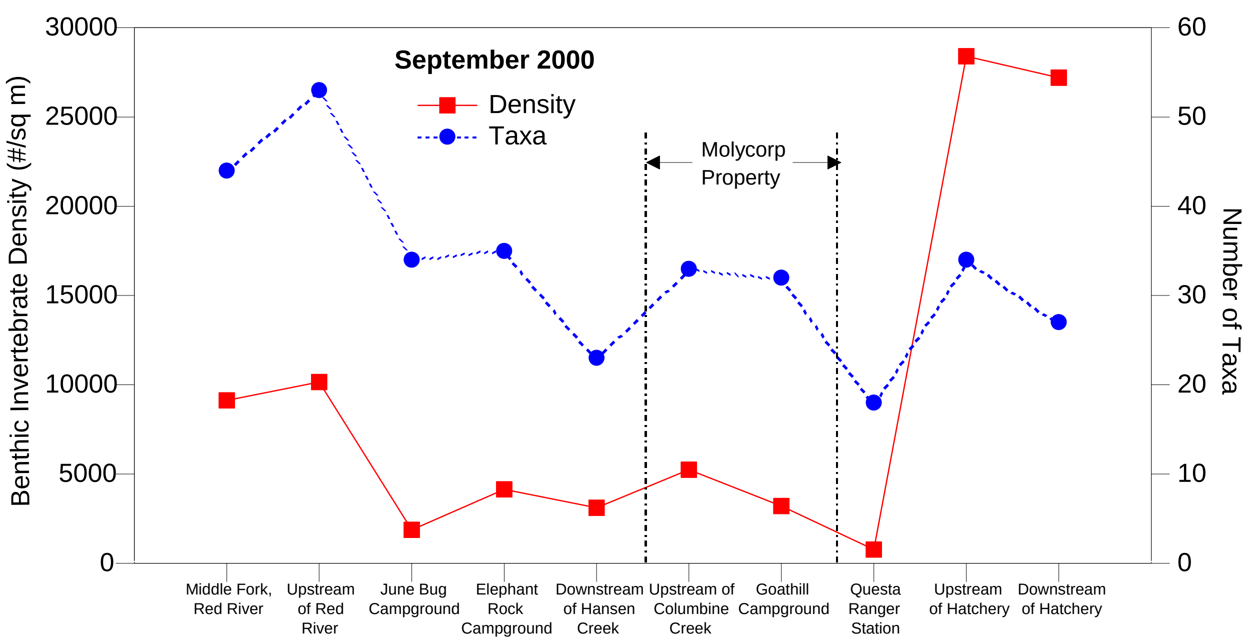


FIGURE 4: Trends in benthic invertebrate density and number of taxa for data collected in April 2000 (top) and September 2000 (bottom).

Downstream of Hansen Creek, benthic invertebrate populations were reduced compared to the reference sites (Table 2, Fig. 4). Density in April 2000 was significantly less ($p < 0.05$) than three of four reference sites (Table 2, Fig. 4). Based on replicate data, values for total number of taxa, number of EPT taxa, and diversity downstream of Hansen Creek were significantly less ($p < 0.05$) than all four reference sites. The value for percent EPT taxa was significantly less ($p < 0.05$) than only one reference site, on Columbine Creek. Values for total number of taxa and diversity indicated similar population levels between the sites at Elephant Rock Campground and downstream from Hansen Creek (Table 2). There was a 25% reduction in density from the Elephant Rock Campground site to the downstream Hansen Creek site. However, replicate data indicated that neither density nor diversity were significantly different ($p > 0.05$). Number of EPT taxa and % EPT taxa increased downstream of Hansen Creek compared to Elephant Rock Campground (Table 2), and this difference was significant ($p < 0.05$), indicating further recovery in some population parameters. However, reduced population parameters downstream of Hansen Creek compared to most of the reference sites indicates the presence of water quality impacts.

At the two sites adjacent to the Molycorp property (the site downstream of the mill/upstream of Columbine Creek and the site at Goathill Campground) in April 2000, density was reduced relative to the reference sites and the site downstream of Hansen Creek (Table 2, Fig. 4), and these differences were significant ($p < 0.05$). Although total number of taxa and number of EPT taxa at the sites adjacent to the Molycorp property were significantly reduced ($p < 0.05$) relative to the reference sites (Table 2), they were not significantly different ($p > 0.05$) from the site downstream from Hansen Creek. Diversities at both of these sites were greater than 2.5, indicating balanced communities (Table 2). In fact, based on replicate data, diversity at the site downstream of the mill/upstream of Columbine Creek was significantly greater ($p < 0.05$) than at the site downstream of Hansen Creek. The species composition at the two sites adjacent to the Molycorp property included numerous mayfly species, which are considered to be particularly sensitive to metals impacts (Clements 1991, 1994; Clements *et al*. 1988) as well as stoneflies and caddisflies (Appendix B), which can be more tolerant. Although densities at these two sites were reduced relative to the site downstream of Hansen Creek, total number of taxa and number of EPT taxa were similar, and diversities indicated balanced populations. The high percentage of EPT taxa and the presence of multiple mayfly species indicate that this reach of the river is able to sustain sensitive aquatic insect species.

The site at the Questa Ranger Station had reduced values for density, total number of taxa, and number of EPT taxa in April 2000 compared to most other study sites (Table 2, Fig. 4), and these differences were significant ($p < 0.05$). These data indicate significant impairment to the aquatic community. However, four taxa of mayflies were present, and overall diversity was among the highest observed for non-reference sites. These data indicate a continuing impact downstream of Capulin Canyon and Capulin Springs leading to reduced density, total number of taxa, and number of EPT taxa, but that some sensitive forms of benthic invertebrates are still present.

The final two sites on the Red River, upstream and downstream of the fish hatchery, demonstrated the recovery in density and total number of taxa in April 2000 (Table 2, Fig. 4), which had significantly greater values ($p< 0.05$) than the sites at Goathill Campground and above the Questa Ranger Station. Number of EPT taxa was also significantly greater ($p < 0.05$) at these sites than at the site above the Questa Ranger Station. This recovery is probably due, in part, to the input of diluting water from Cabresto Creek.

The overall longitudinal trend along the Red River in April 2000 shows a gradual declining pattern in the total number of taxa, with the lowest values at Goathill Campground and the Questa Ranger Station, and a recovery downstream of Cabresto Creek (Fig. 4). Although impacts are evident, these impacts do not render the river unsuitable to benthic invertebrates.

The trend in benthic invertebrate density in the Red River in April 2000 was more variable than that for number of taxa (Fig. 4). The greatest difference in densities between the highest and lowest sites was a 98% reduction, while the greatest difference for number of taxa was 51%. Four of the ten sites sampled in the Red River contained densities of invertebrates greater than 4,500/m^2, while lower densities were found at June Bug Campground and the sites from Hansen Creek downstream to the Questa Ranger Station (Fig. 4).

The benthic invertebrate data in April 2000 indicate three general areas of impact on the Red River. However, trends in benthic invertebrate data, especially number of taxa, are not as clear as they were for fish population parameters. The first general area exhibiting impacts occurs downstream of the town of Red River (i.e., June Bug Campground), where impacts have consistently been documented in the past (CEC 1997, 1998, 1999, 2000). In April 2000, these impacts resulted in a substantial reduction in density, and smaller differences in the other population parameters (Table 2). The most extensive section of impact in April 2000 occurs downstream of Hansen Creek. The most severe impact in this section appears downstream of Capulin Canyon and Capulin Springs, at the Questa Ranger Station. Density at this site exhibited a 98% reduction from the site upstream of the town of Red River.

<u>September 2000</u>

The overall pattern in the Red River drainage in September 2000 indicated that values for number of EPT taxa and diversity were significantly greater ($p < 0.05$) at all four reference sites compared to the sites on the Red River from June Bug Campground downstream to past the hatchery. Density and number of taxa were greater for at least three of the four reference sites compared to most of the sites from June Bug Campground downstream to the Questa Ranger Station. As in April 2000, these differences between the reference sites and the sites downstream of the town of Red River indicate significant impacts to the benthic invertebrate populations.

Density was reduced at June Bug and Elephant Rock campgrounds relative to the reference sites, similar to April 2000 (Table 3, Fig. 4). Density at June Bug Campground was significantly less ($p < 0.05$) than all four reference sites. At Elephant Rock Campground, density was significantly less ($p < 0.05$) than three of the four reference sites. Density was significantly higher ($p < 0.05$) at Elephant Rock Campground compared to June Bug Campground, indicating a longitudinal recovery was occurring between these two sites. Values for the other population parameters also appeared reduced at these two sites (Table 3, Fig. 4). Replicate data showed diversity and number of EPT taxa at June Bug and Elephant Rock campgrounds were significantly less ($p < 0.05$) than all four reference sites, and number of taxa significantly less ($p < 0.05$) than at least two reference sites. However, sensitive taxa (i.e., EPT taxa) were still present, and diversity values greater than 2.50 indicated balanced populations (Table 3).

The overall pattern for percent EPT taxa in September 2000 was not as clear as the other parameters. All four reference sites had significantly higher ($p < 0.05$) values than only three sites, at Elephant Rock Campground, below Hansen Creek, and below the hatchery.

TABLE 3 Benthic invertebrate population parameters for collection sites on the Red River and tributaries. Data collected in September 2000 by Chadwick Ecological Consultants, Inc.

Site	Density (#/m^2)	Total # of Taxa	# EPT Taxa	EPT Taxa as % Total Taxa	Diversity Index (H')
Middle Fork, Red River (Reference)	9,124	44	20	45	4.25
Red River					
Upstream of Town of Red River (Reference)	10,156	53	26	49	4.39
June Bug Campground	1,874	34	14	41	2.90
Downstream of Elephant Rock Campground, upstream of Hansen Creek	4,140	35	12	34	3.08
Downstream of Hansen Creek, upstream of mill	3,112	23	8	35	2.89
Downstream of mill, upstream of Columbine Creek	5,240	33	16	48	2.82
Goathill Campground	3,204	32	14	44	3.21
Upstream of Questa Ranger Station	770	18	8	44	2.70
Upstream of hatchery diversion	28,396	34	14	41	2.46
Downstream of hatchery	27,208	27	9	33	3.11
Tributaries					
Columbine Creek (Reference)	5,414	45	24	53	3.72
Cabresto Creek (Reference)	7,700	47	26	55	4.22

Population parameters in September 2000 at the site downstream of Hansen Creek were reduced compared to the reference sites and Elephant Rock Campground (Table 3, Fig. 4). Density below Hansen Creek was significantly less ($p < 0.05$) than all four reference sites. Although not significantly different from the density at Elephant Rock Campground, the trend data indicated a 25% decrease from Elephant Rock Campground to the site below Hansen Creek (Table 3). Based on replicate data, values for total number of taxa, number of EPT taxa, diversity, and EPT taxa as % of total taxa were significantly less ($p < 0.05$) than all four reference sites. Compared to Elephant Rock Campground, values for total number of taxa and number of EPT taxa were significantly less ($p < 0.05$) at the site downstream of Hansen Creek. Although not significantly different, diversity below Hansen Creek was also lower than at Elephant Rock Campground. Similar to April 2000, the reduced population below Hansen Creek compared to the reference sites indicates water quality impacts in this section of the Red River.

Benthic invertebrate populations were reduced in September 2000 at the two sites adjacent to the Molycorp property (the site downstream of the mill/upstream of Columbine Creek and the site at Goathill Campground) compared to the reference sites (Table 3, Fig. 4). Total number of taxa, diversity, and number of EPT taxa at these two sites were all significantly less ($p < 0.05$) than at all four reference sites, and density was significantly less ($p < 0.05$) than at least two reference sites. However, population parameters at these two sites adjacent to the Molycorp property were generally greater than the next site upstream, just below Hansen Creek (Table 3, Fig. 4). Total number of taxa, number of EPT taxa, and percent EPT taxa were all significantly greater ($p < 0.05$) at both sites compared to the site below Hansen Creek. Additionally, density was significantly greater ($p < 0.05$) below the mill compared to below Hansen Creek, and diversity was significantly greater ($p < 0.05$) at Goathill Campground. These data indicate that populations adjacent to the Molycorp property were more abundant, and contained a higher proportion of sensitive taxa compared to the site below Hansen Creek. In addition, diversity values at these two sites indicated balanced populations.

The site at the Questa Ranger Station had a reduced population in September 2000 compared to the reference sites and most of the other sites (Table 3, Fig. 4). Values for density, total number of taxa, number of EPT taxa, and diversity were all significantly less ($p < 0.05$) than all four reference sites. As in April 2000, these patterns indicate significant impairment to the aquatic community. However, EPT taxa were still present, including four mayfly taxa, indicating conditions sufficient to support at least some forms of sensitive taxa.

The furthest downstream sites, above the hatchery diversion and below the hatchery, had much greater densities than all the other sites, including the reference sites (Table 3, Fig. 4), with these differences being significant ($p < 0.05$). The high densities were due to abundance assemblages of *Eukiefferiella* sp. (a true fly) at both sites, and due to *Ochrotrichia* sp. and *Hydropsyche* sp. (two caddisfly taxa) at the site below the hatchery (Appendix B). Although values for total number of taxa, diversity, and number of EPT taxa were all significantly less ($p < 0.05$) at both sites compared to the reference sites, generally higher values compared to the site at the Questa Ranger Station indicated a recovery is occurring in this lower portion of the study reach.

The greater densities of the three taxa discussed above at the lowest two sites are probably related to several factors affected by low flows in 2000. Based on U.S. Geological Survey (USGS) data, flows in 2000 were relatively low (USGS unpubl. data). Since higher flows tend to dislodge benthic invertebrates, and taxa such as *Hydropsyche* sp. are better adapted to lower flows (Allan 1995), low flows in 2000 probably did not dislodge as many benthic invertebrates compared to previous years. Additionally, there are two sources of nutrient input downstream of the town of Questa - the Questa sewage treatment facility and the Red River Fish Hatchery. Low flows in the Red River in 2000 would have less of a dilution effect on these nutrient inputs, thus increasing productivity and probably increasing densities of at least some taxa. Low flows would also tend to increase water temperatures and, in kind, productivity. These three factors probably promoted higher densities of *Eukiefferiella* sp., *Hydropsyche* sp., and *Ochrotrichia* at the lowest two sites on the Red River.

The longitudinal patterns for benthic invertebrate populations in September 2000 were generally similar to April 2000, and reflect the overall pattern observed in 2000 and in previous years. There was a general declining pattern in density, total number of taxa, and number of EPT taxa, with the lowest values near the Questa Ranger Station, and the beginning of a recovery downstream of Cabresto Creek (Fig. 4). There were three general areas of impact on the Red River in September 2000: downstream of the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon, extending down to the Questa Ranger Station.

Sediment

Fine Sediment and Texture Analysis

The percentage of fine sediment in riffles in April 2000 varied relatively little from site to site along the length of the Red River (Table 4). The percentage of fines in the Red River ranged from 4.0% at the site downstream of the mill and upstream of Columbine Creek to 30.4% at the site upstream of the hatchery diversion. The average value for the sites downstream of the town of Red River was 11.3% fines. This is similar to the average of 12.3% found in the four reference sites (Columbine and Cabresto creeks, the Middle Fork of the Red River, and the site upstream of the town of Red River). There is no clear longitudinal trend in the percent of fine sediment in riffles along the length of the Red River. Regression analysis indicated that there was no relationship in April 2000 between percent fine sediment and benthic invertebrate density (p = 0.61).

TABLE 4: Percentage of fines and texture analysis of sediment samples from the Red River and tributaries, April 2000.

Site	% Fines (<2 mm)	Texture		
		% Clay	% Silt	% Sand
Middle Fork, Red River (Reference)	9.2	4	15	81
Red River				
Upstream of Town of Red River (Reference)	12.8	5	15	80
June Bug Campground	12.5	2	15	83
Downstream of Elephant Rock Campground, upstream of Hansen Creek	7.5	5	15	80
Downstream of Hansen Creek, upstream of mill	6.0	8	11	81
Downstream of mill, upstream of Columbine Creek	4.0	15	5	80
Goathill Campground	9.7	2	10	88
Upstream of Questa Ranger Station	8.5	0	15	85
Upstream of hatchery diversion	30.4	0	2	98
Downstream of hatchery	11.9	1	5	94
Tributaries				
Columbine Creek (Reference)	15.0	2	10	88
Cabresto Creek (Reference)	12.3	0	5	95

The lack of a longitudinal trend in fine sediment, despite the presence of point sources of sediment in the drainage, is probably due to two factors. The first, and probably most important, factor is that the sediment samples were taken from riffle areas similar to the benthic invertebrate sampling locations. These areas of the stream are erosional; the fines apparently are not accumulating in riffles. Although there is sediment accumulation in other habitat types (runs and pools), especially at sites from the town of Red River downstream to the Questa Ranger Station (based on visual observation), the absence of a longitudinal trend indicates that the sediment load does not exceed the ability of the river to keep excessive levels of sediment from accumulating in the riffles.

The second factor is related to the actual sampling technique used. The freeze core method has been shown to be very effective in quantifying the amount of fine material in the substrate (Petts *et al*. 1989). The technique involves driving the core sampler into the substrate. While pounding the sampler with a sledge hammer, the deposited fine sediment on the surface of the substrate may be dislodged and lost downstream. Although this technique was the same at every sampling site, it would probably have a greater effect at sampling locations with higher current velocities and/or more densely packed substrate (which requires more pounding to drive in the sampler). However, based on our visual observations, this factor was minor and the riffles at the various sites appeared to be similar in the amount of fines present in 2000.

The texture of the fine sediment varied relatively little among sites in April 2000. Sand accounted for 80-98% of the fine material at all sites (Table 4). Clay particles were present at most sites in small amounts. The highest proportion of clay was found at the site downstream from the mill and upstream of Columbine Creek. Silt particles were more abundant than clay particles at most of the sites in April 2000.

In September 2000, the abundance of fines in the Red River ranged from 19.0% at the site just upstream of the Questa Ranger Station to 27.8% at Goathill Campground (Table 5). Three sites on the Red River were not analyzed for percent fines and texture in September 2000, due to accidental mixing of samples by the analytical laboratory, thus compromising the sample quality. Percent fines in September did not vary appreciably between sites. The average value for the sites downstream of the town of Red River was 21.8% fines. This is similar to the average of 21.9% for three of the four reference sites (Columbine and Cabresto creeks and the Red River upstream of the town of Red River). As in April, there was no discernable longitudinal trend in percent fines along the length of the Red River. Regression analysis indicated no significant relationship in September 2000 between percent surface fines and density of benthic invertebrates in the Red River ($p = 0.99$).

Sediment texture varied little between sites in September 2000, similar to April (Table 5). Sand comprised 75 % to 90 % of the fine material at all sites. Clay comprised from 8 % to 12 % of the sediment, and silt usually less, comprising 0% to 13%.

TABLE 5: Percentage of fines and texture analysis of sediment samples from the Red River and tributaries, September 2000. NC = not calculated; due to lab error, samples for fines and texture compromised.

Site	% Fines (<2 mm)	Texture		
		% Clay	% Silt	% Sand
Middle Fork, Red River	NC	NC	NC	NC
Red River				
Upstream of Town of Red River	23.8	12	13	75
June Bug Campground	19.8	12	8	80
Downstream of Elephant Rock Campground, upstream of Hansen Creek	20.2	10	2	88
Downstream of Hansen Creek, upstream of mill	22.5	10	4	86
Downstream of mill, upstream of Columbine Creek	NC	NC	NC	NC
Goathill Campground	27.8	10	0	90
Upstream of Questa Ranger Station	19.0	10	2	88
Upstream of hatchery diversion	NC	NC	NC	NC
Downstream of hatchery	21.2	8	2	90
Tributaries				
Columbine Creek	17.6	8	2	90
Cabresto Creek	24.3	10	5	85

Stream sediment characteristics exhibited seasonal variability in 2000. Percent fines increased from April to September 2000 at all nine sites that had data for both sampling periods (Tables 4 and 5). This included sites on the Red River downstream of the town of Red River and the reference sites. The seasonal averages for percent fines in study sites in the Red River downstream of the town of Red River were 11.3% in April and 21.8% in September 2000. A similar increase was observed at the reference sites, increasing from an average of 12.3% in April to 21.9% in September. This increase could be due to lower flows, typical of fall, losing their capacity to carry sediment downstream, thus leading to deposition within the study area. Lower velocities, especially during low flow conditions during summer months, can lead to increased amounts of fines being deposited into stream substrates (Giles *et al*. 1991, as cited in Wood and Armitage 1997).

Sediment texture also varied between seasons in 2000. The percent abundance of silt in bottom sediments decreased from April to September at eight of the nine sites having data for both seasons (Tables 4 and 5). Conversely, percent abundance of clay increased at all nine of those sites over the same time period. Seasonal variability in the percentage of sand was not as clear, increasing at some sites and decreasing at others.

Metals Analysis

Results of the sediment metals analysis from April 2000 indicated that concentration of metals was variable between sites, with only one clear longitudinal trend (Table 6, Fig. 5). Zinc exhibited the clearest longitudinal pattern for sediment concentrations, with values increasing in a downstream direction. Sediment from the study site downstream of the fish hatchery had the highest concentration (208 mg/Kg), followed by the sites near Goathill Campground and the Questa Ranger Station (136 and 124 mg/Kg, respectively). A similar pattern was observed in 1999.

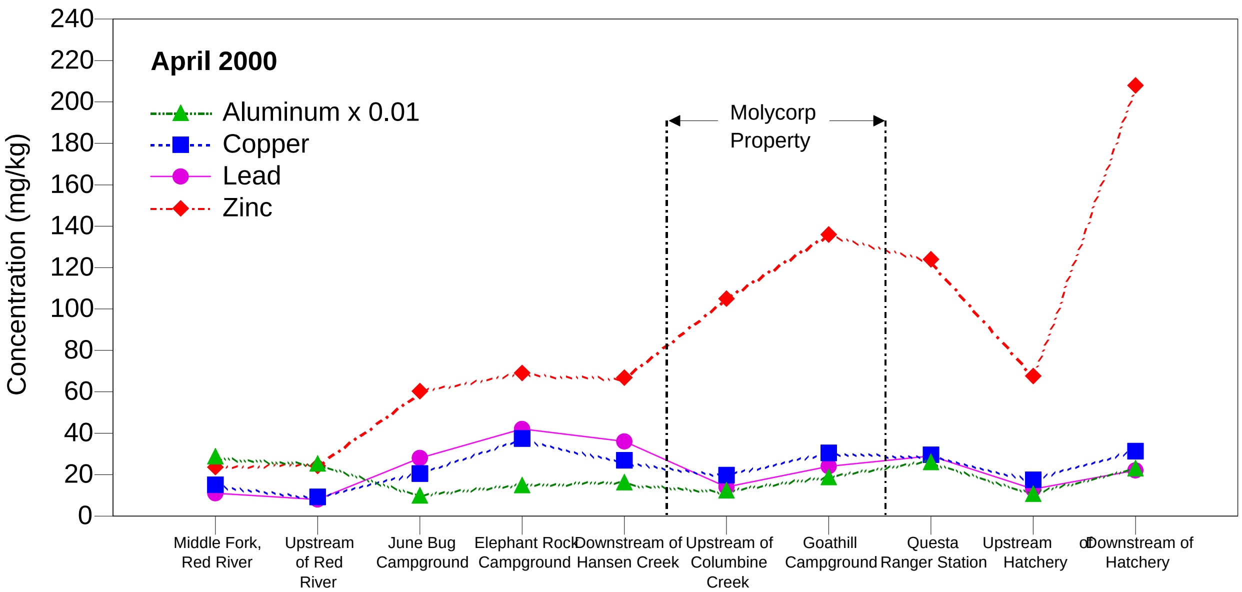
Cadmium concentrations were low, ≤ 0.7 mg/Kg at all sites. Aluminum concentrations did not have a clear longitudinal pattern, with some of the highest concentrations in the reference sites on the tributaries and the upper two sites on the Red River. The highest concentration of aluminum downstream from the town of Red River was measured at the study site downstream of Capulin Springs and upstream of the Questa Ranger Station, with a value of 2,610 mg/Kg (Table 6, Fig. 5). The lowest value (1,000 mg/Kg) was observed at June Bug Campground.

Copper, lead, and zinc sediment concentrations in April 2000 began to increase appreciably at the site just downstream of the town of Red River compared to the reference sites on the Red River (Fig. 5). Levels of copper in sediments downstream of the town of Red River in April 2000 were higher than in sediments from the reference sites on the upper Red River and in Columbine and Cabresto creeks (Table 6). Interestingly, levels of lead in sediments from all the sites on the Red River were less than from Columbine Creek (Table 6). Levels of zinc in sediments from the first three sites downstream of the town of Red River were substantially higher than the reference sites upstream of town, but closer in value (and still higher) than the reference sites on Columbine and Cabresto creeks (Table 6).

TABLE 6: Concentration of metals (mg/Kg) in sediment samples from study sites on the Red River and tributaries, April 2000.

	Sediment Concentration (mg/Kg)				
Site	Aluminum	Cadmium	Copper	Lead	Zinc
Middle Fork, Red River (Reference)	2,890	<0.2	15	11	24
Red River					
Upstream of Town of Red River (Reference)	2,540	<0.2	9	8	24
June Bug Campground	1,000	<0.2	21	28	60
Downstream Elephant Rock Campground, upstream of Hansen Creek	1,500	0.2	37	42	69
Downstream of Hansen Creek, upstream of mill	1,640	<0.2	27	36	67
Downstream of mill, upstream of Columbine Creek	1,250	0.3	20	14	105
Goathill Campground	1,890	0.4	31	24	136
Upstream of Questa Ranger Station	2,610	<0.2	30	29	124
Upstream of hatchery diversion	1,080	0.2	18	13	68
Downstream of hatchery	2,310	0.7	31	22	208
Tributaries					
Columbine Creek (Reference)	3,180	0.2	13	45	57
Cabresto Creek (Reference)	1,060	<0.2	7	9	48

In regard to sediment criteria for heavy metals, very few reference criteria have been published to date, although Ontario, Canada has sediment criteria that include cadmium, copper, lead, and zinc (Persaud *et al*. 1993). Their sediment quality guidelines have three levels of effect - No Effect Level, Lowest Effect Level, and Severe Effect Level. The No Effect Level describes concentrations that do not affect fish or benthic invertebrates. Sediment at this level is considered clean. The Lowest Effect Level describes concentrations that have no effect on the majority of the fish and benthic invertebrates. Sediment at this level is considered clean to marginally polluted. The Severe Effect Level describes concentrations that are likely to effect the health of fish and benthic invertebrates. Sediment at this level is considered heavily polluted. The latter two levels are based on the long-term effects which the contaminants may have on the sediment-dwelling organisms (benthic invertebrates).



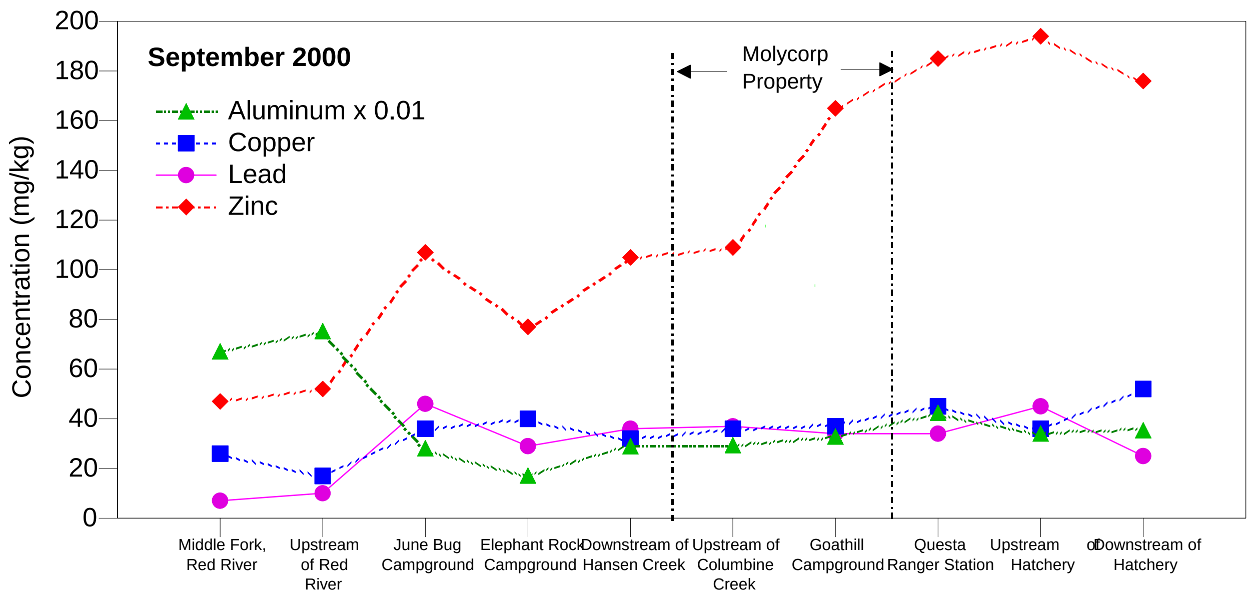


FIGURE 5: Sediment concentrations of aluminum, copper, lead, and zinc from study sites in the Red River drainage, April 2000 (top) and September 2000 (bottom).

The metal concentrations in the sediment samples from the Red River drainage in April 2000 were compared to the Ontario standards. Cadmium concentrations in April 2000 were all less than the Lowest Effect Level of 0.6 mg/Kg, except for the site downstream of the hatchery, which had a cadmium concentration of 0.7 mg/Kg (Table 6). Copper concentrations in the Red River drainage in April 2000 ranged from 6 to 37 mg/Kg, with sites downstream of the town of Red River being above the Lowest Effect Level of 16 mg/Kg, but much less than the Severe Effect Level of 110 mg/Kg. Concentrations of lead ranged from 8 to 45 mg/Kg in the drainage, with only three sites (Elephant Rock, downstream of Hansen Creek, and Columbine Creek) having levels higher than the Lowest Effect Level of 31 mg/Kg. These three sites had levels of lead just barely above the Lowest Effect Level, and much less than the Severe Effect Level of 250 mg/Kg. Zinc concentrations ranged from 24 to 208 mg/Kg, with three sites (Goathill, Questa Ranger Station, and downstream of the hatchery) surpassing the Lowest Effect Level of 120 mg/Kg. However, these concentrations were much less than the Severe Effect Level for zinc of 820 mg/Kg.

Sediment metals analysis from September 2000 also indicated variability between sites (Table 7, Fig. 5). Zinc was the only metal to exhibit a clear longitudinal trend, with values increasing in a downstream direction. The site upstream of the fish hatchery diversion had the highest concentration (194 mg/Kg), followed by the sites near the Questa Ranger Station and the site downstream of the hatchery (185 and 176 mg/Kg, respectively). This pattern of increased sediment zinc concentrations in a downstream direction is similar to the pattern observed in April 2000 (Fig. 5).

Cadmium concentrations in September 2000 were low, $\leq$0.7 mg/Kg at all sites. Aluminum concentrations in September 2000 were highest at the four reference sites upstream of the town of Red River and in the tributaries. There was a slight increasing trend in sediment aluminum concentrations from Elephant Rock Campground downstream to the Questa Ranger Station (Table 7, Fig. 5).

Similar to April, copper, lead, and zinc sediment concentrations in September 2000 increased appreciably at June Bug Campground, the first site downstream of the town of Red River (Table 7, Fig. 5). Copper concentrations in the Red River sediments downstream of town were all greater than in sediments from the reference sites (Table 7). Lead concentrations in sediments downstream of town were all greater than the reference sites in the Red River upstream of town, but similar to those in sediments from Columbine

Creek. Interestingly, sediment aluminum concentrations decreased dramatically downstream of the town of Red River, where they were all lower than three of the four reference sites (Fig. 5).

TABLE 7: Concentration of metals (mg/Kg) in sediment samples from study sites on the Red River and tributaries, September 2000.

	Sediment Concentration (mg/Kg)				
Site	Aluminum	Cadmium	Copper	Lead	Zinc
Middle Fork, Red River (Reference)	6,710	<0.2	26	7	47
Red River					
Upstream of Town of Red River (Reference)	7,530	<0.2	17	10	52
June Bug Campground	2,810	0.5	36	46	107
Downstream Elephant Rock Campground, upstream of Hansen Creek	1,720	0.2	40	29	77
Downstream of Hansen Creek, upstream of mill	2,900	<0.2	32	36	105
Downstream of mill, upstream of Columbine Creek	2,940	0.2	37	37	109
Goathill Campground	3,290	0.5	37	34	165
Upstream of Questa Ranger Station	4,240	0.5	45	34	185
Upstream of hatchery diversion	3,410	0.6	36	45	194
Downstream of hatchery	3,540	0.7	52	25	176
Tributaries					
Columbine Creek (Reference)	4,700	0.3	18	31	78
Cabresto Creek (Reference	4,080	<0.2	9	17	82

Upon comparison with the Ontario sediment standards, cadmium concentrations in September 2000 were less than or equal to the Lowest Effect Level of 0.6 mg/Kg, except for the site downstream of the hatchery, with a value of 0.7 mg/Kg (Table 7). Copper concentrations in the Red River drainage in September 2000 ranged from 9 to 52 mg/Kg, with almost all sites greater than the Lowest Effect Level of 16 mg/Kg, but much less than the Severe Effect Level of 110 mg/Kg. Lead concentrations ranged from 7 to 46 mg/Kg in the drainage, with seven sites having values greater than or equal to the Lowest Effect Level of 31 mg/Kg, including the reference site on Columbine Creek (Table 7). All lead concentrations were much less than the Severe Effect Level of 250 mg/Kg. Zinc concentrations in September 2000 ranged from 47 to 194 mg/Kg, with four sites (from Goathill Campground downstream to below the hatchery) surpassing the Lowest

Effect Level of 120 mg/Kg (Table 7). However, all these concentrations were much less than the zinc Severe Effect Level of 820 mg/Kg.

The data from the April and September heavy metals analysis for sediments from the Red River drainage indicated that sediment metal concentrations sometimes exceeded the Lowest Effect Levels, but were always much less than the Severe Effects Levels. These results suggest that sediment metals concentrations do not pose a severe threat to fish and benthic invertebrates in the Red River drainage.

The Ontario guidelines did not include effect levels for aluminum, so sediment concentrations from the Red River drainage were compared to results from another study. In the lower Rio Grande Valley and Laguna Atascosa National Wildlife Refuge, Texas, sediment concentrations of aluminum ranged from 940 to 20,000 mg/Kg, which were within the baseline concentrations for soils in the western conterminous United States (Wells *et al*. 1988). Sediment concentrations in the Red River drainage in April and September 2000 ranged from 1,000 to 3,180 mg/Kg, and from 1,720 to 7,530 mg/Kg, respectively, with the higher levels from the tributaries and the upstream reference sites. All of these concentrations were within the range reported from Texas, and within baseline concentrations for the western United States.

There were some significant relationships ($p < 0.05$) between levels of metals in sediments and benthic invertebrate population parameters (Fig. 6 and Appendix C). In April and September 2000, levels of copper had a significant, negative relationship with number of taxa, number of EPT taxa, and diversity. Aluminum and zinc had significant relationships in September 2000 with number of taxa, number of EPT taxa, and diversity. Although the relationship with zinc was negative, as with copper, the relationship with aluminum was positive. This means that sites with higher aluminum concentrations also had higher values for the benthic invertebrate population parameters, which challenges common sense. However, the highest aluminum levels in the Red River in September 2000 were at the two reference sites, above the town of Red River. These two sites artificially created the positive relationship. There may be other factors in this section of river positively affecting benthic invertebrate populations, overriding any potential effects from aluminum, thus producing the positive relationship. When these two sites were dropped as outliers from the analysis of aluminum (an accepted statistical method), there were no significant relationships between aluminum and any benthic invertebrate population parameters.

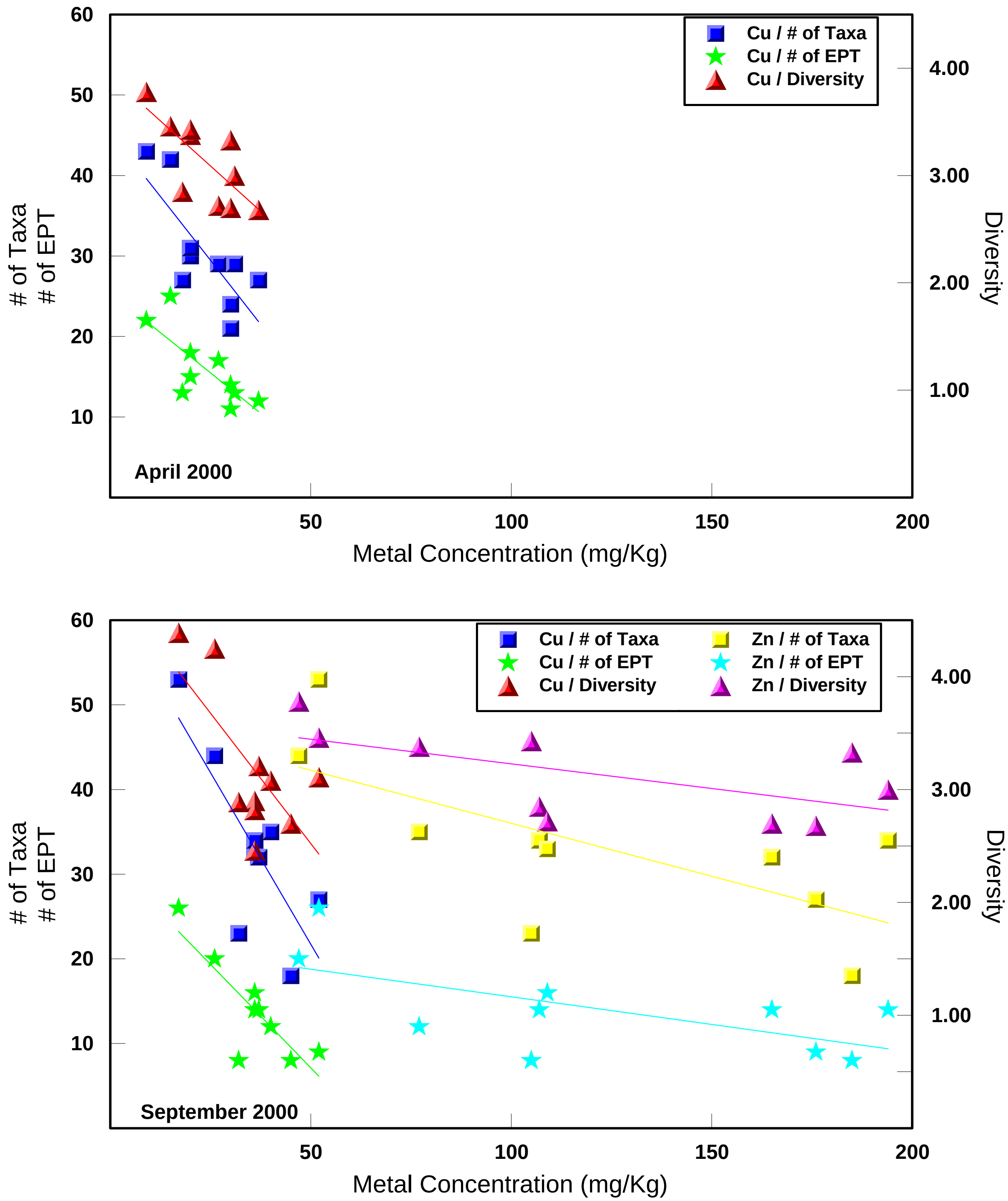


FIGURE 6: Significant ($p < 0.05$) negative relationships between sediment metal concentrations and benthic invertebrate population parameters from study sites in the Red River drainage, April 2000 (top) and September 2000 (bottom).

As discussed above, there were significant negative relationships between two metals, copper and zinc, and three population parameters, number of taxa, number of EPT taxa, and diversity (Fig. 6). These data suggest that sediment levels of these metals have some impact on populations of benthic invertebrates in the Red River.

Toxicity Testing

None of the *C. dubia* exposed to Red River water column samples were determined to have had significant ($p < 0.05$) impacts on survival. All concentrations were observed to have between 90% and 100% survival at the end of seven days exposure (Table 8). However, mean *C. dubia* reproduction was significantly ($p < 0.05$) reduced, relative to a corresponding control, at the Zweigle Dam reference site (11.8 vs. 18.2 neonates), at the site downstream of Hansen Creek (12.1 vs. 26.4 neonates), at Goat Hill Campground (11.7 vs. 28.9 neonates), and downstream of Outfall 001 (11.1 vs. 18.2 neonates). These data indicate that the water column in the Red River was chronically toxic to *C. dubia* at four of six sites sampled along its length.

The survival of *C. dubia* exposed to Red River sediment (Table 9) was significantly ($p < 0.05$) reduced in samples from the Zweigle Dam site (60% survival) and by samples collected downstream of Capulin Canyon (30% survival). None of the other samples were determined to have a significant effect on *C. dubia* survival. In addition to causing a significant reduction in survival of *C. dubia*, sediment samples from the Zweigle Dam site (8.5 vs. 18.1 neonates) and downstream of Capulin Canyon (4.6 vs. 18.1 neonates) were observed to significantly reduce the mean number of neonates produced by the exposed organisms. While no significant effects were detected to the survival of organisms exposed to sediment samples from June Bug Campground, *C. dubia* exposed to this sample were observed to have significantly decreased reproduction (17.6 vs. 23.5 neonates).

Fathead minnow embryos were exposed to both water column and sediment samples from the same sites as the *C. dubia* discussed above. These organisms were checked for number alive, number hatched, and terata (collectively known as number affected) at the end of the seven-day test period (Table 10). None of the water column samples from the Red River were determined to have significantly ($p < 0.05$) affected the fathead minnows exposed to those samples. Of the sediment samples, only the sample from the June Bug Campground was determined to have a significant ($p < 0.05$), negative effect on the test organisms (55% vs.

7.5% affected). These results indicate that none of the water column samples collected were toxic to fathead minnows, while only the sediment sample from June Bug Campground was toxic to fathead minnows.

TABLE 8: *C. dubia* water column, Red River toxicology data, October 2000 (preliminary).

Agency	Site	% Survival	Mean Reproduction
NMED	Zweigle Dam (RR06)	100	11.8*
CEC	June Bug (RR16)	100	23.2
CEC	June Bug Control	90	25.8
CEC	Downstream of Hansen (RR20)	100	12.1*
CEC	Downstream of Hansen Control	100	26.4
CEC	Goat Hill (RR28)	90	11.7*
CEC	Goat Hill Control	100	28.9
NMED	Downstream of Capulin Canyon (RR29)	100	16.6*
NMED	Downstream of Outfall 001 (RR35)	100	11.1*
NMED	Control	100	18.2

* Value significantly different ($P < 0.05$) than corresponding Control value.

TABLE 9: *C. dubia* sediment, Red River toxicology data, October 2000 (preliminary).

Agency	Site	% Survival	Mean Reproduction
NMED	Zweigle Dam (RR06)	60*	8.5*
CEC	June Bug (RR16)	90	17.6*
CEC	June Bug Control	100	23.5
CEC	Downstream of Hansen (RR20)	80	17.1
CEC	Downstream of Hansen Control	90	23.8
CEC	Goat Hill (RR28)	100	7.3
CEC	Goat Hill Control	100	19.0
NMED	Downstream of Capulin Canyon (RR29)	30*	4.6*
NMED	Downstream of Outfall 001 (RR35)	80	15.1
NMED	Control	100	18.1

* Value significantly different ($P < 0.05$) than corresponding Control value.

TABLE 10: Fathead minnow, Red River toxicology data, October 2000 (preliminary).

Agency	Site	Water Column % Affected	Sediment % Affected
NMED	Zweigle Dam (RR06)	0	0
CEC	June Bug (RR16)	27.5	55*
CEC	June Bug Control	10	7.5
CEC	Downstream of Hansen (RR20)	5	17.5
CEC	Downstream of Hansen Control	10	10
CEC	Goat Hill (RR28)	15	5
CEC	Goat Hill Control	7.5	22.5
NMED	Downstream of Capulin Canyon (RR29)	0	7
NMED	Downstream of Outfall 001 (RR35)	3	3
NMED	Control	0	3

* Value significantly different ($P < 0.05$) than corresponding Control value.

An extensive list of water quality parameters were measured in samples collected October 25, 2000 by the State of New Mexico Department of Health Water Quality Laboratory (Appendix D). Of these parameters, aluminum was the only one that was observed to exceed its chronic water quality criterion or be present at potentially toxic concentrations. Aluminum was observed to be present in levels exceeding the chronic water quality criteria of 0.087 mg/L (USEPA 1988) at three sites: downstream of Hansen Creek, (0.130 mg/L), Goat Hill Campground (0.120 mg/L), and downstream of Capulin Canyon (0.130 mg/L). Samples from each of these sites were observed to cause significantly decreased reproduction of *C. dubia* test organisms in the water column toxicity tests. It is possible that the elevated concentrations of aluminum in these samples was the cause of the chronic toxicity to *C. dubia* in the water column toxicity tests.

RECENT TRENDS IN AQUATIC BIOTA

Fish

Fish population sampling data from the fall of 1997, 1998, 1999, and 2000 collected by CEC and data collected in August 1997 by NMDGF (1997) were compared to evaluate year-to-year variability in fish populations. Resident trout data from spring 1997 collected by CEC are not included as these data are probably not directly comparable to data collected in fall. The presence of YOY fish tends to produce a seasonal trend of more fish being collected in fall compared to spring in any given year, which could complicate annual comparisons.

The resident trout data from 1997, 1998, 1999, and 2000 exhibit nearly identical longitudinal trends for density and biomass (Figs. 7 and 8, respectively). Density and biomass data vary quite a bit over the length of the Red River. The variability suggests three areas of impacts resulting in decreases in trout density and biomass. Impacts appear to be occurring just downstream of the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon (Figs. 7 and 8). High biomass of trout in all four years of CEC sampling occurred at the Elephant Rock Campground site (Fig. 8). Downstream of Hansen Creek, impacts result in substantial reductions in biomass. The high biomass found at Elephant Rock Campground is not matched again at any site along the remainder of the Red River downstream to the hatchery (Fig. 8). In 1997 and 1998, biomass at this site was higher than at all the other sites on the Red River. In 1999, the sampling site which was added to the monitoring program downstream of the hatchery had resident trout biomass that was comparable to that at the Elephant Rock Campground site (Fig. 7). In 2000, the site downstream of the hatchery had biomass more than twice as high as any other site on the river, including the Elephant Rock Campground site (Fig. 7). As discussed previously, the higher biomass is probably due to enriched productivity from the hatchery outflow. Decreased habitat quality (CEC 2000) or poor water quality below the town of Red River and below Hansen Creek could be related to decreased trout populations in these sections.

Lowest density and biomass occurred at the Questa Ranger Station Site from 1997 up through 1999 (Figs. 7 and 8). This site is downstream of Capulin Canyon and Capulin Springs. Density and biomass recover at the site upstream of the fish hatchery, probably due, in part, to the input of relatively clean water from Cabresto Creek, and increase even more downstream of the hatchery, probably aided by the inflow of nutrient rich water. Lowest density and biomass in 2000 was at the site downstream from Hansen Creek, indicating that, at least in some years, impacts in this section can be more severe than near the Questa Ranger Station.

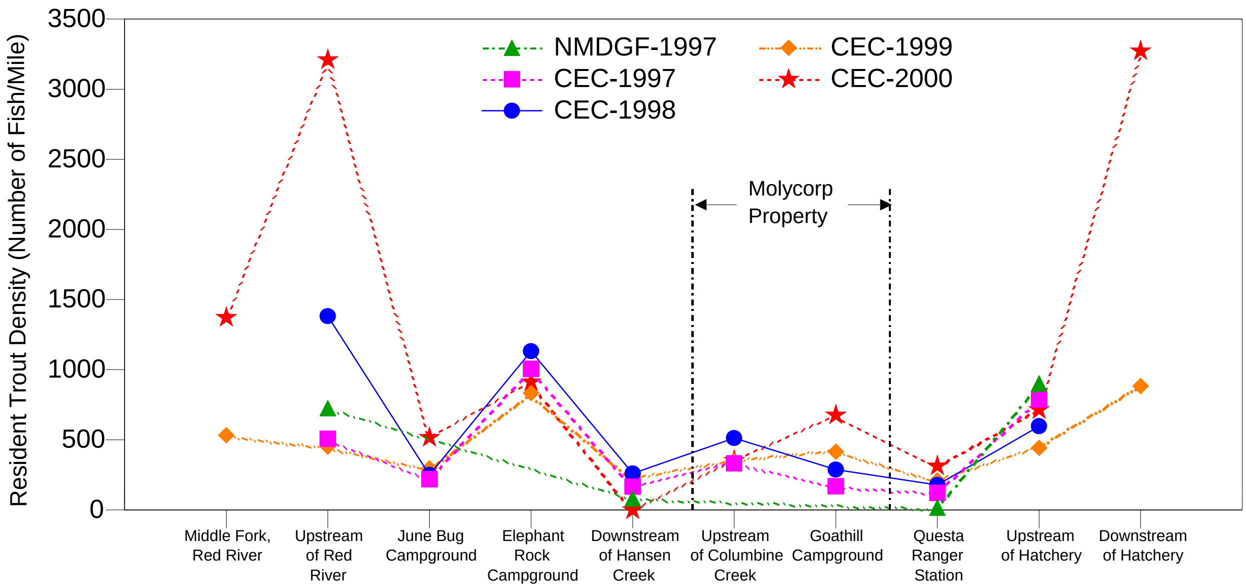


FIGURE 7: Comparison of resident trout density (number per mile) for CEC data collected in fall 1997, 1998, 1999, and 2000 and data from August 1997 collected by NMDGF. Data represent results from all electrofishing passes. Sites on the Middle Fork and downstream of the hatchery added in 1999.

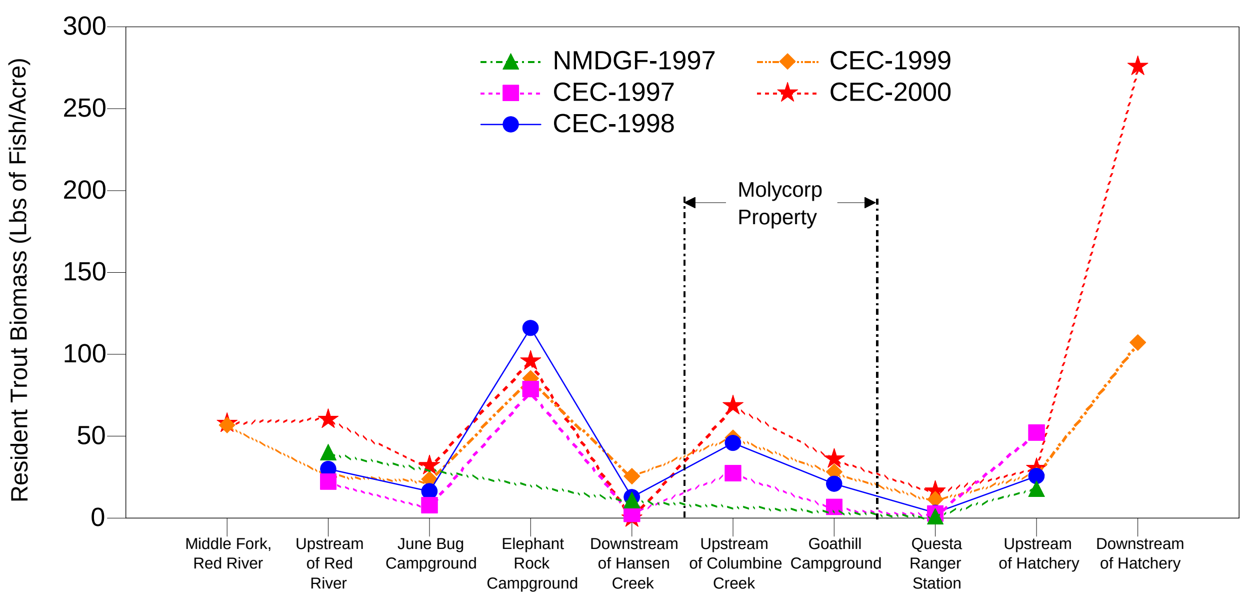


FIGURE 8: Comparison of resident trout biomass (pounds per acre) for CEC data collected in fall 1997, 1998, 1999, and 2000 and data from August 1997 collected by NMDGF. Data represent results from all electrofishing passes. Sites on the Middle Fork and downstream of the hatchery added in 1999.

Year-to-year variability in trout populations is common in the western United States (Hall and Knight 1981, Platts and Nelson 1988, Scarnecchia and Bergersen 1987). Based on data from 1997 to 2000 in the Red River, we attributed at least some of the variability in trout populations to variability in flow conditions from year to year (CEC 1999). There is frequently an inverse relationship between the timing and magnitude of spring snowmelt runoff flows and fish density (McCullough 1997, Pearsons *et al.* 1992). In years of lower spring runoff, trout generally exhibit higher density and biomass. This has been attributed to the vulnerability of trout fry to displacement during years with higher than normal spring runoff (Anderson and Nehring 1985). Variability between 1997 and 1998 and between 1999 and 2000 followed this pattern. At seven of the eight sites sampled on the Red River in 1998, resident fish density and biomass were higher than in 1997 (Figs. 7 and 8). We attributed this to the fact that in 1998, spring runoff was relatively low. USGS gaging records at the Questa gage (Fig. 1) indicate that peak daily flow was only 139 cfs in May and June 1998. In contrast, average peak daily flow over a 31-year period (1958-1988) was 209 cfs, and peak daily flow during runoff in 1997 was 347 cfs. The low runoff year in 1998 appears to have allowed trout density and biomass to increase at most locations in the Red River. A similar pattern was observed between 1999 and 2000. Peak spring runoff in 1999 was 288 cfs, much higher than in 2000 with a value of 48 cfs. This decrease in peak flows from 1999 to 2000 corresponded to higher density and biomass values at most of the study sites in 2000 compared to 1999 (Figs. 7 and 8).

However, this inverse relationship between peak runoff flows and density and biomass did not hold up as well between 1998 and 1999. In 1999, runoff flows were above the 31-year average (209 cfs), with a peak runoff flow of 288 cfs. Peak runoff in 1998 was 139 cfs, approximately 50% lower. Based on the pattern discussed above for the periods between 1997 and 1998 and between 1999 and 2000, the relatively high flows in 1999 compared to 1998 should have resulted in lower trout density and biomass in 1999. However, density was lower at only four sites in 1999, and biomass was lower at only one site in 1999. This lack of a strong pattern between 1998 and 1999 suggests that there may also exist additional environmental factors, other than peak runoff flow, that also control trout density and biomass in the Red River drainage.

The number of YOY resident trout does appear to vary with peak flows in the Red River. There were lower numbers of YOY collected at the eight sites on the Red River in the higher flow years of 1997 and 1999; many more were collected in the lower flow years of 1998 and 2000 (Table 11). The number of

YOY represents all resident trout (brook trout, brown trout, cutthroat trout, and hybrid trout) collected at the corresponding sites. Site lengths varied between years, but not substantially. The number of YOY collected seems to be inversely related to peak runoff flow (Table 11), although the relationship is not significant ($p = 0.11$). In the two years with relatively high runoff flows, there were fewer young trout; and in 1998 and 2000, when runoff flows were substantially below average, the number of trout fry was much higher at the Red River sites. Although we have no flow records for the tributaries, assuming the flow years followed the same pattern in these two streams, the YOY catch pattern is not as strong in these streams, except in 2000, when very low runoff flows corresponded to a substantially higher number of YOY.

TABLE 11: Number of young-of-the-year resident trout collected during electrofishing at study sites on the Red River and tributaries, 1997-2000, and peak runoff flow data.

Site	1997	1998	1999	2000
Red River				
Upstream of Town of Red River	7	41	4	198
June Bug Campground	0	1	0	15
Downstream Elephant Rock Campground, upstream of Hansen Creek	3	10	3	17
Downstream of Hansen Creek, upstream of mill	7	7	0	0
Downstream of mill, upstream of Columbine Creek	0	8	0	0
Goathill Campground	0	3	2	13
Upstream of Questa Ranger Station	7	5	2	6
Upstream of hatchery diversion	6	5	3	18
Total	**30**	**80**	**14**	**267**
Tributaries				
Columbine Creek	5	7	10	66
Cabresto Creek	26	24	22	83
Total	**31**	**31**	**22**	**149**
Peak Runoff Flow (cfs)	**347**	**139**	**288**	**48**
Average Peak Runoff Flow 1958-1988 (cfs)	**209**	**209**	**209**	**209**

The implications of this variable pattern of peak flows versus density, biomass, and YOY abundance is that there may be a time lag between high flow years and resulting lower density and biomass of trout in future years. A single wet or dry year and the resulting year-class strength may have little effect on the variability of trout density and biomass in the long term, as other important factors may have a greater effect. However, a few consecutive wet years could result in several consecutive poor year-classes of trout, and thus lower density and biomass in the future. Conversely, several low flow years may result in relatively high density and biomass.

Benthic Invertebrates

Benthic invertebrate data from fall 2000, fall 1999, fall 1998, fall 1997 (CEC 1998, 1999, 2000) and early winter 1995 (Woodward Clyde 1996) are compared to evaluate year-to-year variability in invertebrate populations (Figs. 9 and 10). The year-to-year variability in density appears to be much greater for benthic invertebrate population parameters (Figs. 9 and 10) than for fish parameters (Figs. 7 and 8).

The trends in all five years are generally consistent, with reduced densities and numbers of taxa downstream of the town of Red River and Hansen Creek, reaching a minimum at the Questa Ranger Station site (Figs. 9 and 10). This site is downstream of the confluence with Capulin Canyon and Capulin Springs, and consistently represents the most impacted section of the Red River. A trend of low benthic invertebrate population parameters was also found in this section of the river by Jacobi *et al*. (1998).

The trends in all five years are also consistent in exhibiting substantial recovery at the site upstream of the fish hatchery. This site is downstream of the confluence with Cabresto Creek. Apparently, the recovery pattern is enhanced by dilution water from Cabresto Creek, which allows the benthic invertebrate populations to recover to levels comparable to those found in the reaches of the Red River upstream of Hansen Creek. This trend was also demonstrated in Jacobi *et al*. (1998).

During four of the five years, including 2000, there was a substantial decrease in density downstream of Hansen Creek as compared to the site immediately upstream (Fig. 9). A corresponding sharp decrease in number of taxa did not necessarily occur every year (Fig. 10). Impacts that affect density appear to be occurring in some years; however, the fact that density was relatively high at this site in 1997 suggests that these impacts may be alleviated in other years.

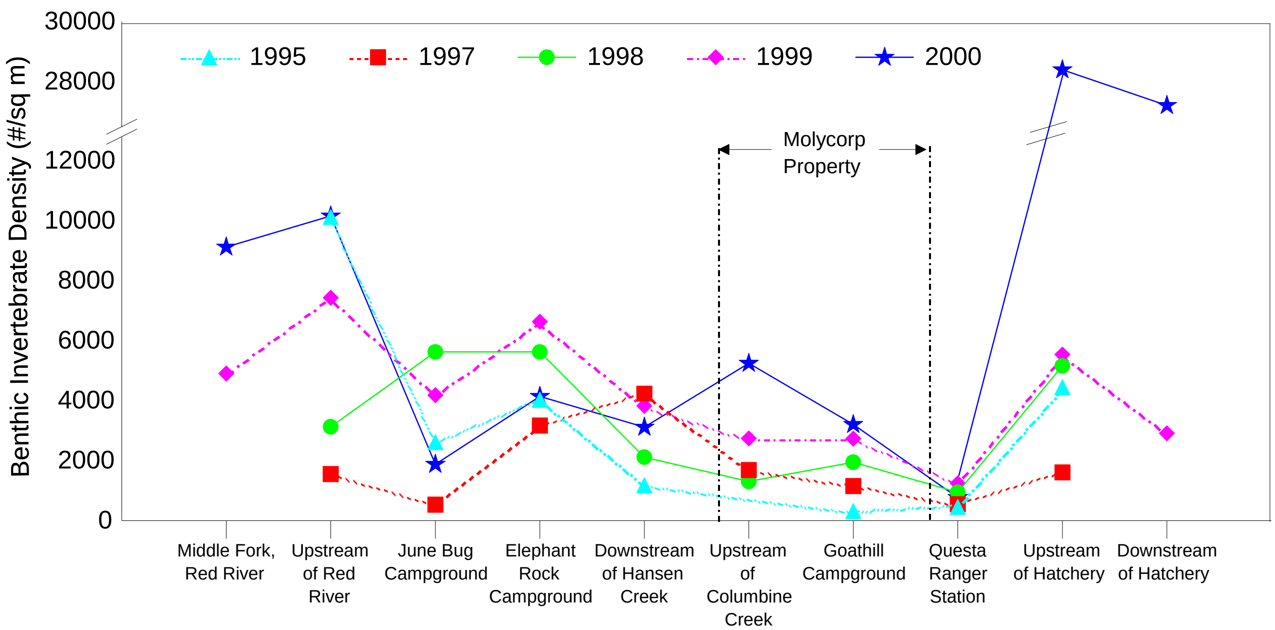


FIGURE 9: Comparison of benthic invertebrate density (#/m^2) for data collected by CEC in fall 1997, fall 1998, fall 1999, and fall 2000, and at corresponding sites by NMED in December 1995.

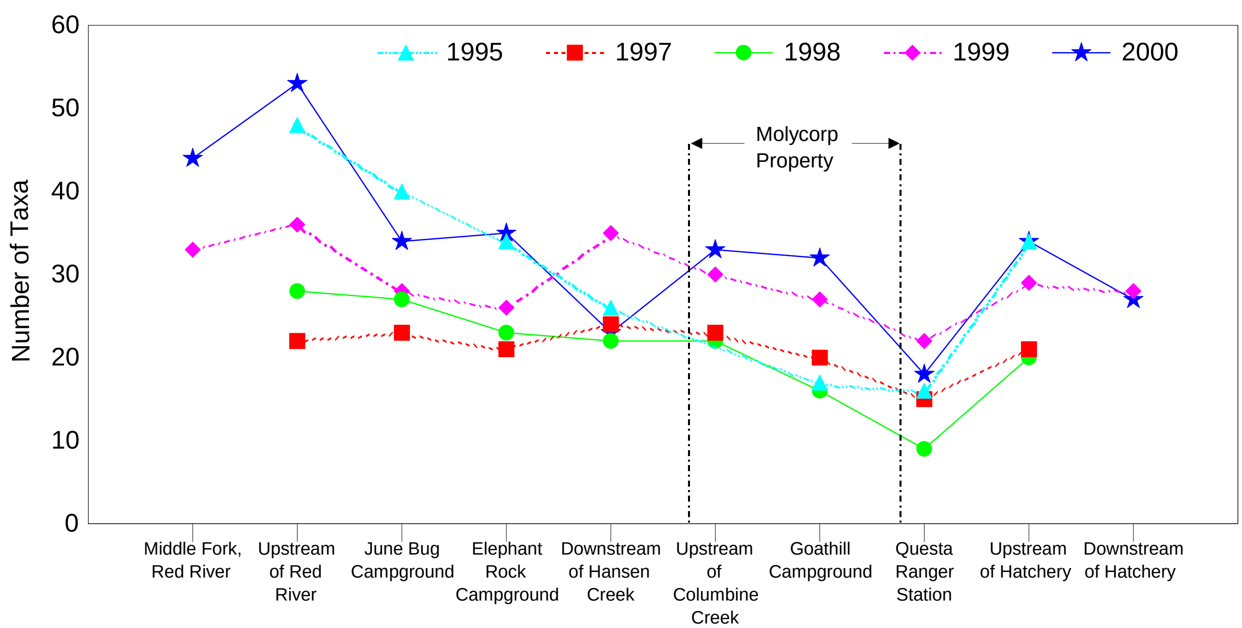


FIGURE 10: Comparison of number of benthic invertebrate taxa for data collected by CEC in fall 1997, fall 1998, fall 1999, and fall 2000, and at corresponding sites by NMED in December 1995.

During four of the five years, (1995, 1997, 1999, 2000) density was relatively low at the June Bug Campground site, just downstream of the town of Red River (Fig. 9). The number of taxa present at that site was reduced in 1995, 1999, and 2000 relative to the upstream reference sites (Fig. 10). As with Hansen Creek, it appears that the section of the river near the town of Red River may be experiencing impacts. In a previous report (CEC 2000), we stated that the low density years corresponded to the years with higher runoff flows, and that these flows may explain some of the variation in density from year to year. However, 2000 experienced the lowest runoff flows since this study began, but density in the fall was still low. The correlation between density at June Bug Campground and runoff flows may not be as strong as previously thought.

Regressions were conducted to determine if there was a statistical relationship between peak runoff flow and density or number of taxa of benthic invertebrates. When data from all sites on the Red River were combined, there was no significant relationship between flow and density or number of taxa. Likewise, when sites were analyzed separately, no statistically significant relationships were found. These results indicate that some factor or combination of factors, other than peak runoff flows, are affecting annual variability of benthic invertebrate populations along the entire length of the Red River.

RECENT TRENDS IN SEDIMENT

Annual variability (i.e., from 1999 to 2000) in sediment characteristics was also observed at the study sites. Percent fines decreased from September 1999 to September 2000 at eight of the nine Red River sites having data for both periods (Fig. 11). A similar decrease was observed for the reference sites on Columbine and Cabresto creeks. This decrease from September 1999 to September 2000 is opposite of what one would expect, based on USGS data from the stream gage at Questa. Annual flows in 2000 were much less than in 1999, leading one to expect greater levels of surface fines in September 2000. However, this was not the case, with higher levels occurring in 1999, the year with the higher annual flows. Texture also varied between years. Percent abundance of clay and silt increased from September 1999 to September 2000 at all nine sites having data for both periods. Conversely, percent abundance of sand decreased at those same sites.

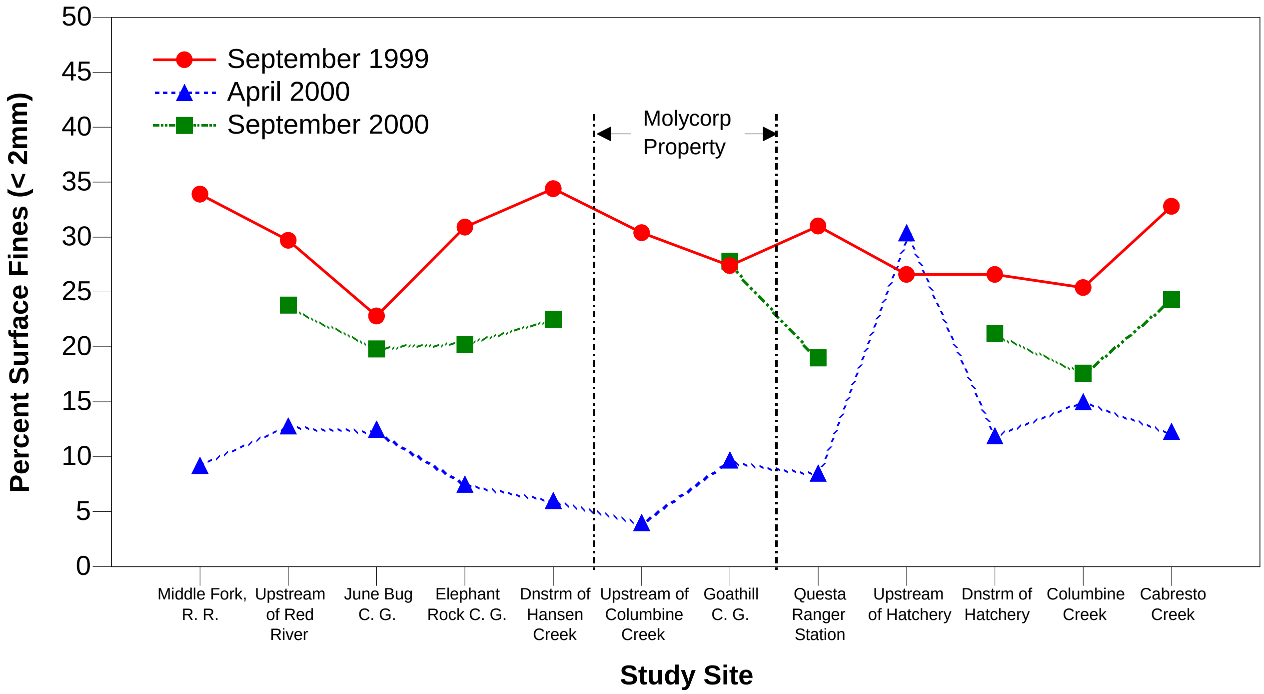


FIGURE 11: Percent surface fines (<2 mm) from sieve analysis on freeze core sediment samples from the Red River and tributaries, 1999-2000.

The metal concentration data from the sediments from September 1999, April 2000, and September 2000 generally show the same trends between seasons and between years (Fig. 12). However, the actual levels of metal concentrations in sediments were variable between seasons and between years (Fig. 12). For example, sediment concentrations for aluminum, copper, and zinc in April 2000 were lower at most sites compared to values from September 1999 and September 2000. This pattern was not as evident for lead. These lower concentrations in April 2000 could be related to the seasonality of flows in the Red River drainage. Some spring snowmelt runoff had occurred by April 2000, which allowed access for sampling the streams. These early runoff flows may have washed some metals-laden sediments downstream out of the study area, thus decreasing sediment concentrations. The lower flows typical of the fall season probably do not have the capacity to wash metals-laden sediments downstream, thus depositing them within the study area. The higher flows in spring probably contribute to the seasonally lower sediment concentrations in April 2000 compared to September 1999 and September 2000, similar to the seasonally lower levels of percent fines in the substrate discussed earlier.

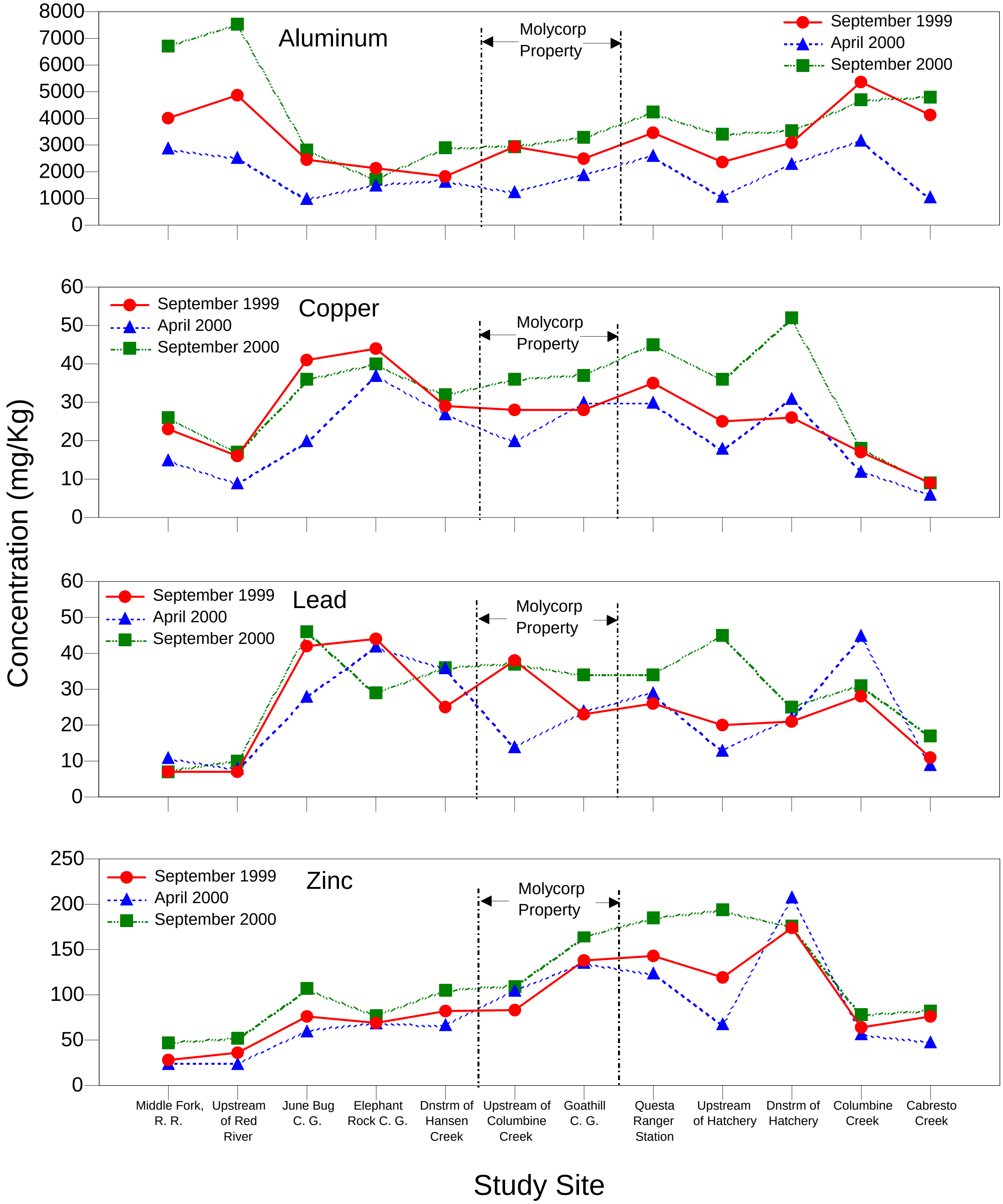


FIGURE 12: Seasonal variations in concentrations of aluminum, copper, lead, and zinc from sediments in the Red River and tributaries, 1999 and 2000.

Sediment metal concentrations in September 1999 and September 2000 indicated another interesting temporal variation. For aluminum, copper, lead, and zinc, concentrations at most sites in September 2000 were greater than in September 1999 (Fig. 12). These differences are also most likely due to streamflows in the Red River drainage. Stream gaging records by the USGS at the Quest gage indicate that annual flows in 2000 were much lower than in 1999 (USGS, unpubl. data). Flows in 2000 probably had less capacity to carry metals-laden sediments out of the study area, resulting in higher levels in September 2000 compared to September 1999.

HISTORICAL TRENDS IN AQUATIC BIOTA

Fish

Fish population data providing longitudinal patterns of fish density are available from three different time periods of mine operation (Fig. 13). Data from 1960 were collected prior to the initiation of open pit mining, and represent baseline data. Present conditions are represented by data collected in fall 1997, 1998, 1999, 2000 by CEC and in August 1997 by NMDGF. Data collected during the intervening period of open pit mine operation (1974-1988) are also plotted.

As in past reports (CEC 1997, 1998, 1999, 2000), in order to make the data sets for the four periods comparable, only first-pass electrofishing data were used, since this was the primary sampling method used during the earlier studies. Also, since rainbow trout are largely maintained by stocking, and are not as directly controlled by habitat and water quality conditions as are resident fish, rainbow trout numbers have been omitted from the comparison. Lastly, since most of the historic data only present density data, longitudinal comparisons of biomass could not be made.

As stated in our past reports (CEC 1997, 1998, 1999, 2000), data collection techniques over the years have varied in methods used and efficiency of collecting fish. This makes direct comparisons between the three different historical periods more difficult. However, assuming that the methods and sampling efficiencies were at least consistent within each historical time period, comparisons of the longitudinal trends are reasonable.

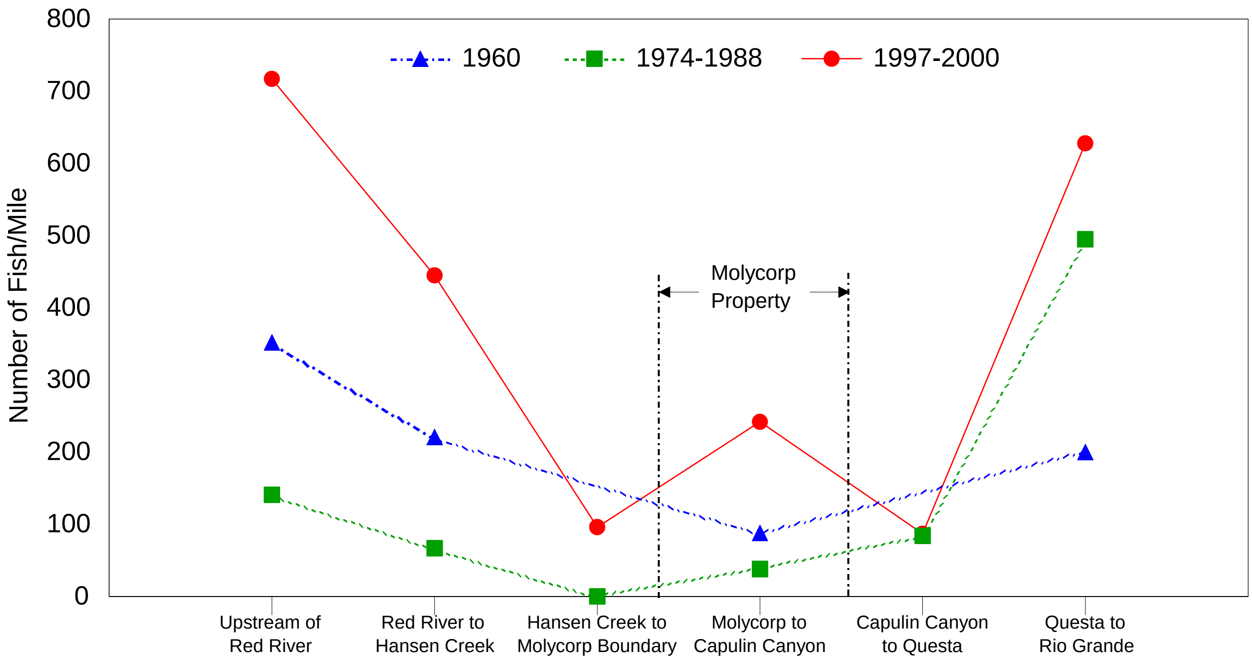


FIGURE 13: Longitudinal trends in fish density (#/mile) for baseline conditions (1960 data), open pit mine operation (1974-1988 data), and present conditions (1997-2000). First pass data only, rainbow trout excluded

The longitudinal trends in fish density (number of fish/mile) are similar during all three time periods. The trends all indicate relatively high fish density upstream of the town of Red River, decreasing density downstream of Hansen Creek, and increasing density downstream of Questa (Fig. 13). This trend holds for baseline conditions (1960 data), during the intervening period of open pit mine operation (1974-1988), and present conditions (spring, summer, and fall 1997, fall 1998, fall 1999, and fall 2000 data). These are the same trends identified in our earlier reports (CEC 1997, 1998, 1999, 2000).

The trends in trout density in all three periods indicate that impacts are first occurring to the suitability of the Red River to support trout near the town of Red River. The trends in trout density in all three periods also indicate further impacts to trout downstream of Hansen Creek (Fig. 13). Downstream of Hansen Creek and through the section of the Red River adjacent to the Molycorp property, trout density remains low. During all three sampling periods, there was also a substantial increase in resident trout density in the reach of the Red River downstream of Questa. In this lower reach of the river, trout density returned to levels comparable to or higher than those found in the reach upstream of the town of Red River (Fig. 13).

As stated previously, these longitudinal patterns in fish abundance could, in part, be related to habitat differences between sites. However, there are probably other factors (e.g., water quality, nutrient enrichment) also closely related to fish abundance at some sites.

Benthic Invertebrates

For benthic invertebrates, the collected data also were divided into three time periods. Baseline conditions were represented by data collected in 1965, apparently prior to the initiation of open pit mining. Benthic invertebrate data collected in 1995, fall 1997, fall 1998, fall 1999, and spring and fall 2000 represent present conditions. Data available from the intervening period (1970-1992) represent conditions during open pit mining.

Comparisons are made between the two population parameters of density (#/m^2) and number of taxa. As with the historical fish data, techniques for sampling and analyzing invertebrates may have varied between the periods, making direct comparisons over time difficult. However, assuming similar techniques were employed within each historical time period, comparisons of the downstream trends are reasonable.

The longitudinal trends in density for the three sampling periods (1965, 1970-1992, and 1995-2000) show a similar pattern of decreasing density downstream from the headwaters of the Red River, with low densities of benthic invertebrates downstream of Hansen Creek (Fig. 14). In the remainder of the Red River from the Molycorp property downstream past Questa, the data from the three sampling periods also have a similar trend (Fig. 14). Low densities continue to occur adjacent to the Molycorp Mine, and lowest densities are found near the Questa Ranger Station in the reach of the river downstream of Capulin Canyon. This is followed by an increase in density in the reach downstream of Questa, after Cabresto Creek inputs relatively clean water into the Red River. This general trend has not changed since 1965. These are the same trends identified in our earlier reports (CEC 1997, 1998, 1999, 2000).

The trend in number of taxa for three sampling periods (1965, 1970-1992, and 1995-2000) indicates a gradual decrease in taxa along the length of the Red River to the reach downstream of Capulin Canyon (Fig. 15). This is followed by an increase in number of taxa downstream of Questa for two of these periods (1970-1992, 1995-2000).

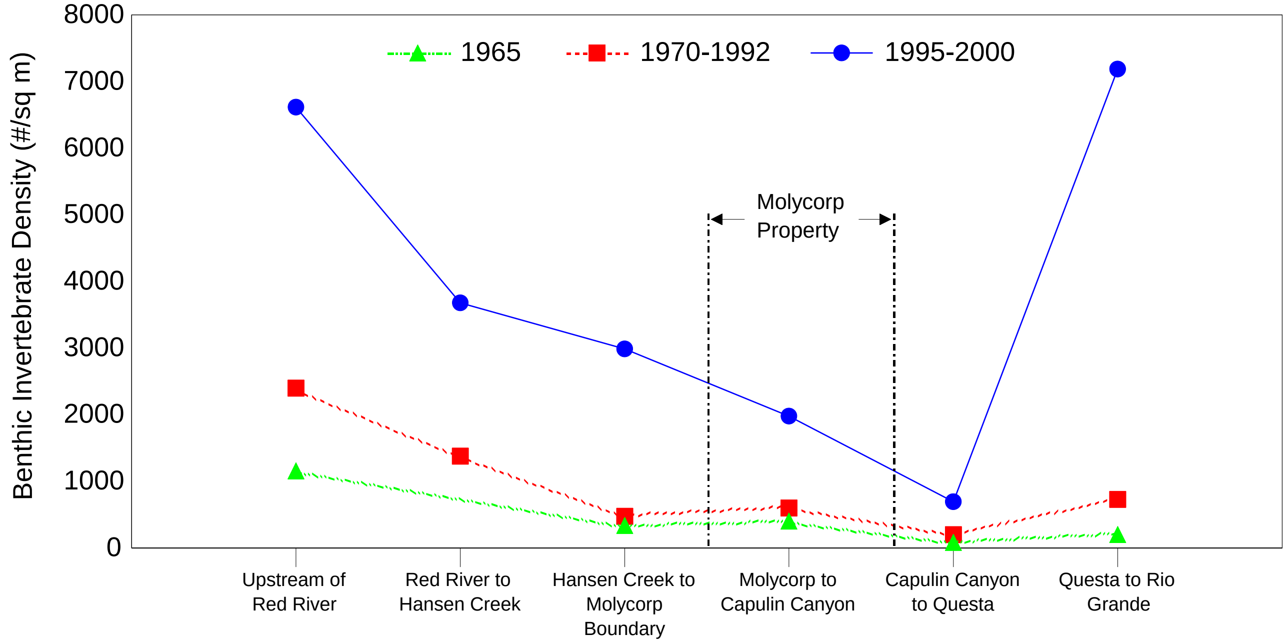


FIGURE 14: Longitudinal trends in benthic invertebrate density (#/m^2) for baseline conditions (1965 data), open pit mine operation (1970-1992 data), and present conditions (fall 1995, fall 1997, fall 1998, fall 1999, spring and fall 2000 data). Analysis includes sites on Middle Fork and downstream of hatchery.

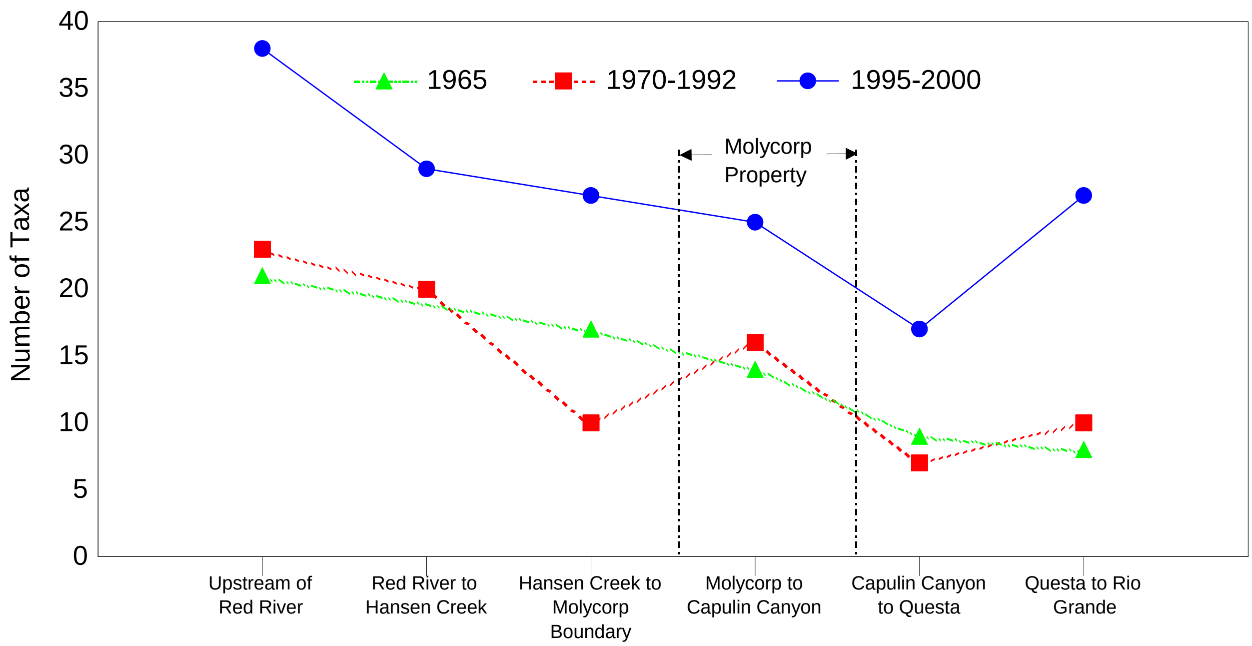


FIGURE 15: Longitudinal trends in number of benthic invertebrate taxa for baseline conditions (1965 data), open pit mine operation (1970-1992 data), and present conditions (fall 1995, fall 1997, fall 1998, fall 1999, and spring and fall 2000 data). Analysis includes sites on Middle Fork and downstream of hatchery.

In all six reaches for data collected in 1995-2000, densities and number of taxa are substantially higher than during the baseline period (1965) and the period of open pit and underground mine operation (Figs.14 and 15). As mentioned in our earlier reports, this may be partly due to different methods of data collection and analysis. However, these data indicate that the Red River is at least as suitable for sustaining benthic invertebrates at present as it was prior to the initiation of open pit mine operations.

CONCLUSIONS

The lower reaches of the Red River, especially the sections adjacent to the Molycorp Mine downstream to Questa, have been referred to as biologically impoverished, devoid of aquatic life, or even a biological desert. This is not true. Data for 2000 indicate the presence of resident populations of fish and benthic invertebrates at all sites along the length of the Red River. At the most impacted site on the river, the site at the Questa Ranger Station downstream of Capulin Canyon, 24 species and 18 species of benthic invertebrates were collected in April and September, respectively, and one species of fish was present in 2000. There were no sections of the Red River that were severely impacted to the point of biological impoverishment. There seems to be multiple areas and pathways (chemical, physical) of minor to moderate impacts along the river that affect fish and invertebrates to varying degrees. The fact that these impacts do not reduce the Red River to a biological desert, and the fact that multiple species of fish and invertebrates, including sensitive species, are present along the length of the Red River tend to make interpretation of the data more difficult.

Our previous reports (CEC 1997, 1998, 1999, 2000) concluded that the primary impacts to the suitability of the Red River to sustain aquatic biota were occurring just downstream of the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon. Downstream of the confluence of Cabresto Creek, conditions improved for both fish and benthic invertebrates. The cause of these impacts appeared to be the input of excess sediment from a number of sources and decreased water quality, especially at locations receiving drainage from hydrothermal scars. Those reports further concluded that baseline data indicated these impacts were present prior to the initiation of open pit mining at the Molycorp Questa Mine, and in reaches of the Red River upstream of the mine. Those reports also concluded that present population levels of fish and benthic invertebrates are higher than during baseline conditions, suggesting that there have been improvements in the suitability of the Red River to support aquatic biota since the 1960s (CEC 1997).

Resident trout populations in each year from 1997-2000 showed similar trends, indicating three areas of impact resulting in decreases in trout abundance. Impacts appear to be occurring downstream of the town of Red River, downstream of Hansen Creek, and downstream of Capulin Canyon. The trout data collected in fall 2000 exhibited nearly the same longitudinal trend in density as that found for baseline conditions (1960) and the period of open pit operation (1974-1988). The most recent density and biomass data from fall 2000 support the conclusions of our previous reports; the trends have not changed. Data from 1999 and 2000 suggested variability in abundance of YOY trout may be negatively released to peak runoff flows.

The trends in benthic invertebrate population parameters from data collected in the fall 2000 were similar to the trends from the baseline (1965) and open pit mine operation periods (1970-1992). Density data indicates impacts near the town of Red River, downstream of Hansen Creek and downstream of Capulin Canyon. All three data sets indicate increasing density at sites downstream of Questa. Trends in the number of taxa are more gradual than for density. Data from all three periods indicate a general decrease in the number of benthic invertebrate taxa from upstream of Red River downstream to the site near the Questa Ranger Station, downstream of Capulin Canyon.

At all sites along the river, including the sites in the most impacted reaches, numerous species of sensitive EPT taxa are present. This includes several species of mayflies, which are especially sensitive to metals impacts, as well as more tolerant caddisfly species. This indicates that the impacts occurring along the length of the Red River are not severe, and the river is suitable for sustaining invertebrate species along its entire length.

Benthic invertebrate data from 1995 - 2000 indicate similar patterns in the downstream reaches of the Red River. In the upstream reaches of the river, population parameters seem to be more variable from year to year. Data from 1999 and 2000 indicated that benthic invertebrate population levels may be negatively related to sediment concentrations of some metals.

Sediment metals concentrations exhibited some longitudinal variation along the length of the Red River in 2000, with zinc showing the clearest trend, increasing in a downstream direction, with its highest values at the sites bracketing the fish hatchery. Aluminum concentrations were highest at the upstream and tributary reference sites. Annual comparisons between 1999 and 2000 showed lowest sediment concentrations in April 2000, followed by September 1999 and September 2000. These seasonal differences may be related to the ability of streamflows to carry metal-laden sediments downstream, out of the study area, with higher flows in spring and lower flows fall.

Sediment concentrations of metals were compared to sediment quality guidelines from Ontario, and to another sediment study. Sediment concentrations of copper, lead, and zinc in the Red River sometimes exceeded the Lowest Effect Level, but not by much, and were always much less than the Severe Effect Level. Aluminum concentrations in the Red River were comparable to those in a wildlife refuge in Texas, and within baseline concentrations from the western United States.

Toxicity testing of water and sediment at sites along the Red River indicated conditions that are chronically toxic existed at several locations for invertebrates and fish. Both water and sediment tests indicated toxicity to zooplankton upstream and downstream of the Molycorp mine, including a site upstream of the town of Red River. Sediment tests identified toxicity to fish at the June Bug Campground, upstream of Molycorp. The results of these tests are further evidence of multiple areas of impacts to aquatic organisms along the length of the Red River.

LITERATURE CITED

Allan, J.D. 1995. *Stream Ecology*. Chapman & Hall, London, England.

Anderson, R.M., and R.B. Nehring. 1985. Impacts of stream discharge on trout rearing habitat and trout recruitment in the South Platte River, Colorado. Pages 59-64. IN: Olson, F.W., R.G. White, and R.H. Hamre (eds.). *Proceedings of the Symposium on Small Hydropower and Fisheries*. American Fisheries Society, Bethesda, MD.

Canton, S.P., and J.W. Chadwick. 1984. A new modified Hess sampler. *Progressive Fish-Culturist* 46:57-59.

Canton, S.P., and J.W. Chadwick. 1988. Variability in benthic invertebrate density estimates from stream samples. *Journal of Freshwater Ecology* 4:291-298.

Chadwick Ecological Consultants, Inc. 1997. *Aquatic Biological Assessment of the Red River, New Mexico, in the Vicinity of the Questa Molybdenum Mine*. Report prepared for Molycorp, Inc.

Chadwick Ecological Consultants, Inc. 1998. *Fall 1997 Data Addendum, Red River Aquatic Biological Assessment*. Report prepared for Molycorp, Inc.

Chadwick Ecological Consultants, Inc. 1999. *Red River Aquatic Biological Monitoring, 1998*. Report prepared for Molycorp, Inc.

Chadwick Ecological Consultants, Inc. 2000. *Red River Aquatic Biological Monitoring, 1999*. Report prepared for Molycorp, Inc.

Clements, W.H. 1991. Community responses of stream organisms to heavy metals: A review of observational and experimental approaches. Pages 363-391. IN: Newman, M.C., and A.W. McIntosh (eds.). *Metal Ecotoxicology: Concepts and Applications*. Lewis Publishing, Inc., Chelsea, MI.

Clements, W.H. 1994. Benthic invertebrate community responses to heavy metals in the upper Arkansas River basin, Colorado. *Journal of the North American Benthological Society* 13:30-44.

Clements, W.H., D.S. Cherry, and J. Cairns, Jr. 1988. Impact of heavy metals on insect communities in streams: A comparison of observational and experimental results. *Canadian Journal of Fisheries and Aquatic Sciences* 45:2017-2025.

Elliott, J.M. 1977. *Statistical Analysis of Samples of Benthic Invertebrates*. Scientific Publication No. 25. Freshwater Biological Association, Ambleside, England.

Giles, N., V.E. Phillips, and S. Barnard. 1991. *Ecological Effects of Low Flows on Chalk Streams*. Report prepared for the Wiltshire Trust for Nature Conservation.

Grost, R.T., W.A. Hubert, and T.A. Wesche. 1991. Field comparison of three devices used to sample substrate in small streams. *North American Journal of Fisheries Management* 7:347-351

Hall, J.D., and N.J. Knight. 1981. *Natural Variation in Abundance of Salmonid Populations in Streams and Its Implications for Design of Impact Studies, A Review*. EPA-600/3-81-021. Oregon State University, Department of Fisheries and Wildlife.

Hintze, J.L. 1997. *NCSS 97 Statistical System for Windows*. Number Cruncher Statistical Systems. Kaysville, UT.

Jacobi, G.Z., L.R. Smolka, and M.D. Jacobi. 1998. *Benthic Macroinvertebrate Bioassessment of the Red River, New Mexico, USA*. Presented at the 27th Congress of the International Association of Theoretical and Applied Limnology (SIL) in Dublin, Ireland.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*. EPA/600/4-90/303. U.S. Environmental Protection Agency.

Lenat, D.R., and D.L. Penrose. 1996. History of EPT taxa richness metric. *Bulletin of the North American Benthological Society* 13:305-307.

McCullough, B.J. 1997. *Effects of Floods on Brook Trout Populations in the Monongahela National Forest*. M.S. Thesis. Pennsylvania State University, College Station.

New Mexico Department of Game and Fish. 1960. Stream Survey Forms.

New Mexico Department of Game and Fish. 1997. Stream Survey Forms, August 11-12, 1997.

Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resiliance of stream fish assemblages. *Transactions of the American Fisheries Society* 121:427-436.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*. Ontario Ministry of the Environment, Toronto, Ontario, Canada.

Petts, G.E., M.C. Thoms, K. Brittan, and B. Atkins. 1989. A freeze-coring technique applied to pollution by fine sediments in gravel-bed rivers. *The Science in Total Environment* 84:259-272.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers*. EPA/444/4-89-001. U.S. Environmental Protection Agency.

Platts, W.S., and R.L. Nelson. 1988. Fluctuations in trout populations and their implications for land-use evaluation. *North American Journal of Fisheries Management* 8:333-345.

Scarnecchia, D.L., and E.P. Bergersen. 1987. Trout production and standing crop in Colorado's small streams, as related to environmental features. *North American Journal of Fisheries Management* 7:315-330.

Schilling, J. 1990. A history of the Questa Molybdenum (Moly) Mines, Taos County, New Mexico. Pages 381-386. IN: *New Mexico Geological Society Guidebook.* 41st Field Conference.

Slifer, D. 1996. *Red River Ground Water Investigation*. New Mexico Environment Department, Surface Water Quality Bureau. Final report submitted to U.S. Environmental Protection Agency Region VI.

U.S. Department of Health, Education, and Welfare. 1966. *A Water Quality Survey: Red River of the Rio Grande, New Mexico*. Federal Water Pollution Control Administration. Ada, OK.

U.S. Environmental Protection Agency. 1988. *Ambient Water Quality Criteria for Aluminum - 1988.* EPA 440/5-86-008. Office of Water, Washington, DC.

U.S. Environmental Protection Agency. 1994. *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, 3rd Edition. EPA/600/4-91-002. Office of Research and Development, Cincinnati, OH.

Van Deventer, J.S., and W.S. Platts. 1983. Sampling and estimating fish populations from streams. *Transactions of the North American Wildlife and Natural Resource Conference* 48:349-354.

Van Deventer, J.S., and W.S. Platts. 1989. *Microcomputer Software System for Generating Population Statistics from Electrofishing Data - User's Guide for MicroFish 3.0*. General Technical Report INT-265/1989. U.S. Forest Service.

Wallace, J.B., J.W. Grubaugh, and M.R. Whiles. 1996. Biotic indices and stream ecosystem processes: results from an experimental study. *Ecological Applications* 6:140-151.

Wells, F.C., G.A. Jackson, W.J. Rogers. 1988. *Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage, in the Lower Rio Grande Valley and Laguna Atascosa National Wildlife Refuge, Texas, 1986-87.* Water-Resources Investigations Report 87-4277. U.S. Geological Survey, Austin, TX.

Wiederholm, T. 1989. Responses of aquatic insects to environmental pollution. Pages 508-557. IN: Resh, V.H., and D.M. Rosenberg (eds.). *The Ecology of Aquatic Insects*. Praeger Scientific, New York, NY.

Wilhm, J.L. 1970. Range of diversity index in benthic macroinvertebrate populations. *Journal of Water Pollution Control Federation* 42:R221-R224.

Wood, P.J., and P.D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. *Environmental Management* 21:203-217.

Woodward-Clyde. 1996. Red River, New Mexico, Benthic Macroinvertebrate Survey - December 1995.

APPENDIX A

Fish Population Data

Molycorp
Middle Fork
09/21/00

Pass	Species	Length	Weight	K	Ws	Wr
1	BKT	49	0.4	0.34		
1	BKT	49	0.6	0.51		
1	BKT	55	1.8	1.08		
1	BKT	55	1.9	1.14		
1	BKT	56	2.1	1.20		
1	BKT	58	1.3	0.67		
1	BKT	58	1.4	0.72		
1	BKT	58	1.7	0.87		
1	BKT	58	1.9	0.97		
1	BKT	59	1.8	0.88		
1	BKT	59	2.3	1.12		
1	BKT	61	1.7	0.75		
1	BKT	62	1.5	0.63		
1	BKT	63	2.3	0.92		
1	BKT	63	2.3	0.92		
1	BKT	63	2.4	0.96		
1	BKT	64	2.1	0.80		
1	BKT	64	2.2	0.84		
1	BKT	65	2.1	0.76		
1	BKT	65	3.1	1.13		
1	BKT	65	3.2	1.17		
1	BKT	67	2.8	0.93		
1	BKT	67	3.1	1.03		
1	BKT	68	2.6	0.83		
1	BKT	68	2.7	0.86		
1	BKT	68	3.1	0.99		
1	BKT	69	2.3	0.70		
1	BKT	69	2.9	0.88		
1	BKT	70	2.8	0.82		
1	BKT	70	3.1	0.90		
1	BKT	70	3.3	0.96		
1	BKT	70	3.4	0.99		
1	BKT	71	3.9	1.09		
1	BKT	73	3.6	0.93		
1	BKT	74	2.9	0.72		
1	BKT	76	2.9	0.66		
1	BKT	76	4.2	0.96		
1	BKT	78	4.4	0.93		
1	BKT	101	10	0.97		
1	BKT	103	11	1.01		
1	BKT	105	11	0.95		
1	BKT	140	29	1.06	27.9	103.9
1	BKT	142	25	0.87	29.1	85.8
1	BKT	144	32	1.07	30.4	105.3
1	BKT	148	34	1.05	33.0	102.9
1	BKT	151	31	0.90	35.1	88.3
1	BKT	168	49	1.03	48.6	100.8
1	BKT	182	65	1.08	62.0	104.8
1	BKT	186	62	0.96	66.2	93.6
1	BKT	201	97	1.19	83.9	115.7

1	BKT	206	82	0.94	90.4	90.7
1	BKT	206	100	1.14	90.4	110.6
1	BKT	213	92	0.95	100.1	91.9
1	BKT	220	93	0.87	110.4	84.2
1	RBT	200	82	1.03	86.2	95.2
1	RBT	240	139	1.01	149.5	93.0
2	BKT	47	0.9	0.87		
2	BKT	52	1	0.71		
2	BKT	54	1.2	0.76		
2	BKT	55	1.4	0.84		
2	BKT	62	1.9	0.80		
2	BKT	63	1.6	0.64		
2	BKT	63	1.9	0.76		
2	BKT	65	2.2	0.80		
2	BKT	69	3.2	0.97		
2	BKT	72	2.7	0.72		
2	BKT	72	3.3	0.88		
2	BKT	148	31	0.96	33.0	93.8
2	BKT	174	52	0.99	54.1	96.2

BKT

	Length	Weight	K	Wr
N:	67	67	67	15
Min:	47	0.4	0.34	84.2
Max:	220	100	1.20	115.7
Mean:	91	15	0.90	97.9

RBT

	Length	Weight	K	Wr
N:	2	2	2	2
Min:	200	82	1.01	95.2
Max:	240	139	1.03	93.0
Mean:	220	111	1.02	94.1

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BKT	54	13	70	+/- 5.9	0.04	1750	+/- 148	57.9
RBT	2	0	2	+/- 0	0.04	50	+/- 0	12.2

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BKT	0.051	1372	+/- 116	45.4
RBT	0.051	39	+/- 0	9.5

Pass	Species	Length	Weight	K	Ws	Wr
1	BKT	60	1.7	0.79		
1	BKT	65	2.7	0.98		
1	BKT	66	3.1	1.08		
1	BKT	67	2.3	0.76		
1	BKT	67	2.4	0.80		
1	BKT	68	3.0	0.95		
1	BKT	69	2.7	0.82		
1	BKT	70	2.6	0.76		
1	BKT	70	2.9	0.85		
1	BKT	70	3.7	1.08		
1	BKT	71	4.1	1.15		
1	BKT	72	2.7	0.72		
1	BKT	72	3.3	0.88		
1	BKT	74	3.7	0.91		
1	BKT	74	3.7	0.91		
1	BKT	74	3.7	0.91		
1	BKT	74	3.7	0.91		
1	BKT	74	4.3	1.06		
1	BKT	75	4.0	0.95		
1	BKT	75	4.0	0.95		
1	BKT	75	4.4	1.04		
1	BKT	75	4.8	1.14		
1	BKT	75	4.8	1.14		
1	BKT	77	4.6	1.01		
1	BKT	78	4.1	0.86		
1	BKT	78	4.7	0.99		
1	BKT	78	4.8	1.01		
1	BKT	79	4.2	0.85		
1	BKT	79	4.4	0.89		
1	BKT	79	4.7	0.95		
1	BKT	80	4.2	0.82		
1	BKT	80	4.4	0.86		
1	BKT	80	4.4	0.86		
1	BKT	80	4.6	0.90		
1	BKT	80	4.8	0.94		
1	BKT	81	4.0	0.75		
1	BKT	81	4.4	0.83		
1	BKT	81	4.4	0.83		
1	BKT	81	5.8	1.09		
1	BKT	82	4.3	0.78		
1	BKT	82	4.4	0.80		
1	BKT	82	4.8	0.87		
1	BKT	82	5.3	0.96		
1	BKT	82	5.5	1.00		
1	BKT	83	5.2	0.91		
1	BKT	83	5.3	0.93		
1	BKT	83	5.7	1.00		
1	BKT	85	5.7	0.93		
1	BKT	85	5.8	0.94		
1	BKT	85	6.2	1.01		
1	BKT	85	6.3	1.03		

1	BKT	86	5.3	0.83		
1	BKT	86	5.3	0.83		
1	BKT	86	7.0	1.10		
1	BKT	87	5.8	0.88		
1	BKT	88	6.6	0.97		
1	BKT	88	7.1	1.04		
1	BKT	89	6.4	0.91		
1	BKT	89	6.9	0.98		
1	BKT	89	7.1	1.01		
1	BKT	91	6.0	0.80		
1	BKT	93	8.1	1.01		
1	BKT	95	7.8	0.91		
1	BKT	95	8.2	0.96		
1	BKT	95	9.2	1.07		
1	BKT	96	7.6	0.86		
1	BKT	120	17	0.98		
1	BKT	126	19	0.95		
1	BKT	156	36	0.95	38.8	92.8
1	BKT	167	46	0.99	47.7	96.4
1	BKT	182	58	0.96	62.0	93.5
1	BKT	190	66	0.96	70.7	93.4
1	BKT	200	77	0.96	82.6	93.2
1	BKT	201	80	0.99	83.9	95.4
1	BKT	201	82	1.01	83.9	97.8
1	BKT	223	116	1.05	115.1	100.8
1	BKT	226	116	1.00	119.8	96.8
1	BKT	236	147	1.12	136.7	107.5
1	BKT	250	146	0.93	162.9	89.6
1	BRN	56	1.6	0.91		
1	BRN	57	1.3	0.70		
1	BRN	57	1.8	0.97		
1	BRN	63	2.3	0.92		
1	BRN	66	2.6	0.90		
1	BRN	68	2.7	0.86		
1	BRN	69	2.5	0.76		
1	BRN	69	2.9	0.88		
1	BRN	69	3.9	1.19		
1	BRN	70	2.8	0.82		
1	BRN	72	2.8	0.75		
1	BRN	72	3.8	1.02		
1	BRN	73	3.5	0.90		
1	BRN	73	3.7	0.95		
1	BRN	73	4.2	1.08		
1	BRN	73	4.3	1.11		
1	BRN	74	3.5	0.86		
1	BRN	74	3.9	0.96		
1	BRN	74	4.1	1.01		
1	BRN	75	3.7	0.88		
1	BRN	75	3.7	0.88		
1	BRN	75	3.8	0.90		
1	BRN	75	4.1	0.97		
1	BRN	75	4.4	1.04		

1	BRN	75	4.5	1.07		
1	BRN	75	4.7	1.11		
1	BRN	76	4.2	0.96		
1	BRN	76	44	10.02		
1	BRN	77	4.1	0.90		
1	BRN	77	4.8	1.05		
1	BRN	78	4.3	0.91		
1	BRN	78	4.4	0.93		
1	BRN	78	4.8	1.01		
1	BRN	78	4.8	1.01		
1	BRN	79	4.7	0.95		
1	BRN	79	4.7	0.95		
1	BRN	80	4.6	0.90		
1	BRN	80	5.6	1.09		
1	BRN	81	5.2	0.98		
1	BRN	82	4.9	0.89		
1	BRN	82	5.0	0.91		
1	BRN	83	5.4	0.94		
1	BRN	120	16	0.93		
1	BRN	123	16	0.86		
1	BRN	135	22	0.89		
1	BRN	137	24	0.93		
1	BRN	157	36	0.93	42.6	84.5
1	BRN	165	42	0.93	49.3	85.1
1	BRN	195	65	0.88	80.9	80.3
1	BRN	203	83	0.99	91.2	91.0
1	BRN	258	185	1.08	185.4	99.8
1	BRN	274	214	1.04	221.6	96.6
1	BRN	286	226	0.97	251.6	89.8
1	BRN	300	244	0.90	289.9	84.2
1	BRN	305	274	0.97	304.4	90.0
1	CUT	165	37	0.82	48.2	76.8
1	CUT	175	51	0.95	57.8	88.2
1	CUT	177	50	0.90	59.9	83.5
1	CUT	205	73	0.85	94.4	77.3
1	CUT	257	145	0.85	190.3	76.2
1	HYBRID	43	0.6	0.75		
1	HYBRID	43	0.7	0.88		
1	HYBRID	44	0.3	0.35		
1	HYBRID	45	0.3	0.33		
1	HYBRID	45	0.5	0.55		
1	HYBRID	45	0.5	0.55		
1	HYBRID	48	0.7	0.63		
1	HYBRID	59	1.7	0.83		
1	HYBRID	59	2.1	1.02		
1	HYBRID	60	1.8	0.83		
1	HYBRID	60	1.9	0.88		
1	HYBRID	60	2.1	0.97		
1	HYBRID	61	2.1	0.93		
1	HYBRID	62	2.1	0.88		
1	HYBRID	62	2.5	1.05		
1	HYBRID	63	2.3	0.92		

1	HYBRID	63	2.3	0.92		
1	HYBRID	64	2.5	0.95		
1	HYBRID	65	2.7	0.98		
1	HYBRID	66	2.3	0.80		
1	HYBRID	66	2.6	0.90		
1	HYBRID	68	2.5	0.80		
1	HYBRID	68	2.7	0.86		
1	HYBRID	69	2.5	0.76		
1	HYBRID	69	3.4	1.03		
1	HYBRID	70	2.8	0.82		
1	HYBRID	70	3.2	0.93		
1	HYBRID	70	3.4	0.99		
1	HYBRID	72	3.5	0.94		
1	HYBRID	102	9.1	0.86		
1	HYBRID	110	12	0.90		
1	HYBRID	141	33	1.18		
1	RBT	201	85	1.05	87.5	97.2
1	RBT	225	122	1.07	123.0	99.2
1	RBT	257	168	0.99	183.9	91.3
1	RBT	257	174	1.03	183.9	94.6
1	RBT	268	207	1.08	208.8	99.1
1	RBT	270	192	0.98	213.5	89.9
1	RBT	272	194	0.96	218.3	88.9
1	RBT	273	194	0.95	220.8	87.9
1	RBT	274	192	0.93	223.2	86.0
1	RBT	274	219	1.06	223.2	98.1
1	RBT	275	202	0.97	225.7	89.5
1	RBT	275	221	1.06	225.7	97.9
1	RBT	275	226	1.09	225.7	100.1
1	RBT	277	194	0.91	230.7	84.1
1	RBT	278	219	1.02	233.2	93.9
1	RBT	278	246	1.14	233.2	105.5
1	RBT	278	246	1.14	233.2	105.5
1	RBT	280	211	0.96	238.3	88.5
1	RBT	280	236	1.08	238.3	99.0
1	RBT	283	236	1.04	246.2	95.9
1	RBT	284	243	1.06	248.8	97.7
1	RBT	287	254	1.07	256.8	98.9
1	RBT	288	254	1.06	259.5	97.9
1	RBT	295	240	0.93	279.1	86.0
1	RBT	295	254	0.99	279.1	91.0
1	RBT	296	274	1.06	282.0	97.2
1	RBT	296	315	1.21	282.0	111.7
1	RBT	298	271	1.02	287.8	94.2
1	RBT	298	305	1.15	287.8	106.0
1	RBT	302	274	0.99	299.6	91.5
1	RBT	302	300	1.09	299.6	100.1
1	RBT	303	278	1.00	302.6	91.9
1	RBT	305	315	1.11	308.7	102.0
1	RBT	305	325	1.15	308.7	105.3
1	RBT	312	305	1.00	330.6	92.3
1	RBT	321	335	1.01	360.3	93.0

1	RBT	321	410	1.24	360.3	113.8
1	RBT	374	545	1.04	572.0	95.3
1	RBT	405	745	1.12	727.7	102.4
2	BKT	59	2.1	1.02		
2	BKT	61	1.9	0.84		
2	BKT	67	2.3	0.76		
2	BKT	71	2.6	0.73		
2	BKT	72	3.2	0.86		
2	BKT	72	3.5	0.94		
2	BKT	74	3.8	0.94		
2	BKT	74	4.0	0.99		
2	BKT	75	3.3	0.78		
2	BKT	75	4.5	1.07		
2	BKT	76	3.8	0.87		
2	BKT	77	3.8	0.83		
2	BKT	77	4.5	0.99		
2	BKT	79	3.0	0.61		
2	BKT	79	3.8	0.77		
2	BKT	79	4.4	0.89		
2	BKT	80	4.6	0.90		
2	BKT	80	4.6	0.90		
2	BKT	80	4.8	0.94		
2	BKT	81	4.8	0.90		
2	BKT	84	6.3	1.06		
2	BKT	85	4.9	0.80		
2	BKT	89	5.6	0.79		
2	BKT	92	5.8	0.74		
2	BKT	92	6.8	0.87		
2	BKT	95	72	8.40		
2	BKT	120	15	0.87		
2	BKT	145	28	0.92	31.0	90.2
2	BKT	206	86	0.98	90.4	95.1
2	BKT	226	128	1.11	119.8	106.8
2	BRN	58	1.3	0.67		
2	BRN	62	2.3	0.97		
2	BRN	77	4.2	0.92		
2	BRN	78	4.7	0.99		
2	BRN	78	4.9	1.03		
2	BRN	80	5.0	0.98		
2	BRN	83	3.8	0.66		
2	BRN	83	6.2	1.08		
2	BRN	85	4.9	0.80		
2	BRN	228	116	0.98	128.6	90.2
2	HYBRID	49	0.8	0.68		
2	HYBRID	52	1.1	0.78		
2	HYBRID	52	1.8	1.28		
2	HYBRID	53	1.3	0.87		
2	HYBRID	53	1.6	1.07		
2	HYBRID	54	1.4	0.89		
2	HYBRID	55	1.3	0.78		
2	HYBRID	55	1.4	0.84		
2	HYBRID	59	1.3	0.63		

2	HYBRID	59	1.7	0.83		
2	HYBRID	60	1.9	0.88		
2	HYBRID	60	2.0	0.93		
2	HYBRID	61	2.1	0.93		
2	HYBRID	61	2.2	0.97		
2	HYBRID	61	2.3	1.01		
2	HYBRID	62	2.4	1.01		
2	HYBRID	65	2.3	0.84		
2	HYBRID	65	2.5	0.91		
2	HYBRID	66	3.1	1.08		
2	HYBRID	67	3.4	1.13		
2	HYBRID	69	2.9	0.88		
2	HYBRID	70	3.4	0.99		
2	HYBRID	71	3.0	0.84		
2	HYBRID	71	3.1	0.87		
2	HYBRID	74	3.4	0.84		
2	HYBRID	75	3.4	0.81		
2	HYBRID	104	11	0.98		
2	HYBRID	200	73	0.91		
2	HYBRID	210	118	1.27		
2	RBT	259	192	1.11	188.3	102.0
2	RBT	296	260	1.00	282.0	92.2

BKT

	Length	Weight	K	Wr
N:	109	109	109	14
Min:	59	1.7	0.61	89.6
Max:	250	147	8.40	107.5
Mean:	96	16	0.99	96.4

BRN

	Length	Weight	K	Wr
N:	65	65	65	10
Min:	56	1.3	0.66	80.3
Max:	305	274	10.02	99.8
Mean:	102	28	1.08	89.2

CUT

	Length	Weight	K	Wr
N:	5	5	5	5
Min:	165	37	0.82	76.2
Max:	257	145	0.95	88.2
Mean:	196	71	0.88	80.4

HYBRID

	Length	Weight	K
N:	61	61	61
Min:	43	0.3	0.33
Max:	210	118	1.28
Mean:	69	6	0.88

RBT

	Length	Weight	K	Wr
N:	41	41	41	41
Min:	201	85	0.91	84.1
Max:	405	745	1.24	113.8
Mean:	288	260	1.05	96.4

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	55	10	66	+/- 3.5	0.167	395	+/- 21	24.40
BKT	79	30	125	+/- 18.4	0.167	748	+/- 110	26.4
CUT	5	0	5	+/- 0	0.167	30	+/- 0	4.7
HYBRID	32	29	61*	--	0.167	365*	--	4.8*
RBT	39	2	41	+/- 0.7	0.167	246	+/- 4	141.0

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.080	825	+/- 44	50.9
BKT	0.080	1562	+/- 230	55.1
CUT	0.080	62	+/- 0	9.7
HYBRID	0.080	762*	--	10.1*
RBT	0.080	512	+/- 9	293.5

* Based on number of fish counted (61)

Pass	Species	Length	Weight	K	Ws	Wr
1	BKT	202	78	0.95	85.1	91.6
1	BRN	56	1.6	0.91		
1	BRN	65	2.4	0.87		
1	BRN	67	2.8	0.93		
1	BRN	70	3.3	0.96		
1	BRN	73	4.0	1.03		
1	BRN	74	4.4	1.09		
1	BRN	75	5.0	1.19		
1	BRN	76	5.1	1.16		
1	BRN	79	4.7	0.95		
1	BRN	80	5.4	1.05		
1	BRN	87	6.3	0.96		
1	BRN	93	6.8	0.85		
1	BRN	126	21	1.05		
1	BRN	167	44	0.94	51.1	86.1
1	BRN	190	68	0.99	74.9	90.7
1	BRN	202	76	0.92	89.8	84.6
1	BRN	218	90	0.87	112.6	79.9
1	BRN	218	100	0.97	112.6	88.8
1	BRN	219	96	0.91	114.1	84.1
1	BRN	227	123	1.05	126.9	96.9
1	BRN	229	124	1.03	130.3	95.2
1	BRN	240	126	0.91	149.7	84.2
1	BRN	242	142	1.00	153.4	92.6
1	BRN	246	123	0.83	161.0	76.4
1	BRN	247	164	1.09	163.0	100.6
1	BRN	273	192	0.94	219.2	87.6
1	RBT	243	156	1.09	155.3	100.5
1	RBT	251	186	1.18	171.2	108.6
1	WS	192	78	1.10		
2	BRN	65	2.6	0.95		
2	BRN	91	7.3	0.97		
2	BRN	94	8.4	1.01		
2	BRN	136	27	1.07		

BKT

	Length	Weight	K	Wr
N:	1	1	1	1
Min:	202	78	0.95	91.6
Max:	202	78	0.95	91.6
Mean:	202	78	0.95	91.6

BRN

	Length	Weight	K	Wr
N:	30	30	30	13
Min:	56	1.6	0.83	76.4
Max:	273	192	1.19	100.6
Mean:	144	53	0.98	88.3

RBT

	Length	Weight	K	Wr
N:	2	2	2	2
Min:	243	156	1.09	100.5
Max:	251	186	1.18	108.6
Mean:	247	171	1.13	104.5

WS

	Length	Weight	K
N:	1	1	1
Min:	192	78	1.10
Max:	192	78	1.10
Mean:	192	78	1.10

	1st Pass	2nd Pass	Pop Est	CI	Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BKT	1	0	1	+/- 0	0.12	8	+/- 0	1.4
BRN	26	4	30	+/- 1.7	0.12	250	+/- 14	29.20
RBT	2	0	2	+/- 0	0.12	17	+/- 0	6.4
WS	1	0	1	+/- 0	0.12	8	+/- 0	1.4

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BKT	0.062	16	+/- 0	2.8
BRN	0.062	484	+/- 27	56.6
RBT	0.062	32	+/- 0	12.1
WS	0.062	16	+/- 0	2.8

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	70	3.6	1.05		
1	BRN	77	4.2	0.92		
1	BRN	79	5	1.01		
1	BRN	81	5.4	1.02		
1	BRN	82	6	1.09		
1	BRN	91	8.2	1.09		
1	BRN	91	7.5	1.00		
1	BRN	96	9.1	1.03		
1	BRN	97	9.4	1.03		
1	BRN	98	8.4	0.89		
1	BRN	98	9.5	1.01		
1	BRN	100	10	1.00		
1	BRN	100	10	1.00		
1	BRN	105	12.5	1.08		
1	BRN	110	14	1.05		
1	BRN	165	42	0.93	49.3	85.1
1	BRN	168	50	1.05	52.0	96.1
1	BRN	170	50	1.02	53.9	92.8
1	BRN	198	76	0.98	84.7	89.8
1	BRN	200	92	1.15	87.2	105.5
1	BRN	208	85	0.94	98.0	86.8
1	BRN	214	96	0.98	106.6	90.1
1	BRN	214	92	0.94	106.6	86.3
1	BRN	215	92	0.93	108.1	85.1
1	BRN	220	110	1.03	115.7	95.1
1	BRN	222	100	0.91	118.8	84.2
1	BRN	229	130	1.08	130.3	99.8
1	BRN	229	125	1.04	130.3	96.0
1	BRN	230	127	1.04	132.0	96.2
1	BRN	235	128	0.99	140.6	91.0
1	BRN	238	150	1.11	146.0	102.7
1	BRN	241	155	1.11	151.5	102.3
1	BRN	243	135	0.94	155.3	86.9
1	BRN	245	155	1.05	159.1	97.4
1	BRN	253	150	0.93	175.0	85.7
1	BRN	254	164	1.00	177.1	92.6
1	BRN	254	160	0.98	177.1	90.4
1	BRN	257	205	1.21	183.3	111.8
1	BRN	262	193	1.07	194.1	99.4
1	BRN	269	202	1.04	209.9	96.3
1	BRN	269	180	0.92	209.9	85.8
1	BRN	270	205	1.04	212.2	96.6
1	BRN	277	220	1.04	228.9	96.1
1	BRN	282	232	1.03	241.3	96.1
1	BRN	299	250	0.94	287.0	87.1
1	BRN	300	270	1.00	289.9	93.1
1	BRN	312	310	1.02	325.6	95.2
1	BRN	342	380	0.95	427.4	88.9
1	RBT	251	180	1.14	171.2	105.1
1	RBT	252	185	1.16	173.3	106.7
1	RBT	265	204	1.10	201.8	101.1
1	RBT	278	238	1.11	233.2	102.0
1	WS	52	1.4	1.00		
2	BRN	85	5.4	0.88		
2	BRN	105	12	1.04		
2	BRN	157	37	0.96	42.6	86.9
2	RBT	300	298	1.10	293.6	101.5

BRN

	Length	Weight	K	Wr
N:	51	51	51	34
Min:	70	3.6	0.88	84.2
Max:	342	380	1.21	111.8
Mean:	190	104	1.01	93.3

RBT

	Length	Weight	K	Wr
N:	5	5	5	5
Min:	251	180	1.10	101.1
Max:	300	298	1.16	101.1
Mean:	269	221	1.12	103.3

WS

	Length	Weight	K
N:	1	1	1
Min:	52	1.4	1.00
Max:	52	1.4	1.00
Mean:	52	1.4	1.00

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	48	3	51	+/- 0.9	0.122	418	+/- 7	95.9
RBT	4	1	5	+/- 1.5	0.122	41	+/- 12	20
WS	1	0	1	+/- 0	0.122	8	+/- 0	<0.1

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.057	895	+/- 16	205.2
RBT	0.057	88	+/- 26	42.9
WS	0.057	18	+/- 0	<0.1

Pass	Species	Length	Weight	K	Ws	Wr
1	RBT	241	181	1.29	151.4	119.5

2nd Pass - No Fish

RBT

	Length	Weight	K	Wr
N:	1	1	1	1
Min:	241	181	1.29	119.5
Max:	241	181	1.29	119.5
Mean:	241	181	1.29	119.5

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
RBT	1	0	1	+/- 0	0.115	9	+/- 0	3.6

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
RBT	0.066	15	+/- 0	6.0

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09/19/00

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	191	73	1.05	76.1	95.9
1	BRN	205	85	0.99	93.8	90.6
1	BRN	205	84	0.98	93.8	89.5
1	BRN	219	112	1.07	114.1	98.1
1	BRN	223	112	1.01	120.4	93.0
1	BRN	226	116	1.00	125.3	92.6
1	BRN	239	128	0.94	147.8	86.6
1	BRN	240	142	1.03	149.7	94.9
1	BRN	246	152	1.02	161.0	94.4
1	BRN	258	167	0.97	185.4	90.1
1	BRN	260	158	0.90	189.7	83.3
1	BRN	262	170	0.95	194.1	87.6
1	BRN	265	179	0.96	200.7	89.2
1	BRN	273	191	0.94	219.2	87.1
1	BRN	281	215	0.97	238.8	90.0
1	BRN	302	277	1.01	295.7	93.7
1	BRN	305	282	0.99	304.4	92.6
2	BRN	242	126	0.89	153.4	82.1

BRN

	Length	Weight	K	Wr
N:	18	18	18	18
Min:	191	73	0.89	82.13
Max:	305	282	1.07	98.13
Mean:	247	154	0.98	90.62

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	17	1	18	+/- 0.5	0.089	202	+/- 6	68.6

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.051	353	+/- 10	119.9

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	62	2.5	1.05		
1	BRN	63	2.7	1.08		
1	BRN	66	2.9	1.01		
1	BRN	77	4.3	0.94		
1	BRN	80	4.5	0.88		
1	BRN	82	5.3	0.96		
1	BRN	83	6.1	1.07		
1	BRN	86	6.3	0.99		
1	BRN	87	6.3	0.96		
1	BRN	88	6.4	0.94		
1	BRN	88	6.2	0.91		
1	BRN	101	11	1.07		
1	BRN	130	21	0.96		
1	BRN	138	25	0.95		
1	BRN	143	27	0.92	32.3	83.6
1	BRN	146	31	1.00	34.3	90.3
1	BRN	155	34	0.91	41.0	82.9
1	BRN	170	45	0.92	53.9	83.5
1	BRN	185	66	1.04	69.2	95.3
1	BRN	187	72	1.10	71.5	100.7
1	BRN	190	67	0.98	74.9	89.4
1	BRN	191	66	0.95	76.1	86.7
1	BRN	192	71	1.00	77.3	91.9
1	BRN	194	70	0.96	79.7	87.8
1	BRN	195	76	1.02	80.9	93.9
1	BRN	195	77	1.04	80.9	95.1
1	BRN	195	71	0.96	80.9	87.7
1	BRN	196	75	1.00	82.2	91.3
1	BRN	196	75	1.00	82.2	91.3
1	BRN	196	62	0.82	82.2	75.5
1	BRN	207	86	0.97	96.6	89.0
1	BRN	219	109	1.04	114.1	95.5
1	BRN	230	119	0.98	132.0	90.2
1	BRN	231	114	0.92	133.7	85.3
1	BRN	233	126	1.00	137.1	91.9
1	BRN	237	126	0.95	144.2	87.4
1	BRN	266	176	0.94	203.0	86.7
1	BRN	283	198	0.87	243.9	81.2
2	BRN	75	4.2	1.00		
2	BRN	125	19	0.97		
2	BRN	135	24	0.98		
2	BRN	136	25	0.99		
2	BRN	142	27	0.94	31.6	85.4
2	BRN	180	55	0.94	63.8	86.1
2	BRN	191	70	1.00	76.1	92.0
2	BRN	193	68	0.95	78.5	86.6
2	BRN	197	73	0.95	83.4	87.5

2	BRN	218	99	0.96	112.6	87.9
2	BRN	223	107	0.96	120.4	88.9
2	BRN	264	151	0.82	198.5	76.1

BRN

	Length	Weight	K	Wr
N:	50	50	50	32
Min:	62	2.5	0.82	75.5
Max:	283	198	1.10	100.7
Mean:	163	57	0.97	88.3

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	38	12	54	+/- 7.9	0.188	287	+/- 42	36.1

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.08	675	+/- 99	84.8

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	68	3	0.95		
1	BRN	73	3.7	0.95		
1	BRN	103	11	1.01		
1	BRN	135	23	0.93		
1	BRN	141	24	0.86	31.0	77.5
1	BRN	144	30	1.00	33.0	91.0
1	BRN	183	56	0.91	67.0	83.5
1	BRN	190	78	1.14	74.9	104.1
1	BRN	193	68	0.95	78.5	86.6
1	BRN	203	77	0.92	91.2	84.5
1	BRN	207	81	0.91	96.6	83.9
1	BRN	219	104	0.99	114.1	91.1
1	BRN	229	112	0.93	130.3	86.0
1	BRN	234	114	0.89	138.9	82.1
1	BRN	249	149	0.97	166.9	89.3
1	BRN	282	194	0.87	241.3	80.4
2	BRN	79	4.7	0.95		
2	BRN	87	5.9	0.90		
2	BRN	121	16	0.90		
2	BRN	132	21	0.91		
2	BRN	133	21.5	0.91		
2	BRN	170	39	0.79	53.9	72.4
2	BRN	176	51	0.94	59.7	85.4
2	BRN	177	51	0.92	60.7	84.0
2	BRN	203	78	0.93	91.2	85.6
3	BRN	59	1.9	0.93		

BRN

	Length	Weight	K	Wr
N:	26	26	26	16
Min:	59	1.9	0.79	72.4
Max:	282	194	1.14	104.1
Mean:	161	55	0.93	85.4

	1st Pass	2nd Pass	3rd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	16	9	1	26	+/- 2.3	0.191	136	+/- 12	16.5

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.083	313	+/- 28	38

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	75	3.4	0.81		
1	BRN	76	3.5	0.80		
1	BRN	76	3.7	0.84		
1	BRN	81	4.7	0.88		
1	BRN	87	4.2	0.64		
1	BRN	88	6.1	0.90		
1	BRN	90	6.3	0.86		
1	BRN	94	8.7	1.05		
1	BRN	95	8.2	0.96		
1	BRN	97	8	0.88		
1	BRN	97	9.1	1.00		
1	BRN	100	9.4	0.94		
1	BRN	100	10	1.00		
1	BRN	103	10	0.92		
1	BRN	111	15	1.10		
1	BRN	165	39	0.87	49.3	79.0
1	BRN	168	49	1.03	52.0	94.2
1	BRN	178	56	0.99	61.8	90.7
1	BRN	180	58	0.99	63.8	90.8
1	BRN	181	57	0.96	64.9	87.8
1	BRN	185	62	0.98	69.2	89.5
1	BRN	190	64	0.93	74.9	85.4
1	BRN	217	101	0.99	111.1	90.9
1	BRN	219	102	0.97	114.1	89.4
1	BRN	231	126	1.02	133.7	94.3
1	BRN	231	130	1.05	133.7	97.3
1	BRN	239	140	1.03	147.8	94.7
1	HYBRID	107	14	1.14		
1	RBT	189	68	1.01		
1	RBT	201	80	0.99		
1	RBT	202	86	1.04		
1	RBT	204	87	1.02		
1	RBT	205	114	1.32		
1	RBT	207	88	0.99		
1	RBT	217	100	0.98		
1	RBT	221	102	0.94		
1	RBT	241	142	1.01		
1	RBT	244	151	1.04		
1	RBT	245	146	0.99		
1	RBT	248	152	1.00		
1	RBT	248	172	1.13		
1	RBT	249	180	1.17		
1	RBT	250	168	1.08		
1	RBT	272	188	0.93		
1	RBT	276	215	1.02		
1	RBT	279	231	1.06		
1	RBT	280	219	1.00		
1	RBT	358	540	1.18		
2	BRN	72	3.6	0.96		
2	BRN	85	5.9	0.96		
2	BRN	96	9	1.02		
2	BRN	104	12	1.07		

2	BRN	116	15	0.96		
2	BRN	116	16	1.03		
2	BRN	118	17	1.03		
2	BRN	163	51	1.18	47.6	107.2
2	BRN	180	58	0.99	63.8	90.8
2	BRN	195	66	0.89	80.9	81.6
2	BRN	218	100	0.97	112.6	88.8
2	BRN	234	118	0.92	138.9	85.0
2	BRN	240	135	0.98	149.7	90.2
2	RBT	213	96	0.99	104.2	92.1
2	RBT	235	140	1.08	140.3	99.8
2	RBT	237	154	1.16	144.0	107.0
2	RBT	238	144	1.07	145.8	98.8
2	RBT	242	147	1.04	153.3	95.9
2	RBT	251	170	1.08	171.2	99.3
2	RBT	262	175	0.97	195.0	89.8
2	RBT	291	276	1.12	267.8	103.1
2	RBT	301	274	1.00	296.6	92.4
3	BRN	110	13	0.98		
3	BRN	196	82	1.09	82.2	99.8
3	BRN	217	92	0.90	111.1	82.8
3	RBT	177	50	0.90		
3	RBT	227	124	1.06	126.4	98.1
3	RBT	229	132	1.10	129.8	101.7
3	RBT	261	192	1.08	192.7	99.6

BRN

	Length	Weight	K	Wr
N:	43	43	43	20
Min:	72	3.4	0.64	79.0
Max:	240	140	1.18	107.2
Mean:	145	44	0.96	90.5

HYBRID

	Length	Weight	K
N:	1	1	1
Min:	107	14	1.14
Max:	107	14	1.14
Mean:	107	14	1.14

RBT

	Length	Weight	K	Wr
N:	33	33	33	12
Min:	177	50	0.90	89.8
Max:	358	540	1.32	107.0
Mean:	242	161	1.05	98.1

Molycorp
Upstream of Hatchery Diversion
09/20/00

	1st Pass	2nd Pass	3rd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	27	13	3	44	+/- 3.8	0.142	310	+/- 27	30.10
HYBRID	1	0	0	1	+/- 0	0.142	7	+/- 0	0.2
RBT	20	9	4	35	+/- 5.2	0.142	246	+/- 37	87.3

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.063	698	+/- 60	67.7
HYBRID	0.063	16	+/- 0	0.5
RBT	0.063	556	+/- 82	197.4

Molycorp
Downstream of Hatchery
09/20/00

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	77	4.5	0.99		
1	BRN	81	4.5	0.85		
1	BRN	82	5.5	1.00		
1	BRN	85	6	0.98		
1	BRN	88	9	1.32		
1	BRN	95	9.1	1.06		
1	BRN	96	9.5	1.07		
1	BRN	100	9	0.90		
1	BRN	100	9.5	0.95		
1	BRN	100	10	1.00		
1	BRN	100	10	1.00		
1	BRN	104	10	0.89		
1	BRN	104	10	0.89		
1	BRN	105	11	0.95		
1	BRN	106	12	1.01		
1	BRN	107	11	0.90		
1	BRN	107	11	0.90		
1	BRN	108	11	0.87		
1	BRN	109	13	1.00		
1	BRN	110	11	0.83		
1	BRN	110	11	0.83		
1	BRN	110	12	0.90		
1	BRN	110	12	0.90		
1	BRN	110	13	0.98		
1	BRN	111	10	0.73		
1	BRN	111	11	0.80		
1	BRN	111	14	1.02		
1	BRN	114	11	0.74		
1	BRN	116	16	1.03		
1	BRN	116	16	1.03		
1	BRN	116	16	1.03		
1	BRN	118	16	0.97		
1	BRN	119	17	1.01		
1	BRN	120	16	0.93		
1	BRN	120	16	0.93		
1	BRN	121	18	1.02		
1	BRN	124	17	0.89		
1	BRN	125	17	0.87		
1	BRN	125	19	0.97		
1	BRN	126	18	0.90		
1	BRN	126	21	1.05		
1	BRN	127	20	0.98		
1	BRN	127	20	0.98		
1	BRN	127	21	1.03		
1	BRN	128	20	0.95		
1	BRN	128	22	1.05		

1	BRN	132	21	0.91		
1	BRN	132	24	1.04		
1	BRN	133	24	1.02		
1	BRN	133	24	1.02		
1	BRN	134	24	1.00		
1	BRN	135	21	0.85		
1	BRN	135	35	1.42		
1	BRN	137	27	1.05		
1	BRN	138	24	0.91		
1	BRN	139	26	0.97		
1	BRN	141	25	0.89	31.0	80.7
1	BRN	142	25	0.87	31.6	79.0
1	BRN	143	28	0.96	32.3	86.7
1	BRN	145	29	0.95	33.6	86.2
1	BRN	149	36	1.09	36.5	98.7
1	BRN	152	44	1.25	38.7	113.7
1	BRN	153	43	1.20	39.5	109.0
1	BRN	155	39	1.05	41.0	95.1
1	BRN	155	40	1.07	41.0	97.6
1	BRN	157	40	1.03	42.6	93.9
1	BRN	158	43	1.09	43.4	99.1
1	BRN	159	30	0.75	44.2	67.9
1	BRN	159	41	1.02	44.2	92.7
1	BRN	163	49	1.13	47.6	103.0
1	BRN	163	49	1.13	47.6	103.0
1	BRN	165	43	0.96	49.3	87.2
1	BRN	165	44	0.98	49.3	89.2
1	BRN	171	51	1.02	54.8	93.0
1	BRN	174	47	0.89	57.7	81.4
1	BRN	180	65	1.11	63.8	101.8
1	BRN	200	86	1.08	87.2	98.6
1	BRN	215	101	1.02	108.1	93.5
1	BRN	219	98	0.93	114.1	85.9
1	BRN	220	107	1.00	115.7	92.5
1	BRN	223	111	1.00	120.4	92.2
1	BRN	223	119	1.07	120.4	98.8
1	BRN	228	123	1.04	128.6	95.7
1	BRN	229	122	1.02	130.3	93.7
1	BRN	230	131	1.08	132.0	99.3
1	BRN	231	148	1.20	133.7	110.7
1	BRN	233	134	1.06	137.1	97.7
1	BRN	235	138	1.06	140.6	98.1
1	BRN	236	140	1.07	142.4	98.3
1	BRN	236	140	1.07	142.4	98.3
1	BRN	237	142	1.07	144.2	98.5
1	BRN	239	131	0.96	147.8	88.6
1	BRN	239	154	1.13	147.8	104.2

1	BRN	245	162	1.10	159.1	101.8
1	BRN	246	141	0.95	161.0	87.6
1	BRN	249	150	0.97	166.9	89.9
1	BRN	250	159	1.02	168.9	94.1
1	BRN	251	147	0.93	170.9	86.0
1	BRN	251	161	1.02	170.9	94.2
1	BRN	252	176	1.10	173.0	101.8
1	BRN	253	148	0.91	175.0	84.6
1	BRN	253	167	1.03	175.0	95.4
1	BRN	253	170	1.05	175.0	97.1
1	BRN	253	172	1.06	175.0	98.3
1	BRN	254	183	1.12	177.1	103.4
1	BRN	255	159	0.96	179.1	88.8
1	BRN	260	196	1.12	189.7	103.3
1	BRN	261	194	1.09	191.9	101.1
1	BRN	264	183	0.99	198.5	92.2
1	BRN	265	182	0.98	200.7	90.7
1	BRN	265	212	1.14	200.7	105.6
1	BRN	267	199	1.05	205.3	96.9
1	BRN	267	211	1.11	205.3	102.8
1	BRN	275	224	1.08	224.0	100.0
1	BRN	277	231	1.09	228.9	100.9
1	BRN	280	220	1.00	236.3	93.1
1	BRN	282	230	1.03	241.3	95.3
1	BRN	283	258	1.14	243.9	105.8
1	BRN	284	218	0.95	246.5	88.5
1	BRN	285	249	1.08	249.0	100.0
1	BRN	286	272	1.16	251.6	108.1
1	BRN	289	276	1.14	259.5	106.3
1	BRN	292	270	1.08	267.6	100.9
1	BRN	293	232	0.92	270.3	85.8
1	BRN	294	241	0.95	273.1	88.3
1	BRN	294	274	1.08	273.1	100.3
1	BRN	304	269	0.96	301.5	89.2
1	BRN	307	292	1.01	310.4	94.1
1	BRN	308	312	1.07	313.4	99.6
1	BRN	312	309	1.02	325.6	94.9
1	BRN	312	320	1.05	325.6	98.3
1	BRN	314	309	1.00	331.8	93.1
1	BRN	315	318	1.02	335.0	94.9
1	BRN	316	312	0.99	338.1	92.3
1	BRN	319	345	1.06	347.7	99.2
1	BRN	330	340	0.95	384.4	88.4
1	BRN	332	298	0.81	391.4	76.1
1	BRN	333	345	0.93	394.9	87.4
1	BRN	336	412	1.09	405.5	101.6
1	BRN	337	402	1.05	409.1	98.3

1	BRN	339	417	1.07	416.3	100.2
1	BRN	340	408	1.04	420.0	97.1
1	BRN	345	445	1.08	438.6	101.5
1	BRN	358	483	1.05	489.3	98.7
1	BRN	371	575	1.13	543.9	105.7
1	BRN	375	507	0.96	561.4	90.3
1	RBT	158	49	1.24		
1	RBT	193	74	1.03		
1	RBT	203	88	1.05	90.1	97.6
1	RBT	220	98	0.92	114.9	85.3
1	RBT	240	141	1.02	149.5	94.3
1	RBT	242	148	1.04	153.3	96.5
1	RBT	250	144	0.92	169.2	85.1
1	RBT	260	178	1.01	190.5	93.4
2	BRN	91	7.3	0.97		
2	BRN	91	7.5	1.00		
2	BRN	95	9.1	1.06		
2	BRN	98	9	0.96		
2	BRN	107	12	0.98		
2	BRN	107	13	1.06		
2	BRN	109	14	1.08		
2	BRN	119	18	1.07		
2	BRN	121	20	1.13		
2	BRN	122	19	1.05		
2	BRN	126	19	0.95		
2	BRN	126	21	1.05		
2	BRN	127	21	1.03		
2	BRN	128	21	1.00		
2	BRN	130	25	1.14		
2	BRN	131	25	1.11		
2	BRN	137	25	0.97		
2	BRN	137	28	1.09		
2	BRN	138	27	1.03		
2	BRN	141	31	1.11	31.0	100.1
2	BRN	144	32	1.07	33.0	97.1
2	BRN	147	33	1.04	35.0	94.2
2	BRN	153	26	0.73	39.5	65.9
2	BRN	156	41	1.08	41.8	98.1
2	BRN	212	91	0.96	103.7	87.8
2	BRN	219	112	1.07	114.1	98.1
2	BRN	229	132	1.10	130.3	101.3
2	BRN	241	152	1.09	151.5	100.3
2	BRN	241	152	1.09	151.5	100.3
2	BRN	250	152	0.97	168.9	90.0
2	BRN	252	188	1.17	173.0	108.7
2	BRN	253	163	1.01	175.0	93.1
2	BRN	255	188	1.13	179.1	105.0

2	BRN	261	172	0.97	191.9	89.6
2	BRN	266	182	0.97	203.0	89.7
2	BRN	271	208	1.05	214.5	97.0
2	BRN	277	215	1.01	228.9	93.9
2	BRN	277	215	1.01	228.9	93.9
2	BRN	278	228	1.06	231.3	98.6
2	BRN	299	295	1.10	287.0	102.8
2	BRN	306	300	1.05	307.4	97.6
2	BRN	308	315	1.08	313.4	100.5
2	BRN	310	298	1.00	319.5	93.3
2	BRN	311	273	0.91	322.5	84.6
2	BRN	315	340	1.09	335.0	101.5
2	BRN	320	360	1.10	351.0	102.6
2	BRN	337	420	1.10	409.1	102.7
2	BRN	358	428	0.93	489.3	87.5
2	RBT	184	66	1.06		
2	RBT	207	88	0.99	95.6	92.0
2	RBT	213	98	1.01	104.2	94.0
2	RBT	217	101	0.99	110.3	91.6
2	RBT	248	168	1.10	165.1	101.7

BRN

	Length	Weight	K	Wr
N:	194	194	194	119
Min:	77	4.5	0.73	65.9
Max:	375	575	1.42	113.7
Mean:	198	124	1.01	95.5

RBT

	Length	Weight	K	Wr
N:	13	13	13	10
Min:	158	49	0.92	85.1
Max:	260	178	1.24	101.7
Mean:	218	111	1.03	93.2

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	146	48	216	+/- 19.2	0.214	1009	+/- 90	275.9
RBT	8	5	16	+/- 11.8	0.214	75	+/- 55	18.4

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.066	3273	+/- 291	894.9
RBT	0.066	242	+/- 179	59.2

Pass	Species	Length	Weight	K	Ws	Wr
1	BKT	63	1.9	0.76		
1	BKT	66	2.1	0.73		
1	BKT	70	2.7	0.79		
1	BKT	71	2.8	0.78		
1	BKT	74	3	0.74		
1	BKT	77	3.5	0.77		
1	BKT	80	4.1	0.80		
1	BKT	82	4.5	0.82		
1	BKT	87	5.8	0.88		
1	BKT	92	5.7	0.73		
1	BKT	137	21	0.82	26.1	80.4
1	BKT	140	23	0.84	27.9	82.4
1	BKT	142	24	0.84	29.1	82.4
1	BKT	142	26	0.91	29.1	89.2
1	BKT	216	95	0.94	104.4	91.0
1	BRN	80	4.3	0.84		
1	BRN	85	5.5	0.90		
1	BRN	137	23	0.89		
1	BRN	142	28	0.98	31.6	88.5
1	BRN	143	28	0.96	32.3	86.7
1	HYBRID	41	0.4	0.58		
1	HYBRID	42	0.4	0.54		
1	HYBRID	45	0.7	0.77		
1	HYBRID	46	0.6	0.62		
1	HYBRID	47	0.7	0.67		
1	HYBRID	47	0.7	0.67		
1	HYBRID	49	0.9	0.76		
1	HYBRID	49	0.9	0.76		
1	HYBRID	50	0.9	0.72		
1	HYBRID	50	1.1	0.88		
1	HYBRID	50	1.2	0.96		
1	HYBRID	51	1	0.75		
1	HYBRID	51	1.1	0.83		
1	HYBRID	52	1	0.71		
1	HYBRID	52	1.2	0.85		
1	HYBRID	52	1.2	0.85		
1	HYBRID	52	1.3	0.92		
1	HYBRID	54	1.4	0.89		
1	HYBRID	55	1	0.60		
1	HYBRID	55	1.5	0.90		
1	HYBRID	56	1.3	0.74		
1	HYBRID	57	2	1.08		
1	HYBRID	58	1.2	0.62		
1	HYBRID	58	1.4	0.72		
1	HYBRID	58	1.4	0.72		
1	HYBRID	59	1.6	0.78		
1	HYBRID	59	1.9	0.93		
1	HYBRID	59	2	0.97		
1	HYBRID	60	1.4	0.65		
1	HYBRID	60	1.5	0.69		
1	HYBRID	60	1.6	0.74		

1	HYBRID	60	1.6	0.74
1	HYBRID	60	2	0.93
1	HYBRID	61	1.6	0.70
1	HYBRID	61	2	0.88
1	HYBRID	62	2.7	1.13
1	HYBRID	63	2.1	0.84
1	HYBRID	63	2.4	0.96
1	HYBRID	64	2.4	0.92
1	HYBRID	65	2	0.73
1	HYBRID	65	2.1	0.76
1	HYBRID	65	2.5	0.91
1	HYBRID	65	2.5	0.91
1	HYBRID	65	2.7	0.98
1	HYBRID	65	3.1	1.13
1	HYBRID	67	2.4	0.80
1	HYBRID	69	2.9	0.88
1	HYBRID	70	2.9	0.85
1	HYBRID	70	2.9	0.85
1	HYBRID	70	3.2	0.93
1	HYBRID	71	2.7	0.75
1	HYBRID	74	3.2	0.79
1	HYBRID	90	6.5	0.89
1	HYBRID	95	8	0.93
1	HYBRID	101	9	0.87
1	HYBRID	104	11	0.98
1	HYBRID	105	11	0.95
1	HYBRID	105	11	0.95
1	HYBRID	106	11	0.92
1	HYBRID	107	11	0.90
1	HYBRID	107	11	0.90
1	HYBRID	108	14	1.11
1	HYBRID	112	12	0.85
1	HYBRID	112	13	0.93
1	HYBRID	115	14	0.92
1	HYBRID	120	15	0.87
1	HYBRID	121	13	0.73
1	HYBRID	125	15	0.77
1	HYBRID	135	22	0.89
1	HYBRID	138	22	0.84
1	HYBRID	139	27	1.01
1	HYBRID	145	32	1.05
1	HYBRID	148	35	1.08
1	HYBRID	149	35	1.06
1	HYBRID	151	36	1.05
1	HYBRID	151	37	1.07
1	HYBRID	158	33	0.84
1	HYBRID	158	36	0.91
1	HYBRID	160	40	0.98
1	HYBRID	161	46	1.10
1	HYBRID	165	42	0.93
1	HYBRID	165	47	1.05
1	HYBRID	170	50	1.02

1	HYBRID	171	50	1.00		
1	HYBRID	178	62	1.10		
1	HYBRID	180	48	0.82		
1	HYBRID	180	68	1.17		
1	HYBRID	181	60	1.01		
1	HYBRID	186	68	1.06		
1	HYBRID	187	58	0.89		
1	HYBRID	190	64	0.93		
1	HYBRID	192	75	1.06		
1	HYBRID	195	70	0.94		
1	HYBRID	198	76	0.98		
1	HYBRID	198	80	1.03		
1	HYBRID	206	84	0.96		
1	HYBRID	211	84	0.89		
1	HYBRID	212	104	1.09		
1	HYBRID	222	95	0.87		
1	RBT	200	85	1.06	86.2	98.7
1	RBT	201	83	1.02	87.5	94.9
1	RBT	206	82	0.94	94.2	87.0
1	RBT	208	82	0.91	97.0	84.5
1	RBT	214	100	1.02	105.7	94.6
1	RBT	230	130	1.07	131.5	98.9
1	RBT	235	150	1.16	140.3	106.9
1	RBT	237	120	0.90	144.0	83.4
1	RBT	238	135	1.00	145.8	92.6
1	RBT	239	145	1.06	147.7	98.2
1	RBT	240	135	0.98	149.5	90.3
1	RBT	245	150	1.02	159.2	94.2
1	RBT	245	180	1.22	159.2	113.1
1	RBT	246	180	1.21	161.1	111.7
1	RBT	246	185	1.24	161.1	114.8
1	RBT	251	170	1.08	171.2	99.3
1	RBT	251	180	1.14	171.2	105.1
1	RBT	255	210	1.27	179.6	116.9
1	RBT	264	210	1.14	199.5	105.3
1	RBT	267	205	1.08	206.4	99.3
1	RBT	268	190	0.99	208.8	91.0
1	RBT	272	210	1.04	218.3	96.2
1	RBT	276	265	1.26	228.2	116.1
1	RBT	278	220	1.02	233.2	94.3
1	RBT	287	255	1.08	256.8	99.3
1	RBT	288	250	1.05	259.5	96.3
1	RBT	307	330	1.14	314.9	104.8
1	RBT	320	360	1.10	356.9	100.9
2	BKT	62	1.9	0.80		
2	BKT	77	3.9	0.85		
2	HYBRID	50	1	0.80		
2	HYBRID	50	1	0.80		
2	HYBRID	51	1	0.75		
2	HYBRID	51	1.3	0.98		
2	HYBRID	52	1.1	0.78		
2	HYBRID	53	1.1	0.74		

2	HYBRID	53	1.7	1.14
2	HYBRID	55	1.5	0.90
2	HYBRID	56	1.3	0.74
2	HYBRID	58	1.2	0.62
2	HYBRID	59	1.6	0.78
2	HYBRID	59	1.8	0.88
2	HYBRID	59	2	0.97
2	HYBRID	60	2.1	0.97
2	HYBRID	62	2.3	0.97
2	HYBRID	64	2.3	0.88
2	HYBRID	73	2.8	0.72
2	HYBRID	98	10	1.06
2	HYBRID	105	11	0.95
2	HYBRID	106	12	1.01
2	HYBRID	114	15	1.01
2	HYBRID	118	16	0.97

BKT

	Length	Weight	K	Wr
N:	17	17	17	5
Min:	62	1.9	0.73	80.4
Max:	216	95	0.94	91.0
Mean:	99	14	0.81	85.1

BRN

	Length	Weight	K	Wr
N:	5	5	5	2
Min:	80	4.3	0.84	86.7
Max:	143	28	0.98	88.5
Mean:	117	18	0.91	87.6

HYBRID

	Length	Weight	K
N:	121	121	121
Min:	41	0.4	0.54
Max:	222	104	1.17
Mean:	96	17	0.88

RBT

	Length	Weight	K	Wr
N:	28	28	28	28
Min:	200	82	0.90	83.4
Max:	320	360	1.27	116.9
Mean:	251	178	1.08	99.6

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BKT	15	2	17	+/- 1.1	0.067	254	+/- 16	7.80
BRN	5	0	5	+/- 0	0.067	75	+/- 0	3.0
HYBRID	99	22	126	+/- 7.3	0.067	1881	+/- 109	70.5
RBT	28	0	28	+/- 0	0.067	418	+/- 0	164.1

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BKT	0.054	315	+/- 20	9.7
BRN	0.054	93	+/- 0	3.7
HYBRID	0.054	2333	+/- 135	87.4
RBT	0.054	518	+/- 0	203.3

Pass	Species	Length	Weight	K	Ws	Wr
1	BRN	44	0.3	0.35		
1	BRN	48	0.5	0.45		
1	BRN	50	0.8	0.64		
1	BRN	53	0.7	0.47		
1	BRN	53	1.2	0.81		
1	BRN	53	1.7	1.14		
1	BRN	54	0.9	0.57		
1	BRN	54	1.2	0.76		
1	BRN	54	1.4	0.89		
1	BRN	54	1.5	0.95		
1	BRN	55	1.3	0.78		
1	BRN	55	1.5	0.90		
1	BRN	56	1.6	0.91		
1	BRN	57	1.7	0.92		
1	BRN	58	1.2	0.62		
1	BRN	58	1.5	0.77		
1	BRN	58	1.6	0.82		
1	BRN	58	1.9	0.97		
1	BRN	58	2	1.03		
1	BRN	59	1.7	0.83		
1	BRN	59	1.8	0.88		
1	BRN	59	2	0.97		
1	BRN	59	2	0.97		
1	BRN	60	2	0.93		
1	BRN	60	2	0.93		
1	BRN	60	2	0.93		
1	BRN	60	2.1	0.97		
1	BRN	61	2	0.88		
1	BRN	61	2.1	0.93		
1	BRN	61	2.3	1.01		
1	BRN	61	2.4	1.06		
1	BRN	61	2.4	1.06		
1	BRN	62	1.2	0.50		
1	BRN	62	1.8	0.76		
1	BRN	62	2.1	0.88		
1	BRN	62	2.3	0.97		
1	BRN	62	2.7	1.13		
1	BRN	63	2.3	0.92		
1	BRN	64	2	0.76		
1	BRN	64	2	0.76		
1	BRN	64	2.2	0.84		
1	BRN	64	2.2	0.84		
1	BRN	64	2.2	0.84		
1	BRN	64	2.2	0.84		
1	BRN	65	2.6	0.95		
1	BRN	65	2.9	1.06		
1	BRN	66	2.9	1.01		
1	BRN	67	2.6	0.86		
1	BRN	67	2.8	0.93		
1	BRN	72	3.3	0.88		
1	BRN	92	6.9	0.89		

1	BRN	98	8	0.85		
1	BRN	101	9	0.87		
1	BRN	103	10	0.92		
1	BRN	103	11	1.01		
1	BRN	104	9	0.80		
1	BRN	105	10	0.86		
1	BRN	105	10	0.86		
1	BRN	105	12	1.04		
1	BRN	106	9	0.76		
1	BRN	106	11	0.92		
1	BRN	107	11	0.90		
1	BRN	108	13	1.03		
1	BRN	109	10	0.77		
1	BRN	109	11	0.85		
1	BRN	110	13	0.98		
1	BRN	110	13	0.98		
1	BRN	111	12	0.88		
1	BRN	112	11	0.78		
1	BRN	113	11	0.76		
1	BRN	115	12	0.79		
1	BRN	115	14	0.92		
1	BRN	115	14	0.92		
1	BRN	116	14	0.90		
1	BRN	125	17	0.87		
1	BRN	148	25	0.77	35.8	69.9
1	BRN	160	36	0.88	45.0	79.9
1	BRN	162	40	0.94	46.7	85.6
1	BRN	174	48	0.91	57.7	83.1
1	BRN	183	56	0.91	67.0	83.5
1	BRN	200	74	0.93	87.2	84.8
1	BRN	207	82	0.92	96.6	84.9
1	BRN	208	84	0.93	98.0	85.7
1	BRN	218	96	0.93	112.6	85.3
1	BRN	220	102	0.96	115.7	88.2
1	BRN	246	152	1.02	161.0	94.4
1	BRN	248	124	0.81	165.0	75.2
1	BRN	252	138	0.86	173.0	79.8
1	BRN	255	147	0.89	179.1	82.1
1	BRN	275	174	0.84	224.0	77.7
2	BRN	49	1	0.85		
2	BRN	52	0.9	0.64		
2	BRN	54	1.4	0.89		
2	BRN	54	1.4	0.89		
2	BRN	55	1	0.60		
2	BRN	55	1.2	0.72		
2	BRN	55	2.4	1.44		
2	BRN	57	1.8	0.97		
2	BRN	60	1.3	0.60		
2	BRN	60	1.8	0.83		
2	BRN	62	1.5	0.63		
2	BRN	64	2.8	1.07		
2	BRN	65	2.3	0.84		

2	BRN	66	2.4	0.83		
2	BRN	68	2.8	0.89		
2	BRN	102	7	0.66		
2	BRN	103	10	0.92		
2	BRN	111	14	1.02		
2	BRN	149	29	0.88	36.5	79.5
2	BRN	173	42	0.81	56.8	74.0
2	BRN	199	75	0.95	85.9	87.3
2	BRN	203	98	1.17	91.2	107.5
2	BRN	206	80	0.92	95.2	84.0
2	BRN	207	85	0.96	96.6	88.0
2	CUT	87	5.4	0.82		

BRN

	Length	Weight	K	Wr
N:	114	114	114	21
Min:	44	0.3	0.35	69.9
Max:	275	174	1.44	107.5
Mean:	98	19	0.87	83.8

CUT

	Length	Weight	K
N:	1	1	1
Min:	87	5.4	0.82
Max:	87	5.4	0.82
Mean:	87	5.4	0.82

	1st Pass	2nd Pass	Pop Est	CI	Site Area (acre)	Density (#/acre)	95% CI	Biomass (lbs/acre)
BRN	90	24	121	+/- 9.4	0.08	1512	+/- 118	63.3
CUT	0	1	1*	--	0.08	12*	--	0.1*

	Site Length (miles)	Density (#/mile)	95% CI	Biomass (lbs/mile)
BRN	0.054	2241	+/- 174	93.9
CUT	0.054	18*	--	0.2*

* Based on number collected (1)

APPENDIX B

Benthic Invertebrate Data

Note:

All data have been recalculated using the correct conversion factor for the modified Hess sampler (11.63).

GD 3/15/04

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Town
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1129	3210	1070	7490	2699	3119
Cultus aestivalis					47	9
Paraleuctra sp.			23	233	93	70
Prostoia besametsa	1105	3140	861	6466	2373	2789
Sweltsa sp.		70	186	744	186	237
Taenionema sp.	12					2
Zapada oregonensis gr.	12			47		12
EPHEMEROPTERA	606	1163	1024	3814	1026	1527
Baetis tricaudatus	105	326	140	186	186	189
Cinygmula sp.			47			9
Drunella coloradensis	12	93	209	558	233	221
Drunella doddsi	477	628	302	2512	419	868
Drunella grandis	12	70			47	26
Epeorus longimanus			140	279	47	93
Ephemerella infrequens		23	23	93	47	37
Rhithrogena hageni		23	163	186	47	84
TRICHOPTERA	430	605	581	3118	2234	1393
Arctopsyche grandis			23		93	23
Brachycentrus americanus	186	326	349	2140	1954	991
Lepidostoma sp. A					47	9
Lepidostoma sp. B			23	47		14
Oligophlebodes minutus					47	9
Rhyacophila brunnea gr.				93		19
Rhyacophila coloradensis gr.				47		9
Rhyacophila sibirica gr.	244	279	186	791	93	319
COLEOPTERA	81	116	116	47	186	110
Heterlimnius corpulentus	81	116	93	47	186	105
Postelichus sp.			23			5
DIPTERA	1885	1721	1046	8792	5072	3702
Bibiocephala grandis				47		9
Brillia sp.	47					9
Chelifera/Metachela		23				5
Cricotopus sp.	361	407	23	663	1175	526
Diamesa sp.				267		53
Dicranota sp.			23		93	23
Mallochohelea sp.				47	47	19
Micropsectra sp.	419	47	256	395	2105	644
Pagastia sp.	314	616	163	1977	442	702
Pericoma sp.	744	605	558	2977	884	1154
Prosimulium sp.		23		2419	279	544
Rheocricotopus sp.			23			5
Tipula sp.					47	9
TURBELLARIA			140			28
Polycelis coronata			140			28

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Town
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	12		1140	93	93	268
Stephansoniana tandyi	12		1140	93	93	268
NEMATODA	35				47	16
Unid. Nematoda	35				47	16
HYDRACARINA	244	419	326	884	1489	672
Lebertia sp.	244	419	326	837	1442	654
Sperchon/Sperchonopsis					47	9
Testudacarus/Torrenticola				47		9
TOTAL (#/sq. meter)	4422	7234	5443	24238	12846	10835
NUMBER OF TAXA	18	18	25	27	29	43
SHANNON-WEAVER (H')						3.79
TOTAL EPT TAXA	9	10	14	15	16	22
EPT INDEX (% of Total Taxa)	50	56	56	56	55	51
EPHEMEROPTERA ABUNDANCE (% of Total Density)	14	16	19	16	8	14

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: June Bug
SAMPLED: 04/05/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	24	12	58	47	81	44
Prostoia besametsa	12	12	23	35	58	28
Sweltsa sp.	12		35	12	23	16
EPHEMEROPTERA	386	151	338	571	489	386
Baetis tricaudatus	70	116	140	105	105	107
Cinygmula sp.			12		12	5
Drunella doddsi	47					9
Drunella grandis	198		174	326	244	188
Epeorus longimanus	12					2
Ephemerella infrequens	12				23	7
Rhithrogena hageni	47	35	12	140	105	68
TRICHOPTERA	116	93	129	129	385	170
Arctopsyche grandis				12		2
Brachycentrus americanus	23	35	47	23	326	91
Lepidostoma sp. A				12		2
Oligophlebodes minutus	12		12	12	12	10
Rhyacophila coloradensis gr.	58	58	35	12	12	35
Rhyacophila sibirica gr.	23		35	58	35	30
COLEOPTERA			12	81	35	25
Heterlimnius corpulentus			12	81	23	23
Narpus concolor					12	2
DIPTERA	454	338	280	176	153	279
Atherix pachypus	12			12	12	7
Ceratopogonidae			12		12	5
Chelifera/Metachela	23		12		23	12
Cricotopus sp.	372	302	221	105	35	207
Diamesa sp.	47	12	35	35	12	28
Dicranota sp.		12		12		5
Hesperoconopa sp.				12		2
Hexatoma sp.		12				2
Orthocladius lignicola					47	9
Pagastia sp.					12	2
HYDRACARINA	105	186	35	919	466	341
Lebertia sp.	105	186	35	907	454	337
Protzia sp.				12		2
Sperchon/Sperchonopsis					12	2
TOTAL (#/sq. meter)	1085	780	852	1923	1609	1245
NUMBER OF TAXA	17	10	16	19	22	30
SHANNON-WEAVER (H')						3.39
TOTAL EPT TAXA	12	5	10	11	11	15
EPT INDEX (% of Total Taxa)	71	50	63	58	50	50
EPHEMEROPTERA ABUNDANCE (% of Total Density)	36	19	40	30	30	31

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Elephant Rock
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	70					14
Prostoia besametsa	58					12
Taenionema sp.	12					2
EPHEMEROPTERA	524	744	965	210	860	661
Baetis bicaudatus	93					19
Baetis tricaudatus	35		12	12	23	16
Cinygmula sp.	233					47
Drunella doddsi					35	7
Drunella grandis	151	744	872	186	709	532
Rhithrogena hageni	12		81	12	93	40
TRICHOPTERA	559	1303	884	419	710	775
Arctopsyche grandis				12	12	5
Brachycentrus americanus	512	1303	884	407	698	761
Rhyacophila brunnea gr.	12					2
Rhyacophila sibirica gr.	35					7
COLEOPTERA		93	12			21
Optioservus sp.		93	12			21
DIPTERA	2630	5909	2117	2886	1884	3085
Atherix pachypus		186	93	105	116	100
Chelifera/Metachela			12	58		14
Cricotopus sp.	2466	4792	1198	2175	1244	2375
Diamesa sp.	105	651	686	419	407	454
Dicranota sp.	35	186	58	12	23	63
Hesperoconopa sp.		47				9
Hexatoma sp.	12				12	5
Mallochohelea sp.				12		2
Pagastia sp.			70		70	28
Pericoma sp.	12	47			12	14
Rheocricotopus sp.				105		21
ANNELIDA						
OLIGOCHAETA	244	419		419	23	221
Stephansoniana tandyi	244	419		419	23	221
HYDRACARINA	454	1768	256	419	209	621
Lebertia sp.	454	1768	244	419	209	619
Testudacarus/Torrenticola			12			2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Elephant Rock
SAMPLED: 04/03/00

TOTAL (#/sq. meter)	4481	10236	4234	4353	3686	5398
NUMBER OF TAXA	17	11	13	14	15	27
SHANNON-WEAVER (H')						2.69
TOTAL EPT TAXA	10	2	4	5	6	12
EPT INDEX (% of Total Taxa)	59	18	31	36	40	44
EPHEMEROPTERA ABUNDANCE (% of Total Density)	12	7	23	5	23	12

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hansen
SAMPLED: 04/05/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	12		23	12	47	19
Capniidae			23			5
Prostoia besametsa	12			12		5
Pteronarcella badia					35	7
Sweltsa sp.					12	2
EPHEMEROPTERA	407	570	720	733	652	616
Baetis tricaudatus		23	23	12		12
Drunella grandis	384	500	488	430	454	451
Epeorus longimanus		12				2
Ephemerella infrequens		12				2
Rhithrogena hageni	23	23	209	291	198	149
TRICHOPTERA	559	396	2163	1350	1477	1187
Arctopsyche grandis	58	140	23	12	81	63
Brachycentrus americanus	419	186	2047	1303	1337	1058
Hydropsyche sp.	12					2
Lepidostoma sp. A					12	2
Lepidostoma sp. B					12	2
Oligophlebodes minutus				35		7
Rhyacophila coloradensis gr.	58	70	93		35	51
Rhyacophila sp. nr. rotunda gr.	12					2
COLEOPTERA	23		23			10
Heterlimnius corpulentus	23					5
Optioservus quadrimaculatus			23			5
DIPTERA	2559	1385	1374	1199	2198	1742
Atherix pachypus	12	12	47	12		17
Chelifera/Metachela	12	23	47		12	19
Cricotopus sp.	1105	163	675	535	174	530
Diamesa sp.	1430	1175	558	628	2000	1158
Dicranota sp.				12		2
Dolichopodidae					12	2
Pagastia sp.			47			9
Rhabdomastix sp.		12		12		5
HYDRACARINA	523	93	884	244	477	445
Lebertia sp.	523	93	861	244	477	440
Testadacarus/Torrenticola			23			5
TOTAL (#/sq. meter)	4083	2444	5187	3538	4851	4019
NUMBER OF TAXA	14	14	15	13	14	29
SHANNON-WEAVER (H')						2.73
TOTAL EPT TAXA	8	8	7	7	9	17
EPT INDEX (% of Total Taxa)	57	57	47	54	64	59
EPHEMEROPTERA ABUNDANCE (% of Total Density)	10	23	14	21	13	15

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Columbine
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	59	35	12	12	47	32
Paraleuctra sp.	12					2
Prostoia besametsa	12	23	12		47	19
Pteronarcella badia	12					2
Sweltsa sp.	23	12		12		9
EPHEMEROPTERA	1534	1035	337	406	605	784
Baetis tricaudatus	267	558	174	174	361	307
Drunella doddsi		12				2
Drunella grandis	244	209	58	58	81	130
Epeorus longimanus		23				5
Ephemerella infrequens		12	12			5
Rhithrogena hageni	1000	221	93	174	163	330
Rhithrogena robusta	23					5
TRICHOPTERA	558	605	209	152	547	415
Arctopsyche grandis	70	58		35	70	47
Brachycentrus americanus	430	384	128	105	291	268
Lepidostoma sp. A		12				2
Oligophlebodes minutus		23				5
Rhyacophila coloradensis gr.	58	105	81		174	84
Rhyacophila sibirica gr.				12		2
Rhyacophila sp. nr. rotunda gr.		23			12	7
COLEOPTERA	24	70	35		12	28
Heterlimnius corpulentus	12	70	23		12	23
Narpus concolor	12		12			5
DIPTERA	163	583	651	36	140	313
Antocha sp.				12		2
Atherix pachypus	23	23	23	12	58	28
Chelifera/Metachela	12	12			12	7
Cricotopus sp.	23	291	407	12	47	156
Diamesa sp.		233	221		23	95
Dicranota sp.	93	12				21
Hesperoconopa sp.		12				2
Rhabdomastix sp.	12					2
ANNELIDA						
OLIGOCHAETA			12			2
Enchytraeidae			12			2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Columbine
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA	47	279	58	12		79
Lebertia sp.	47	267	58	12		77
Sperchon/Sperchonopsis		12				2
TOTAL (#/sq. meter)	2385	2607	1314	618	1351	1653
NUMBER OF TAXA	19	23	14	11	13	31
SHANNON-WEAVER (H')						3.45
TOTAL EPT TAXA	11	14	7	7	8	18
EPT INDEX (% of Total Taxa)	58	61	50	64	62	58
EPHEMEROPTERA ABUNDANCE (% of Total Density)	64	40	26	66	45	47

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Goathill
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	12	12	58	24	12	22
Paraleuctra sp.					12	2
Prostoia besametsa		12	23	12		9
Pteronarcella badia			23	12		7
Sweltsa sp.			12			2
Zapada oregonensis gr.	12					2
EPHEMEROPTERA	349	372	512	652	245	425
Baetis tricaudatus		35		12		9
Drunella doddsi	35				12	9
Drunella grandis	314	23	47	35	47	93
Rhithrogena hageni		314	465	605	186	314
TRICHOPTERA	151	186	419	116	186	211
Arctopsyche grandis	23	23	23	23	35	25
Brachycentrus americanus	81	140	314	81	81	139
Hydropsyche sp.	12		12	12	12	10
Rhyacophila coloradensis gr.	12	23	58		58	30
Rhyacophila sibirica gr.	23		12			7
COLEOPTERA			12			2
Heterlimnius corpulentus			12			2
DIPTERA	12	59	82	12	35	39
Antocha sp.			12			2
Atherix pachypus		12	47	12		14
Cricotopus sp.	12	47			23	16
Pericoma sp.			23		12	7
HYDRACARINA	12	12	12		35	14
Lebertia sp.	12		12		35	12
Sperchon/Sperchonopsis		12				2
TOTAL (#/sq. meter)	536	641	1095	804	513	713
NUMBER OF TAXA	10	10	15	9	11	21
SHANNON-WEAVER (H')						2.69
TOTAL EPT TAXA	8	7	10	8	8	14
EPT INDEX (% of Total Taxa)	80	70	67	89	73	67
EPHEMEROPTERA ABUNDANCE (% of Total Density)	65	58	47	81	48	60

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Questa Ranger Station
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	12		12	12		6
Capniidae				12		2
Nemouridae			12			2
Paraleuctra sp.	12					2
EPHEMEROPTERA	104	12	12	0	12	28
Baetis tricaudatus	23				12	7
Ephemerella infrequens	23					5
Heptageniidae			12			2
Rhithrogena hageni	58	12				14
TRICHOPTERA	128	81	70	116	70	93
Arctopsyche grandis	23			23		9
Brachycentrus americanus	70	81	70	93	70	77
Oligophlebodes minutus	12					2
Rhyacophila sibirica gr.	23					5
COLEOPTERA	23	12			12	9
Heterlimnius corpulentus	23				12	7
Narpus concolor		12				2
DIPTERA	222	60	94	71	47	97
Antocha sp.		12				2
Atherix pachypus		12	12			5
Brillia sp.			12			2
Ceratopogonidae	12					2
Chelifera/Metachela				12		2
Dicranota sp.	70	12	35	47	35	40
Heterotrissocladius sp.	81		12			19
Micropsectra sp.		12			12	5
Pericoma sp.	12					2
Rhabdomastix sp.	47	12	23			16
Tipula sp.				12		2
TOTAL (#/sq. meter)	489	165	188	199	141	233
NUMBER OF TAXA	14	8	8	6	5	24
SHANNON-WEAVER (H')						3.41
TOTAL EPT TAXA	8	2	3	3	2	11
EPT INDEX (% of Total Taxa)	57	25	38	50	40	46
EPHEMEROPTERA ABUNDANCE (% of Total Density)	21	7	6	0	9	12

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Hatchery
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	12	0	128	117	23	56
Isoperla sp.	12		93	70		35
Prostoia besametsa				47		9
Pteronarcella badia			35		23	12
EPHEMEROPTERA	2152	1908	2571	2628	2722	2395
Baetis tricaudatus	2128	1826	2338	2419	2466	2235
Drunella grandis		35	81	23	23	32
Epeorus longimanus	12	12		23	70	23
Paraleptophlebia sp.			12		23	7
Rhithrogena hageni	12	35	140	163	140	98
TRICHOPTERA	117	651	663	279	605	463
Brachycentrus americanus	93	337	419	163	256	254
Hydropsyche sp.		314	244	116	326	200
Hydroptila sp.					23	5
Lepidostoma sp. A	12					2
Rhyacophila coloradensis gr.	12					2
ODONATA	12					2
Argia sp.	12					2
COLEOPTERA	791	547	594	1070	1279	857
Narpus concolor	93	47	12	70	186	82
Optioservus sp.	291	174	221	279	488	291
Zaitzevia parvula	407	326	361	721	605	484
DIPTERA	1025	1536	1268	1396	1978	1440
Atherix pachypus	47	337	640	326	512	372
Chelifera/Metachela		35				7
Cricotopus sp.	919	965	558	1012	1326	956
Mallochohelea sp.	47	47	35	23	140	58
Micropsectra sp.				35		7
Pagastia sp.		140				28
Tipula sp.	12	12	35			12
TURBELLARIA	267	58			186	102
Dugesia sp.	267	58			186	102
NEMATODA	12	12			70	19
Unid. Nematoda	12	12			70	19
MOLLUSCA						
GASTROPODA	12					2
Fossaria sp.	12					2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Hatchery
SAMPLED: 04/03/00

TOTAL (#/sq. meter)	4400	4712	5224	5490	6863	5336
NUMBER OF TAXA	18	17	15	15	17	27
SHANNON-WEAVER (H')						2.86
TOTAL EPT TAXA	7	6	8	8	9	13
EPT INDEX (% of Total Taxa)	39	35	53	53	53	48
EPHEMEROPTERA ABUNDANCE						
(% of Total Density)	49	40	49	48	40	45

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hatchery
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	244	372	663	570	372	444
Isoperla sp.	244	372	663	570	372	444
EPHEMEROPTERA	804	1699	1455	1582	2233	1554
Baetis bicaudatus	12	35				9
Baetis tricaudatus	698	1454	1105	1489	1791	1307
Drunella grandis		35	47			16
Epeorus longimanus	12	12	35			12
Paraleptophlebia sp.	35	58	47	12	163	63
Rhithrogena hageni	47	105	221	81	279	147
TRICHOPTERA	396	686	1803	907	581	875
Brachycentrus americanus	93	407	1082	465	326	475
Glossosoma sp.				12		2
Hydropsyche sp.	279	244	663	430	186	360
Lepidostoma sp. A	12	35	58		23	26
Lepidostoma sp. B					23	5
Rhyacophila coloradensis gr.	12				23	7
COLEOPTERA	128	81	35	128	140	102
Optioservus sp.	128	81	35	128	140	102
DIPTERA	164	163	174	129	303	188
Atherix pachypus		23	58		47	26
Caloparyphus sp.					23	5
Chelifera/Metachela	12	12				5
Cricotopus sp.	58	23		47	47	35
Dicranota sp.	47	23	35	35	23	33
Hesperoconopa sp.					23	5
Hexatoma sp.	12	12				5
Mallochohelea sp.		12				2
Micropsectra sp.				12		2
Tipula sp.	35	58	81	35	140	70
TURBELLARIA	349	198	186	326	1442	500
Dugesia sp.	349	198	186	326	1442	500
ANNELIDA						
OLIGOCHAETA		58	35		46	28
Eiseniella tetraedra		35	35		23	19
Unid. Immature Tubificidae w/o Capilliform Chaetae		23			23	9
HYDRACARINA		12				2
Lebertia sp.		12				2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hatchery
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
MOLLUSCA						
GASTROPODA			12			2
Physa sp.			12			2
TOTAL (#/sq. meter)	2085	3269	4363	3642	5117	3695
NUMBER OF TAXA	17	22	16	13	19	29
SHANNON-WEAVER (H')						3.01
TOTAL EPT TAXA	10	10	9	7	9	13
EPT INDEX (% of Total Taxa)	59	45	56	54	47	45
EPHEMEROPTERA ABUNDANCE (% of Total Density)	39	52	33	43	44	42

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Cabresto Creek
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1371	466	255	1349	2188	1126
Cultus aestivalis	93	12	23	47	47	44
Isoperla sp.					47	9
Malenka sp.	23			23		9
Megarcys signata	23					5
Paraleuctra sp.	465	151	116	698	884	463
Prostoia besametsa	186	105		186	186	133
Sweltsa sp.	558	198	116	395	977	449
Taenionema sp.	23				47	14
EPHEMEROPTERA	1792	1070	2163	1699	4281	2201
Ameletus sp.					47	9
Baetis tricaudatus	163	93	93	93	186	126
Cinygmula sp.	140	105	163	140	326	175
Drunella coloradensis	419	221	349	326	1256	514
Drunella doddsi	209	93	140	186	93	144
Epeorus longimanus	70	81	488	93	558	258
Ephemerella infrequens	791	442	907	814	1675	926
Rhithrogena hageni		35	23	47	140	49
TRICHOPTERA	1256	872	1930	1559	4002	1923
Arctopsyche grandis	70	35	70	70	186	86
Brachycentrus americanus	163	12	70		326	114
Hydropsyche sp.	23				93	23
Lepidostoma sp. A	302	279	1256	93	1210	628
Lepidostoma sp. B			23	23		9
Micrasema bactro			23		47	14
Oligophlebodes minutus	372	337	302	1047	1070	626
Rhyacophila brunnea gr.		35			47	16
Rhyacophila sibirica gr.	326	174	163	326	1023	402
Rhyacophila sp. nr. rotunda gr.			23			5
COLEOPTERA	256	186	326	209	465	288
Heterlimnius corpulentus	256	151	279	186	465	267
Optioservus sp.		35	47	23		21
DIPTERA	3025	1235	1978	768	12982	3999
Antocha sp.		12	47		47	21
Atherix pachypus	23					5
Chelifera/Metachela	23	12	47		47	26
Cricotopus sp.	419	140	47		733	268
Dicranota sp.	140	35	23	47	93	68
Dixa sp.					47	9
Heterotrissocladius sp.	140	140	419	140	4082	984
Hexatoma sp.		12	23	23	93	30

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Cabresto Creek
SAMPLED: 04/03/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
DIPTERA cont.						
Mallochohelea sp.	163	58	93	23	233	114
Micropsectra sp.	1210	430	814	186	4443	1417
Pagastia sp.		35				7
Pericoma sp.	884	361	465	349	2931	998
Prosimulium sp.	23					5
Rhabdomastix sp.					233	47
TURBELLARIA		93	186	93	140	102
Polycelis coronata		93	186	93	140	102
HYDRACARINA	23		46	23	47	28
Lebertia sp.	23		23		47	19
Sperchon/Sperchonopsis			23	23		9
MOLLUSCA						
PELECYPODA					47	9
Sphaerium sp.					47	9
TOTAL (#/sq. meter)	7723	3922	6884	5700	24152	9676
NUMBER OF TAXA	30	30	32	27	37	46
SHANNON-WEAVER (H')						4.24
TOTAL EPT TAXA	19	17	18	17	22	26
EPT INDEX (% of Total Taxa)	63	57	56	63	59	57
EPHEMEROPTERA ABUNDANCE (% of Total Density)	23	27	31	30	18	23

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Columbine Creek
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	557	256	652	490	455	482
Capniidae			12			2
Cultus aestivalis				12	12	5
Doddsia occidentalis	23		70	35	47	35
Hesperoperla pacifica		58	35	12	23	26
Isoperla sp.	93		12	12	23	28
Megarcys signata					12	2
Paraleuctra sp.	93				12	21
Prostoia besametsa			23	35	23	16
Sweltsa sp.	302	128	419	291	244	277
Taenionema sp.	23	70	81	47	47	54
Zapada cinctipes				23	12	7
Zapada oregonensis gr.	23			23		9
EPHEMEROPTERA	2118	1058	1047	1360	1582	1432
Ameletus sp.			35			7
Baetis bicaudatus		35	12		23	14
Baetis tricaudatus	535	465	174	616	512	460
Cinygmula sp.	233	35	70	128	105	114
Drunella coloradensis	302		12	47	93	91
Drunella doddsi	70	105	93	23	70	72
Epeorus longimanus	605	81	233	209	442	314
Ephemerella infrequens	47	23	186	23	58	67
Rhithrogena hageni	233	209	209	279	256	237
Rhithrogena robusta	93	105	23	35	23	56
TRICHOPTERA	140	198	501	130	304	254
Arctopsyche grandis	47	70	23	47	81	54
Brachycentrus americanus				12		2
Glossosomatidae		93		35	23	30
Lepidostoma sp. A	23		12		12	9
Lepidostoma sp. B			326	12		68
Micrasema bactro					12	2
Neothremma sp.			23			5
Oligophlebodes minutus			47		47	19
Rhyacophila brunnea gr.					12	2
Rhyacophila sibirica gr.	70	35	58	12	105	56
Rhyacophila sp. nr. lieftincki gr.			12			2
Rhyacophila sp. nr. rotunda gr.				12	12	5
COLEOPTERA	186	23	302	47	174	146
Heterlimnius corpulentus	163	23	302	35	174	139
Optioservus quadrimaculatus	23			12		7

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Columbine Creek
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
DIPTERA	813	71	524	176	212	357
Brillia sp.			12		12	5
Chelifera/Metachela		12	12		12	7
Cricotopus sp.	23	35	23	12	23	23
Dicranota sp.	23		58		35	23
Hexatoma sp.					12	2
Mallochohelea sp.			35		35	14
Micropsectra sp.	651		233	116	47	209
Oreogeton sp.			35		12	9
Pagastia sp.				12		2
Pericoma sp.	116	12	116	12	12	54
Prosimulium sp.		12		12	12	7
Tipula sp.				12		2
TURBELLARIA	23					5
Polycelis coronata	23					5
ANNELIDA						
OLIGOCHAETA	825	23	279	12	47	237
Eiseniella tetraedra	23	23	279	12	47	77
Stephansoniana tandyi	802					160
HYDRACARINA	70			12		16
Lebertia sp.	70			12		16
TOTAL (#/sq. meter)	4732	1629	3305	2227	2774	2929
NUMBER OF TAXA	27	20	34	33	39	52
SHANNON-WEAVER (H')						4.43
TOTAL EPT TAXA	17	14	24	23	27	34
EPT INDEX (% of Total Taxa)	63	70	71	70	69	65
EPHEMEROPTERA ABUNDANCE (% of Total Density)	45	65	32	61	57	49

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Middle Fork
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1070	489	384	1256	3163	1272
Cultus aestivalis	70	47	12	419	977	305
Megarcys signata	23					5
Paraleuctra sp.	70		12			16
Prostoia besametsa	70	23		93	233	84
Sweltsa sp.	512	140	267	279	651	370
Taenionema sp.	23	23			186	46
Zapada cinctipes		70	35	93	93	58
Zapada oregonensis gr.	302	186	58	372	1023	388
EPHEMEROPTERA	4001	3326	1292	3628	6793	3809
Ameletus sp.		70				14
Baetis bicaudatus	675	535	267	465	1256	640
Baetis tricaudatus	186		47			47
Cinygmula sp.	2117	1931	698	2279	4559	2317
Drunella doddsi	256	23	12		47	68
Epeorus longimanus	23	23	105		372	105
Ephemerella infrequens	419	488	151	791	512	472
Rhithrogena hageni	23	23				9
Rhithrogena robusta	302	233	12	93	47	137
TRICHOPTERA	1302	1047	513	653	419	786
Brachycentrus americanus	23	23		47		19
Glossosoma sp.				47		9
Neothremma sp.	23					5
Oligophlebodes minutus	47		35	140		44
Rhyacophila brunnea gr.	116	93			93	60
Rhyacophila sibirica gr.	907	675	419	372	186	512
Rhyacophila sp. nr. alberta gr.		140	12			30
Rhyacophila sp. nr. rotunda gr.	186	116	47	47	140	107
COLEOPTERA	23	23	12	47	47	30
Heterlimnius corpulentus	23	23	12	47	47	30
DIPTERA	1978	1513	3548	7445	6141	4124
Chelifera/Metachela	70	23	81	47		44
Dicranota sp.	23		47	233	47	70
Hesperoconopa sp.				93		19
Heterotrissocladius sp.	47	70	140		1198	291
Mallochohelea sp.		47	12	93		30
Micropsectra sp.	1140	1186	3256	6885	4559	3405
Oreogeton sp.	395	93	12			100
Pagastia sp.	47				244	58
Pericoma sp.	47	47				19
Prosimulium sp.	209	47		47	93	79
Tipula sp.				47		9
TURBELLARIA				326		65
Polycelis coronata				326		65

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Middle Fork
SAMPLED: 04/04/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
ANNELIDA						
OLIGOCHAETA	23		47	233	47	70
Eiseniella tetraedra	23			233		51
Unid. Immature Tubificidae w/o Capilliform Chaetae			47		47	19
HYDRACARINA	186	116	81	279	93	151
Lebertia sp.	186	93	81	279	93	146
Sperchon/Sperchonopsis		23				5
TOTAL (#/sq. meter)	8583	6514	5877	13867	16703	10307
NUMBER OF TAXA	32	29	25	25	23	42
SHANNON-WEAVER (H')						3.46
TOTAL EPT TAXA	21	19	16	14	15	25
EPT INDEX (% of Total Taxa)	66	66	64	56	65	60
EPHEMEROPTERA ABUNDANCE (% of Total Density)	47	51	22	26	41	37

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Town
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1093	1351	629	1676	512	1050
Cultus sp.			70	140		42
Megarcys signata				47		9
Paraleuctra sp.		47				9
Pteronarcella badia		47				9
Sweltsa sp.	1000	930	419	1163	465	795
Taenionema sp.	93	140	70	140	47	98
Zapada cinctipes		47	47	93		37
Zapada oregonensis gr.		140	23	93		51
EPHEMEROPTERA	4373	4651	2465	4560	4001	4010
Baetis tricaudatus	1163	1349	349	279	744	777
Drunella doddsi	1535	1023	907	1582	1163	1242
Drunella grandis	186	93	70	465	186	200
Epeorus longimanus				47	47	19
Ephemerella infrequens	419	465	302	233	698	423
Heptageniidae	186				93	56
Paraleptophlebia sp.	47					9
Rhithrogena hageni	837	1721	837	1954	1070	1284
TRICHOPTERA	3258	2700	2046	2419	2001	2484
Arctopsyche grandis	419	698	116	186	93	302
Brachycentrus americanus	1582	1163	558	1023	791	1023
Glossosoma sp.			23	93	233	70
Hydropsyche sp.	93		23			23
Lepidostoma sp.	140	419	70	279	186	219
Oligophlebodes sp.	140			47	93	56
Rhyacophila brunnea gr.		47	23			14
Rhyacophila coloradensis gr.		47	279	186		102
Rhyacophila sibirica gr.	698	279	861	512	558	582
Rhyacophila sp. nr. rotunda gr.	186	47	93	93	47	93
COLEOPTERA	745	279	791	419	558	558
Heterlimnius corpulentus	698	279	791	419	558	549
Optioservus quadrimaculatus	47					9
DIPTERA	3211	2003	1791	2561	2932	2500
Ceratopogoninae	140		70	93	93	79
Diamesa sp.		70				14
Dicranota sp.			23			5
Eukiefferiella sp.	186	151	47	140	186	142
Hexatoma sp.	47	47		140	47	56
Micropsectra sp.	58		23	140		44
Oreogeton sp.		47				9
Orthocladius (Euortho.) sp.	58	151	23		58	58
Orthocladius (Symposiocladius) sp.	128					26
Orthocladius/Cricotopus gr.	582	140	535	791	1012	612
Pagastia sp.	58			140	128	65
Pericoma sp.	1814	884	977	1070	1210	1191

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Town
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
DIPTERA Cont.						
Simulium sp.	140	326	47		47	112
Tipula sp.		47	23	47	93	42
Tvetenia sp.		70	23			19
Unid. Orthocladiinae		70			58	26
TURBELLARIA	651	186	23	93	47	200
Polycelis coronata	651	186	23	93	47	200
ANNELIDA						
OLIGOCHAETA	279				141	83
Enchytraeidae					47	9
Lumbriculidae					47	9
Nais sp.	279				47	65
NEMATODA		47		47		19
Unid. Nematoda		47		47		19
HYDRACARINA	977	94	23	1210	2233	907
Lebertia sp.	977	47	23	1163	2093	861
Protzia sp.				47		9
Sperchon/Sperchonopsis					140	28
Testudacarus/Torrenticola		47				9
TOTAL (#/sq. meter)	14587	11311	7768	12985	12425	11811
NUMBER OF TAXA	31	34	32	33	33	53
SHANNON-WEAVER (H')						4.39
TOTAL EPT TAXA	16	18	19	20	16	26
EPT INDEX (% of Total Taxa)	52	53	59	61	48	49
EPHEMEROPTERA ABUNDANCE (% of Total Density)	30	41	32	35	32	34

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: June Bug
SAMPLED: 09/20/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	58	104	47	82	0	59
Pteronarcella badia	23	23		12		12
Sweltsa sp.	35	81	47	70		47
EPHEMEROPTERA	1745	1524	1756	942	1651	1523
Baetis tricaudatus	651	837	628	314	733	633
Drunella doddsi	23	12				7
Drunella grandis	198	140	174	93	81	137
Epeorus deceptivus	12					2
Rhithrogena hageni	861	535	954	535	837	744
TRICHOPTERA	279	175	512	163	327	290
Arctopsyche grandis		12	23	12		9
Brachycentrus americanus	244	105	430	81	291	230
Glossosoma sp.			12			2
Hydropsyche sp.	12			12	12	7
Oligophlebodes sp.					12	2
Rhyacophila sibirica gr.		58	47	58		33
Rhyacophila sp. nr. rotunda gr.	23				12	7
COLEOPTERA		47	163	23	105	68
Heterlimnius corpulentus		47	163	23	105	68
DIPTERA	200	59	128	174	501	213
Atherix pachypus		12		23	23	12
Ceratopogoninae				151	279	86
Conchapelopia/Thienemannimyia gr. sp.					12	2
Diamesa sp.					12	2
Dicranota sp.	12		47			12
Eukiefferiella sp.	47				47	19
Hexatoma sp.	12		12		12	7
Micropsectra sp.	12					2
Neoplasta sp.		12				2
Orthocladius (Euortho.) sp.					35	7
Orthocladius/Cricotopus gr.	12					2
Parametriocnemus sp.	23					5
Polypedilum sp.					23	5
Simulium sp.	47	35	23		23	26
Tvetenia sp.			23			5
Unid. Orthocladiinae	35		23		35	19
ANNELIDA						
OLIGOCHAETA		12				2
Lumbriculidae		12				2
NEMATODA		12				2
Unid. Nematoda		12				2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: June Bug
SAMPLED: 09/20/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA	12	12	81		12	23
Lebertia sp.	12	12	81		12	23
TOTAL (#/sq. meter)	2294	1945	2687	1384	2596	2180
NUMBER OF TAXA	19	16	15	12	19	34
SHANNON-WEAVER (H')						2.90
TOTAL EPT TAXA	10	9	8	9	7	14
EPT INDEX (% of Total Taxa)	53	56	53	75	37	41
EPHEMEROPTERA ABUNDANCE (% of Total Density)	76	78	65	68	64	70

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Elephant Rock
SAMPLED: 09/19/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	186	46	70	442	12	151
Pteronarcella badia	47	23	58	186	12	65
Sweltsa sp.	116	23	12	256		81
Zapada cinctipes	23					5
EPHEMEROPTERA	4604	3047	3233	3211	1768	3172
Baetis tricaudatus	2186	2000	1349	2117	1477	1826
Drunella doddsi	23			47	12	16
Drunella grandis	395	163	198	163	93	202
Rhithrogena hageni	2000	884	1686	884	186	1128
TRICHOPTERA	861	488	384	651	257	529
Arctopsyche grandis	140	47	47	23	12	54
Brachycentrus americanus	651	395	279	582	233	428
Hydropsyche sp.				23		5
Lepidostoma sp.	47	23				14
Rhyacophila sp. nr. rotunda gr.	23	23	58	23	12	28
COLEOPTERA	163	163	58	233	93	142
Heterlimnius corpulentus	163	140	58	233	93	137
Zaitzevia parvula		23				5
DIPTERA	1000	631	443	1118	537	744
Antocha sp.			12			2
Atherix pachypus	140	47	35	186	58	93
Brillia sp.				35		7
Diamesa sp.	151	70		105	12	68
Dicranota sp.	47	47		23		23
Eukiefferiella sp.	47	47	12	35	12	31
Hexatoma sp.	23	23				9
Micropsectra sp.	23		12			7
Neoplasta sp.	93	23	35	23	12	37
Orthocladius/Cricotopus gr.	81	47		35	12	35
Pagastia sp.	105	47		140	105	79
Parametriocnemus sp.	23		35	35		19
Polypedilum sp.				35		7
Simulium sp.	93	140	174	326	314	209
Tipula sp.			12			2
Unid. Orthocladiinae	174	140	116	140	12	116
ANNELIDA						
OLIGOCHAETA	23	46	12	23	12	23
Enchytraeidae	23		12		12	9
Nais bretscheri		23				5
Nais sp.		23		23		9

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Elephant Rock
SAMPLED: 09/19/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA	47	140			58	49
Lebertia sp.	47	140			58	49
MOLLUSCA						
GASTROPODA	23					5
Physa/Physella	23					5
TOTAL (#/sq. meter)	6907	4561	4200	5678	2737	4815
NUMBER OF TAXA	27	24	19	24	19	35
SHANNON-WEAVER (H')						3.08
TOTAL EPT TAXA	11	9	8	10	8	12
EPT INDEX (% of Total Taxa)	41	38	42	42	42	34
EPHEMEROPTERA ABUNDANCE (% of Total Density)	67	67	77	57	65	66

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hansen
SAMPLED: 09/19/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	12	12	128	12	47	42
Pteronarcella badia	12	12	128	12	47	42
EPHEMEROPTERA	733	442	803	524	1070	714
Baetis tricaudatus	686	442	768	477	1023	679
Drunella grandis	47		35	47	47	35
TRICHOPTERA	884	221	1058	721	465	670
Arctopsyche grandis	23		23	23		14
Brachycentrus americanus	849	209	1035	663	442	640
Lepidostoma sp.		12				2
Oligophlebodes sp.				12		2
Rhyacophila coloradensis gr.	12			23	23	12
COLEOPTERA	35	24			140	39
Heterlimnius corpulentus	35	12			140	37
Optioservus sp.		12				2
DIPTERA	815	1513	1141	1768	4745	1996
Antocha sp.			23			5
Atherix pachypus		12	12	35	93	30
Diamesa sp.	35	58			384	95
Empididae	12					2
Eukiefferiella sp.	221	233	512	1023	954	589
Neoplasta sp.				12	93	21
Orthocladius (Euortho.) sp.				70	186	51
Orthocladius/Cricotopus gr.	512	1210	547	628	2663	1112
Pagastia sp.	35		47		186	54
Unid. Orthocladiinae					186	37
ANNELIDA						
OLIGOCHAETA	24	47		256	186	103
Enchytraeidae	12	12		256	163	89
Nais sp.	12	35			23	14
HYDRACARINA	12		105	23	140	56
Lebertia sp.	12		105	23	140	56
TOTAL (#/sq. meter)	2515	2259	3235	3304	6793	3620
NUMBER OF TAXA	15	12	11	14	17	23
SHANNON-WEAVER (H')						2.88
TOTAL EPT TAXA	6	4	5	7	5	8
EPT INDEX (% of Total Taxa)	40	33	45	50	29	35
EPHEMEROPTERA ABUNDANCE (% of Total Density)	29	20	25	16	16	20

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Columbine
SAMPLED: 09/19/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	116	163		70	93	90
Capniidae	23					5
Isogenoides sp.					23	5
Pteronarcella badia	70	163		70	70	75
Sweltsa sp.	23					5
EPHEMEROPTERA	3722	4024	3780	4210	3861	3920
Baetis bicaudatus	233	302	221	116	93	193
Baetis tricaudatus	2373	2396	2570	3396	3233	2794
Drunella grandis		23		47	23	19
Rhithrogena hageni	1116	1303	989	651	512	914
TRICHOPTERA	1395	2232	745	1257	2047	1535
Arctopsyche grandis	23	209	47	140	256	135
Brachycentrus americanus	721	395	221	372	698	481
Glossosoma sp.			35			7
Hydropsyche sp.	535	1303	314	628	721	700
Oligophlebodes sp.			12			2
Rhyacophila coloradensis gr.	70	23	58	70	279	100
Rhyacophila sibirica gr.	23					5
Rhyacophila sp. nr. rotunda gr.	23	302	58	47	93	105
COLEOPTERA	140	232	94	46	46	112
Heterlimnius corpulentus		93	35		23	30
Narpus concolor	47	116	47	23		47
Optioservus quadrimaculatus	70	23	12	23	23	30
Zaitzevia parvula	23					5
DIPTERA	256	791	198	349	373	395
Antocha sp.				23		5
Atherix pachypus	47	140	81	47	70	77
Dicranota sp.	47		12	23		16
Eukiefferiella sp.	23	23	12		35	19
Hexatoma sp.				23		5
Neoplasta sp.	23	23			47	19
Orthocladius/Cricotopus gr.					70	14
Pagastia sp.	23	70	35	35		33
Simulium sp.	23	116		47	23	42
Unid. Orthocladiinae	70	419	58	151	128	165
ANNELIDA						
OLIGOCHAETA				70	23	19
Enchytraeidae				70	23	19

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Columbine
SAMPLED: 09/19/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
NEMATODA			12			2
Unid. Nematoda			12			2
HYDRACARINA	23		58	47		26
Lebertia sp.	23		58	47		26
TOTAL (#/sq. meter)	5652	7442	4887	6049	6443	6099
NUMBER OF TAXA	23	19	20	21	20	33
SHANNON-WEAVER (H')						2.83
TOTAL EPT TAXA	12	10	10	10	11	16
EPT INDEX (% of Total Taxa)	52	53	50	48	55	48
EPHEMEROPTERA ABUNDANCE (% of Total Density)	66	54	77	70	60	64

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Goathill
SAMPLED: 09/18/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	418	47	12	233	81	158
Amphinemura sp.	23					5
Pteronarcella badia	395	35	12	198	81	144
Sweltsa sp.		12		35		9
EPHEMEROPTERA	1443	1837	2524	1640	2780	2044
Ameletus sp.				12		2
Baetis bicaudatus	582	872	1710	593	1128	977
Baetis tricaudatus	70	58	233	23	35	84
Drunella doddsi					35	7
Drunella grandis	47	23	58	23	35	37
Rhithrogena robusta	744	884	523	989	1547	937
TRICHOPTERA	1466	488	325	652	1059	799
Arctopsyche grandis	186	35	23	12	151	81
Brachycentrus americanus	791	174	209	186	384	349
Hydropsyche sp.	419	209	81	407	477	319
Rhyacophila sibirica gr.	70	23		35	35	33
Rhyacophila sp. nr. rotunda gr.		47	12	12	12	17
COLEOPTERA		23	23	47	82	35
Heterlimnius corpulentus					12	2
Narpus concolor		23	23	35	58	28
Zaitzevia parvula				12	12	5
DIPTERA	1187	210	257	431	1024	621
Atherix pachypus	47	12	47	35	35	35
Cladotanytarsus sp.	47					9
Dicranota sp.				12	35	9
Eukiefferiella sp.	128	12	81			44
Hexatoma sp.	23					5
Neoplasta sp.	23	23		12	47	21
Orthocladius/Cricotopus gr.	128		35	186		70
Pagastia sp.			12	35		9
Simulium sp.	23		12			7
Unid. Orthocladiinae	768	163	70	151	907	412
ANNELIDA						
OLIGOCHAETA	23	24		12		12
Enchytraeidae		12		12		5
Nais sp.	23					5
Unid. Immature Tubificidae w/ Capilliform Chaetae		12				2

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Goathill
SAMPLED: 09/18/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
HYDRACARINA			70	35	186	58
Lebertia sp.			70	23	186	56
Sperchon/Sperchonopsis				12		2
TOTAL (#/sq. meter)	4537	2629	3211	3050	5212	3727
NUMBER OF TAXA	19	18	17	23	19	32
SHANNON-WEAVER (H')						3.21
TOTAL EPT TAXA	10	11	9	12	11	14
EPT INDEX (% of Total Taxa)	53	61	53	52	58	44
EPHEMEROPTERA ABUNDANCE (% of Total Density)	32	70	79	54	53	55

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Questa Ranger Station
SAMPLED: 09/18/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA				12		2
Unid. Collembola				12		2
PLECOPTERA		12				2
Paraleuctra sp.		12				2
EPHEMEROPTERA	326	326	372	326	106	291
Baetis bicaudatus	116	116	81	58	12	77
Baetis tricaudatus	163	198	198	221	35	163
Drunella grandis					12	2
Rhithrogena hageni	47	12	93	47	47	49
TRICHOPTERA	373	94	105	70	59	140
Arctopsyche grandis	12		12	12		7
Brachycentrus americanus	128	47	70		12	51
Hydropsyche sp.	233	47	23	58	47	82
COLEOPTERA	47	47	93	47	58	58
Narpus concolor	47	47	93	47	58	58
DIPTERA	337	466	407	454	326	399
Atherix pachypus		12			12	5
Ceratopogoninae			23			5
Neoplasta sp.					12	2
Orthocladius/Cricotopus gr.	23					5
Simulium sp.	47		12			12
Unid. Orthocladiinae	267	454	372	454	302	370
HYDRACARINA	12				12	4
Lebertia sp.					12	2
Testudacarus/Torrenticola	12					2
TOTAL (#/sq. meter)	1095	945	977	909	561	896
NUMBER OF TAXA	11	9	10	8	11	18
SHANNON-WEAVER (H')						2.69
TOTAL EPT TAXA	6	6	6	5	6	8
EPT INDEX (% of Total Taxa)	55	67	60	63	55	44
EPHEMEROPTERA ABUNDANCE (% of Total Density)	30	34	38	36	19	32

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Hatchery
SAMPLED: 09/20/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
COLLEMBOLA	47	186				47
Unid. Collembola	47	186				47
PLECOPTERA	512	327	792	838	512	596
Isoperla sp.	186	47	47	326	93	140
Perlidae		47				9
Pteronarcella badia	326	233	698	512	372	428
Sweltsa sp.			47		47	19
EPHEMEROPTERA	1116	1582	1629	1024	233	1117
Baetis tricaudatus	1023	1396	1582	884	186	1014
Drunella grandis	93			140		47
Heptageniidae			47			9
Rhithrogena hageni		186			47	47
TRICHOPTERA	5212	3583	2233	4326	4420	3955
Brachycentrus americanus	419	279	93	651	512	391
Culoptila sp.	140	419	233	186	186	233
Hydropsyche sp.	4512	2466	1442	2605	2884	2782
Hydroptila sp.	47					9
Lepidostoma sp.	47	93	186	93	326	149
Ochrotrichia sp.	47	326	279	791	512	391
ODONATA					93	19
Argia sp.					93	19
COLEOPTERA	745	2258	1814	2884	2000	1939
Narpus concolor		47				9
Optioservus quadrimaculatus	605	2117	1628	2791	1814	1791
Postelichus sp.		47				9
Zaitzevia parvula	140	47	186	93	186	130
DIPTERA	24656	5490	12141	68664	14282	25045
Atherix pachypus	1303	419	791	1442	186	828
Ceratopogoninae				47	93	28
Eukiefferiella sp.	18317	4559	8408	54882	11339	19501
Neoplasta sp.		47				9
Orthocladius/Cricotopus gr.	989		1686	9851	477	2601
Pagastia sp.			419		477	179
Rheocricotopus sp.					477	95
Rheotanytarsus sp.				942		188
Simulium sp.	4047	465	837	558	279	1237
Tvetenia sp.				942	477	284
Unid. Orthocladiinae					477	95

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Upstream of Hatchery
SAMPLED: 09/20/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
TURBELLARIA	93	279	47		698	223
Dugesia sp.	93	279	47		698	223
HYDRACARINA		140	93		186	83
Lebertia sp.		47				9
Sperchon/Sperchonopsis		93	93		186	74
TOTAL (#/sq. meter)	32381	13845	18749	77736	22424	33024
NUMBER OF TAXA	18	22	19	18	24	34
SHANNON-WEAVER (H')						2.46
TOTAL EPT TAXA	10	10	10	9	10	14
EPT INDEX (% of Total Taxa)	56	45	53	50	42	41
EPHEMEROPTERA ABUNDANCE (% of Total Density)	3	11	9	1	1	3

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hatchery
SAMPLED: 09/20/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA					93	19
Sweltsa sp.					93	19
EPHEMEROPTERA	47	326	0	233	47	131
Baetis tricaudatus		279		233	47	112
Paraleptophlebia sp.	47	47				19
TRICHOPTERA	10374	21771	11073	9769	10048	12606
Brachycentrus americanus	1907	4140	1768	2140	651	2121
Culoptila	47	93	140	93	279	130
Dolophilodes aequalis		47				9
Hydropsyche sp.	2977	7629	4978	4559	1582	4345
Ochrotrichia sp.	5443	9676	4187	2884	7536	5945
Oecetis avara		186		93		56
COLEOPTERA	1582	4838	1210	4001	1722	2671
Heterlimnius corpulentus	1582	4745	1210	3908	1628	2615
Narpus concolor		93		93	47	47
Zaitzevia parvula					47	9
DIPTERA	7629	19584	9630	21260	3769	12373
Caloparyphus sp.		47				9
Eukiefferiella sp.	5385	13072	8478	13165	2652	8550
Euparyphus sp.				47		9
Hexatoma sp.				47		9
Microtendipes sp.		930			151	216
Orthocladius/Cricotopus gr.	965				291	251
Polypedilum sp.	965	2791	384	3745	291	1635
Rheocricotopus sp.		930		2814		749
Rheotanytarsus sp.		465	768	465	291	398
Simulium sp.		419		47	93	112
Tvetenia sp.	314	930		930		435
TURBELLARIA	5722	1582	5024	4047	1628	3601
Dugesia dorotocephala	5722	1582	5024	4047	1628	3601
HYDRACARINA	279	94		465		167
Lebertia sp.	279	47				65
Sperchon/Sperchonopsis		47		465		102
MOLLUSCA						
GASTROPODA	93	47	140	93		75
Physa/Physella	93	47	140	93		75

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Downstream of Hatchery
SAMPLED: 09/20/00

TOTAL (#/sq. meter)	25726	48242	27077	39868	17307	31643
NUMBER OF TAXA	13	22	10	19	16	27
SHANNON-WEAVER (H')						3.11
TOTAL EPT TAXA	5	8	4	6	6	9
EPT INDEX (% of Total Taxa)	38	36	40	32	38	33
EPHEMEROPTERA ABUNDANCE (% of Total Density)	< 1	1	0	1	< 1	< 1

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Cabresto Creek
SAMPLED: 09/22/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1396	651	906	418	4189	1511
Cultus sp.	93		23		140	51
Hesperoperla pacifica	47		23		47	23
Isoperla sp.	93	70	70	116	233	116
Megarcys signata			23			5
Perlodidae				23		5
Pteronarcella badia					47	9
Sweltsa sp.	465	535	628	279	2605	902
Zapada cinctipes	512	23	116		977	326
Zapada oregonensis gr.	186	23	23		140	74
EPHEMEROPTERA	3117	814	2582	1372	5536	2684
Baetis bicaudatus	605	279	791	349	651	535
Baetis tricaudatus	186		116	93	1628	405
Cinygmula sp.			23			5
Drunella coloradensis			23			5
Drunella doddsi	837	209	1070	395	1675	837
Epeorus longimanus					47	9
Ephemerella infrequens	1396	279	419	535	1256	777
Paraleptophlebia sp.			47			9
Rhithrogena robusta	93	47	93		279	102
TRICHOPTERA	2932	930	1653	1862	2885	2054
Arctopsyche grandis	47	23	70	47	186	75
Brachycentrus sp.	47	70	47			33
Glossosoma sp.			93	140	186	84
Hydropsyche sp.	233		140	116	140	126
Lepidostoma sp.	372		93	116	233	163
Oligophlebodes sp.	1582	837	1163	1163	1210	1191
Rhyacophila brunnea gr.	93		47	47	186	75
Rhyacophila sibirica gr.	558			233	744	307
COLEOPTERA	465	279	465	256	977	488
Heterlimnius corpulentus	465	279	465	256	977	488
DIPTERA	2373	977	861	2443	4001	2132
Antocha sp.			23		47	14
Ceratopogoninae	47	47	70	93	186	89
Corynoneura sp.		23				5
Cricotopus (Nostococladius) nostocicola		23				5
Dicranota sp.			23		93	23
Eukiefferiella sp.	58	23				16
Heleniella sp.	58					12
Hexatoma sp.	47			23		14
Micropsectra sp.	744	465	326	1256	2535	1065
Neoplasta sp.	47	47				19

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Cabresto Creek
SAMPLED: 09/22/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
DIPTERA Cont.						
Pagastia sp.	116	47	93	198	116	114
Pericoma sp.	791	233	93	605	744	493
Rheocricotopus sp.		23				5
Rheotanytarsus sp.	349	23		70		88
Simulium sp.		23	140	70		47
Tipula sp.					47	9
Tvetenia sp.	116		93	128	233	114
TURBELLARIA			47		279	65
Polycelis coronata			47		279	65
HYDARCARINA				117		23
Lebertia sp.				47		9
Sperchon/Sperchonopsis				70		14
TOTAL (#/sq. meter)	10283	3651	6514	6468	17867	8957
NUMBER OF TAXA	29	23	32	25	30	47
SHANNON-WEAVER (H')						4.22
TOTAL EPT TAXA	18	11	22	14	20	26
EPT INDEX (% of Total Taxa)	62	48	69	56	67	55
EPHEMEROPTERA ABUNDANCE (% of Total Density)	30	22	40	21	31	30

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Columbine Creek
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	699	559	604	500	653	604
Cultus sp.	35				140	35
Hesperoperla pacifica	35	70	23		47	35
Megarcys signata				35		7
Paraleuctra sp.	128	23	23			35
Prostoia besametsa	12	23				7
Sweltsa sp.	326	256	558	337	419	379
Taenionema sp.	47	47				19
Zapada cinctipes	58	93		47		40
Zapada oregonensis gr.	58	47		81	47	47
EPHEMEROPTERA	2235	2419	3256	1802	3535	2650
Ameletus sp.	12					2
Baetis bicaudatus	1082	1070	1442	337	2093	1205
Drunella coloradensis			23			5
Drunella doddsi	12	116		35	93	51
Epeorus longimanus	12	93	23			26
Ephemerella infrequens	35				93	26
Rhithrogena robusta	1082	1140	1768	1430	1256	1335
TRICHOPTERA	105	163	465	407	606	349
Arctopsyche grandis	35		93	81	140	70
Brachycentrus sp.		23			93	23
Dolophilodes aequalis				35		7
Glossosoma sp.	58	23	70		93	49
Lepidostoma sp.					47	9
Neothremma sp.			23	12	47	16
Rhyacophila angelita gr.		47	209	244	93	119
Rhyacophila brunnea gr.	12	70	70	35	93	56
COLEOPTERA	93	140	651	140	977	400
Heterlimnius corpulentus	93	140	651	140	977	400
DIPTERA	942	1793	953	398	2280	1273
Ceratopogoninae			23		47	14
Dicranota sp.		23	47	12	47	26
Eukiefferiella sp.				35		7
Micropsectra sp.	686	791	488	47	1919	786
Neoplasta sp.		47				9
Oreogeton sp.				12		2
Pagastia sp.		47	23		81	30
Parametriocnemus sp.	23					5
Pericoma sp.	140	47	302	151	186	165
Polypedilum sp.				47		9
Rheocricotopus sp.	23					5

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Columbine Creek
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
DIPTERA Cont.						
Simulium sp.	47	744	47	35		175
Tipula sp.				12		2
Tvetenia sp.		47		12		12
Unid. Orthocladiinae	23	47	23	35		26
TURBELLARIA	12	23				7
Polycelis coronata	12	23				7
ANNELIDA						
OLIGOCHAETA	617	279	977	314	2792	995
Enchytraeidae			442	47	1803	458
Lumbriculidae	291	279	535	267	989	472
Nais sp.	326					65
HYDRACARINA			23	35	47	21
Lebertia sp.			23	35	47	21
TOTAL (#/sq. meter)	4703	5376	6929	3596	10890	6299
NUMBER OF TAXA	27	26	23	26	24	45
SHANNON-WEAVER (H')						3.72
TOTAL EPT TAXA	17	15	12	12	15	24
EPT INDEX (% of Total Taxa)	63	58	52	46	63	53
EPHEMEROPTERA ABUNDANCE (% of Total Density)	48	45	47	50	32	42

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Middle Fork
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
INSECTA						
PLECOPTERA	1350	2280	3070	885	2559	2029
Cultus sp.	47	93	93			47
Isoperla sp.	70	279	372	419		228
Paraleuctra sp.	116	326		93		107
Sweltsa sp.	186	419	744		372	344
Taenionema sp.	675	93	884	186	1814	730
Zapada cinctipes	70	698	651	140	140	340
Zapada oregonensis gr.	186	372	326	47	233	233
EPHEMEROPTERA	1884	2094	3443	2048	1489	2192
Ameletus sp.				93		19
Baetis tricaudatus	116	233	326	47	93	163
Cinygmula sp.				93		19
Drunella coloradensis			47			9
Drunella doddsi	1326	1442	1907	1349	651	1335
Ephemerella infrequens	47	186	326	326	47	186
Rhithrogena robusta	395	233	837	140	698	461
TRICHOPTERA	1698	1954	512	2606	2327	1820
Brachycentrus sp.	70					14
Glossosoma sp.	140		93	47	93	75
Hydropsyche sp.		47				9
Oligophlebodes sp.	395	698		1768	1303	833
Rhyacophila brunnea gr.	302	186	186	233	326	247
Rhyacophila sibirica gr.	791	1023	233	558	605	642
COLEOPTERA	163	140	186	233	140	172
Heterlimnius corpulentus	163	140	186	233	140	172
DIPTERA	954	2838	7119	4978	3583	3894
Ceratopogoninae	93		47	558	233	186
Dicranota sp.					47	9
Eukiefferiella sp.	35					7
Heleniella sp.			582			116
Macropelopia sp.	35					7
Micropsectra sp.	326	221	1465	163	1814	798
Neoplasta sp.	23			93	47	33
Oreogeton sp.	70	140				42
Orthocladius (Symposiocladius) sp.	35					7
Orthocladius/Cricotopus gr.	128	1500	3803	2512		1589
Pagastia sp.	128	977	1175	1349	907	907
Parametriocnemus sp.				163		33
Pericoma sp.	23		47	140	372	116
Polypedilum sp.					116	23
Simulium sp.					47	9
Stempellinella sp.	35					7
Tipula sp.	23					5

MACROINVERTEBRATE DENSITY
CLIENT: Molycorp
SITE: Middle Fork
SAMPLED: 09/21/00

TAXA	REP 1	REP 2	REP 3	REP 4	REP 5	COMPOSITE
TURBELLARIA	186	93	140		186	121
Polycelis coronata	186	93	140		186	121
ANNELIDA						
OLIGOCHAETA	70			791	605	293
Enchytraeidae					47	9
Lumbriculidae				93		19
Nais sp.	70			698	558	265
NEMATODA				47		9
Unid. Nematoda				47		9
HYDRACARINA		93	47	279		84
Lebertia sp.		93	47	279		84
TOTAL (#/sq. meter)	6305	9492	14517	11867	10889	10614
NUMBER OF TAXA	31	22	23	27	24	44
SHANNON-WEAVER (H')						4.25
TOTAL EPT TAXA	16	15	14	15	12	20
EPT INDEX (% of Total Taxa)	52	68	61	56	50	45
EPHEMEROPTERA ABUNDANCE (% of Total Density)	30	22	24	17	14	21

APPENDIX C

Sediment Metals and Benthic Invertebrate

Regression Analysis

TABLE C-1: Results of regression analysis between sediment metals in 2000 and benthic invertebrate population parameters. Only significant ($p \leq 0.05$) results are shown.

Date, Sediment Metal	Density	Number of Taxa	Number of EPT Taxa	EPT Taxa as % Total Taxa	Diversity
April 2000					
Aluminum	--	--	--	--	--
Cadmium	--	--	--	--	--
Copper	--	(−) $p < 0.01$ $R^2 = 0.60$	(−) $p = 0.01$ $R^2 = 0.58$	--	(−) $p = 0.01$ $R^2 = 0.55$
Lead	--	--	--	--	(−) $p = 0.05$ $R^2 = 0.41$
Zinc	(−) $p = 0.05$ $R^2 = 0.39$	--	--	--	--
September 2000					
Aluminum	--	(+) $p = 0.04$ $R^2 = 0.42$	(+) $p = 0.01$ $R^2 = 55$	--	(+) $p < 0.01$ $R^2 = 0.70$
Cadmium	--	--	--	--	--
Copper	--	(−) $p < 0.01$ $R^2 = 0.61$	(−) $p < 0.01$ $R^2 = 0.70$	--	(−) $p = 0.03$ $R^2 = 0.48$
Lead	--	--	--	--	(−) $p < 0.01$ $R^2 = 0.85$
Zinc	--	(−) $p = 0.03$ $R^2 = 0.48$	(−) $p = 0.05$ $R^2 = 0.41$	--	(−) $p = 0.02$ $R^2 = 0.54$

APPENDIX D

Water Quality Data, Toxicity Sampling Sites

TABLE D-1: Summary of water quality parameters analyzed on water column samples collected in conjunction with toxicity samples on October 25, 2000, at six sites on the Red River, New Mexico.

Element	Detect. Limit	Units	Location					
			RR06	RR16	RR20	RR28	RR29	RR35
Alkalinity	2.5	mg/L	88.4	70	55.2	58.2	44.6	83.2
Aluminum	0.01	mg/L	<0.01	0.07	0.13	0.12	0.13	0.05
Ammonia	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate	3	mg/L	102	85.4	67.3	71	54.4	102
Boron	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium	1	mg/L	33	37	44	54	56	94
Calcium	1	mg/L	35	40.1	44	56.8	58	95.1
Carbonate	0	mg/L	5.76	0	0	0	0	0
Chloride	10	mg/L	<10	<10	<10	<10	<10	<10
Chromium	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	0.001	mg/L	<0.001	0.002	0.003	0.002	0.004	0.002
Copper	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hardness	6.6	mg/L	107	133	148	187	192	304
Ion Balance	--	% diff.	4.25	1.25	2.67	4.21	4.88	3.54
Iron	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	1	mg/L	5	8	9	11	12	17
Magnesium	1	mg/L	4.71	7.91	9.24	11	11.5	16.2
Manganese	0.05	mg/L	<0.05	0.14	0.18	0.11	0.37	0.39
Molybdenum	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.3
Nickel	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate + Nitrite	0.1	mg/L	<0.1	<0.1	0.17	0.248	0.247	0.184
pH	0	pH	8.42	7.9	7.76	7.81	7.73	8.04
Potassium	1	mg/L	<5	<5	<5	<5	<5	<5
Silicon	0.1	mg/L	3.3	5.7	6.4	5.9	5.9	7.6
Silver	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	1	mg/L	<5	<5	<5	5.45	5.84	20.8
Strontium	0.1	mg/L	0.2	0.2	0.3	0.4	0.4	0.7
Sulfate	10	mg/L	13.8	56.9	81.6	120	135	232
T. Phosphorus	0.03	mg/L	<0.03	<0.03	0.04	0.094	<0.03	<0.03

TABLE D-1: Continued.

Element	Detect. Limit	Units	Location RR06	RR16	RR20	RR28	RR29	RR35
TDS	10	mg/L	124	176	202	240	258	424
Tin	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TKN	0.1	mg/L	<0.1	<0.1	<0.1	0.129	<0.1	<0.1
TOC	5	mg/L	<5	<5	<5	<5	<5	<5
TSS	3	mg/L	<3	<3	8	<3	19	7
Uranium	0.001	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	0.006
Vanadium	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	0.01	mg/L	<0.01	0.03	0.03	0.06	0.11	0.05