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Aquatic Macroinvertebrate and Physical Habitat Monitoring for Bandelier National Monument

2007 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2009/003

ON THE COVER
Capulin Creek, Bandelier National Monument
Photograph by Stacy Stumpf

Aquatic Macroinvertebrate and Physical Habitat Monitoring for Bandelier National Monument

2007 Summary Report

Natural Resource Technical Report NPS/SCPN/NRTR—2009/003

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Introduction and Background

The National Park Service Inventory and Monitoring (I&M) Program was designed to monitor the status and trends in the condition of park resources, providing park managers with a strong scientific foundation for informing resource management decisions. The Southern Colorado Plateau Network (SCPN) identified aquatic macroinvertebrates as a core vital sign and plans to monitor water-quality conditions and aquatic-ecosystem health of streams in selected SCPN parks (Thomas et al. 2006). Capulin Creek in Bandelier National Monument (Figure 1) was selected by SCPN for long-term monitoring of aquatic macroinvertebrates, water quality, and integrated riparian vital signs.

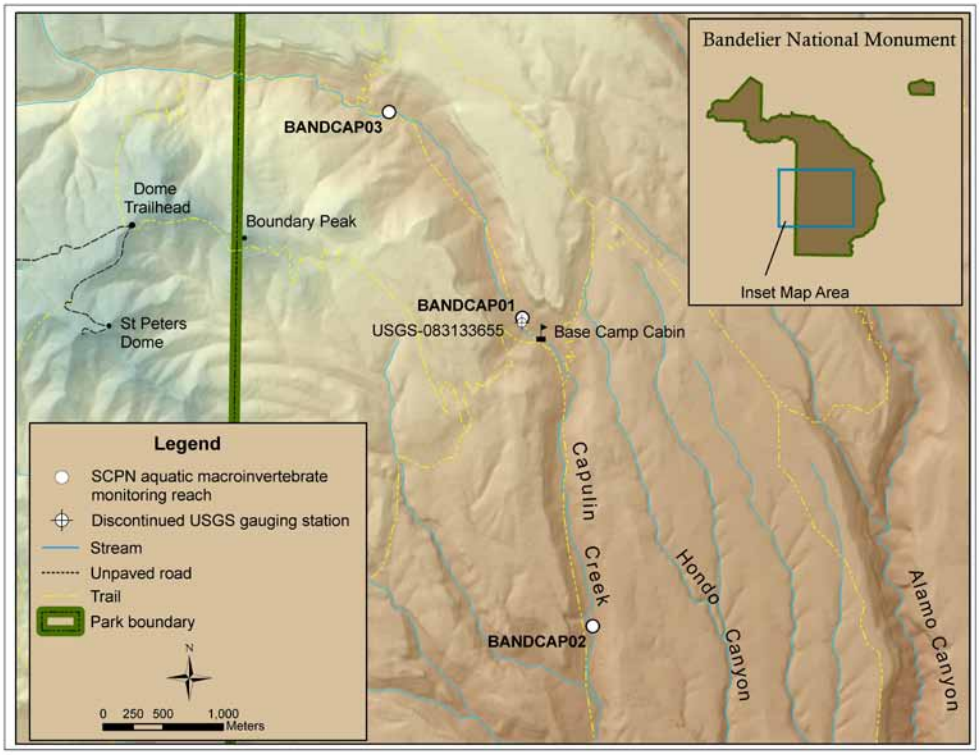

Figure 1. Location map of Capulin Creek, Bandelier National Monument, with three sampling reaches.

In 2005 SCPN initiated a pilot study to develop and test aquatic macroinvertebrate monitoring protocols (Brasher et al. 2006). Two sites at Capulin Creek were sampled during the pilot study. One of the sites included in this report—located <0.3 km upstream from the Base Camp cabin (BANDCAP01)—was initially sampled in that study.

SCPN implemented aquatic macroinvertebrate monitoring at Capulin Creek in Bandelier National Monument during 2007. During this year samples were collected at three sites on Capulin Creek. One of these, BANDCAP01, was selected judgmentally and is co-located with a network water quality monitoring site. The other two sites, 2.6 km downstream of base camp (BANDCAP02) and 2.4 km upstream of base camp (BANDCAP03), were selected using the Generalized Random-Tesselation Stratified (GRTS) design. All three sites were sampled in 2007 to help improve our understanding of the spatial variability of aquatic macroinvertebrate communities collected from Capulin Creek.

The purpose of this report is to (a) document monitoring activities and management actions that occurred in 2007, (b) summarize data that were collected, and (c) place these data in the context of aquatic habitat, biological condition, and management actions within the park through time.

The Capulin Creek watershed is a designated wilderness area managed for recreational use within the monument boundaries. In the upper section of the watershed, the U.S. Forest Service manages land for recreation and timber harvest. In 1996 the Dome Fire burned several thousand acres within the watershed. Although ecological recovery of terrestrial and aquatic communities has been substantial over the past 10 years, effects of this fire can still be observed. Large quantities of woody debris have accumulated in the floodplain and stream channel, and fine sediments are abundant and mobile in the system.

Native Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) populations were extirpated from the stream by flood events following the fire. A reintroduction program for this species is currently underway through a cooperative effort between the Santa Fe National Forest, Bandelier National Monument, and the New Mexico Department of Game and Fish. In addition, managers are currently evaluating the idea of placing native Rio Grande Sucker and native Rio Grande Chub in Capulin Creek as well (S. Fettig, wildlife biologist, BAND, personal communication 2/27/08).

Controlled-fire treatments, if implemented, could potentially impact stream habitat and aquatic communities through increased erosion and sedimentation. Roads and timber harvest on Santa Fe National Forest land also have the potential to affect the stream ecosystem.

Methods

Sample sites

We sampled aquatic macroinvertebrate reaches at three sites on Capulin Creek in Bandelier National Monument during 2007. In downstream order these sites were: BANDCAP03, located 2.4 km upstream from the Base Camp Cabin near where a trail leaves Capulin Canyon heading to Alamo Canyon; BANDCAP01, located about 0.3 km upstream from the Base Camp cabin (at the water-quality monitoring site); and BANDCAP02, located about 2.6 km downstream from the Base Camp Cabin near a break in the western canyon wall. The channel in the site BANDCAP03 has a boulder and cobble substrate and the nearby riparian forest is dominated by alder (*Alnus oblongifolia*). BANDCAP01 is near a discontinued USGS streamflow gauging station (Capulin Canyon at Ranger Cabin – station number 083133655). The channel substrate is primarily cobble and flows through an alder, boxelder (*Acer negundo*), and narrowleaf cottonwood (*Populus angustifolia*) woodland. BANDCAP02 is surrounded by Ponderosa pine (*Pinus ponderosa*), alder, boxelder, and New Mexico olive (*Forestiera pubescens*) and has a mostly fine/sand substrate.

Field methods

From October 12–17, 2007, aquatic macroinvertebrate samples and physical habitat data were collected within a 150-m reach of each site (see Figure 2 for reach layout diagram). A brief description of field methods is provided here and a detailed description of sampling methods can be found in Brasher et al. (2009).

Two types of macroinvertebrate samples were collected in each reach. Quantitative targeted habitat samples were collected from five riffles within each reach to provide estimates of aquatic organism abundance. Each of these samples was collected from a 0.25-m^2 area using a Slack Sampler.

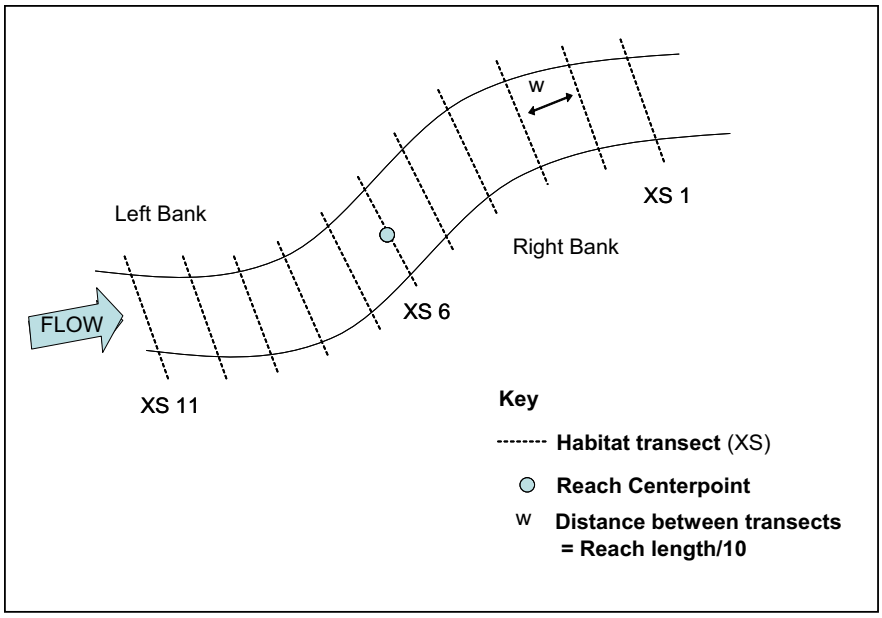

Figure 2. General aquatic-macroinvertebrate monitoring reach layout.

Additionally, one qualitative sample was collected from each reach. A qualitative sample represents a pooled sample of all habitat types that exist along the sampling reach. The goal of qualitative sampling is to provide a comprehensive species list of organisms occurring across all habitat types (Appendix A).

Physical habitat data was collected at 3 scales: microhabitat, transect, and reach. Microhabitat measurements, including depth, velocity, substrate size, and substrate embeddedness, were collected at each of the quantitative targeted riffle sampling locations. Habitat measurements were also collected along 11 transects that were equally spaced throughout the reach (every 15 m). At points across each transect, measurements of stream width, depth, velocity, substrate size, and canopy closure were made. Seven point observations of the type and presence of macroinvertebrate habitats were recorded across each transect (Appendix B). At the reach scale, geomorphic channel unit lengths were measured to characterize general habitat heterogeneity. Dominant vegetation and land cover and observations describing anthropogenic or other disturbances in the reach were also recorded.

Laboratory methods

Macroinvertebrate samples were sorted and identified by the Utah State University BugLab, a Bureau of Land Management laboratory based in Logan, Utah. Samples were sorted under a dissecting scope at 10× magnification. A 500-organism, fixed-count method is used for sub-sampling large samples. Macroinvertebrates were identified to genus by a taxonomist certified by the North American Benthological Society. Ten percent of the sorted samples were re-sorted for quality assurance. Ten percent of the identified samples were re-identified by a second certified taxonomist to ensure data quality. Quantitative and qualitative macroinvertebrate samples will be maintained by the contract aquatic laboratory for an extended period of time (at least five years) in order to provide for repeat subsampling should any data questions arise. For a more detailed description of laboratory methods, see Brasher et al. (2009).

Data analysis

Macroinvertebrate data were summarized in terms of community structure and function. Genera

were classified into functional feeding-guilds using the classifications presented in Poff et al. (2006). If functional class information was not available for a particular genus, a more generalized, family-level classification was applied. Selected macroinvertebrate metrics and indices were calculated and summarized in terms of the mean and standard deviation among replicates. A list of metrics and their definitions can be found in Table 1. The majority of these metrics have been used previously to detect changes in water quality and habitat conditions in other streams in the Southern Rocky Mountains ecoregion (Griffith 2005).

Four metrics were calculated for both qualitative and quantitative samples, including genus richness, proportion of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, and the proportions (individual) of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa (all based on relative abundance of the taxa group). We monitor EPT taxa because they are particularly sensitive to changes in water quality. In addition to these, abundance and taxonomic and functional diversity were calculated for quantitative samples.

Simpson's Diversity Index was chosen as a measure of community diversity. Simpson's Diversity Index was calculated twice—once using taxonomic data, and once using functional data. Simpson's Diversity Index (D) was calculated as:

$$D_s = 1-[(\Sigma\, n(n-1))/(N(N-1))] \qquad (1)$$

where: n = abundance of an individual taxon or functional guild; and N = total number of individuals in sample.

Results

Summary of aquatic macroinvertebrate community data

This report includes data describing aquatic macroinvertebrate communities from samples collected at three sites on Capulin Creek in Bandelier National Monument during 2007. A summary of key metrics for these samples can be found in Table 2. For all tables and figures listed in this section, sampling reach results are presented in left to right order corresponding to an upstream to downstream positioning along Capulin Creek (see Figure 1). In addition, the majority of figures in this section refer to data collected from quantitative targeted riffles unless otherwise noted.

Overall, mean abundance and richness were greatest in the BANDCAP03 site (Figures 3 and 4 respectively). Abundance values for BANDCAP03 were 1.5 times greater than BANDCAP01 and 5.5 times greater than BANDCAP02 (Figure 3). Richness was highest in qualitative samples. Quantitative richness did not differ greatly between BANDCAP03 and BANDCAP01. However, both sites had roughly twice the richness as samples collected from BANDCAP02. Diversity as calculated by the Simpson's Diversity Index did not differ greatly among the three sampling reaches for either taxonomic diversity or functional feeding group diversity (Figure 5).

Ecological tolerance describes how well a species tolerates disturbance. Mean abundance and richness of intolerant taxa decrease from upstream to downstream. Mean abundance of intolerant taxa was 6 to 144 times greater than abundance of tolerant taxa across sampling sites. Richness of intolerant taxa was 2 to 10 times greater than tolerant taxa richness across sampling sites (Figure 6). Relative abundance of EPT taxa was high across all 3 sampling sites (Figure 7). Those taxa were dominated by individuals belonging to the order Ephemeroptera in samples collected from BANDCAP03 and BANDCAP 01. Samples collected from BANDCAP02 were overwhelmingly

Table 1. Selected aquatic macroinvertebrate metrics. .

Metric type	Metric	Definition
Abundance/Richness/Diversity	Total abundance	Total number of individuals.
	Taxa richness	Total number of taxa (measures the overall diversity of macroinvertebrates in a sample).
	Simpson's diversity	A measure of the variety of taxa that takes into account the relative abundance of each taxon.
Tolerance	Dominant taxa	Measures the dominance of the most abundant taxa. Typically calculated as dominant 2, 3, 4, or 5 taxa.
	Relative abundance tolerant taxa	Percent of individuals considered to be tolerant to perturbation.
	Percent richness tolerant taxa	Percent of taxa considered to be tolerant to perturbation.
Functional-Feeding	Relative abundance filtering-collectors	Percent of individuals that filter fine particulate organic matter from the water column.
	Percent richness filtering-collectors	Percent of taxa that filter fine particulate matter from the water column.
	Relative abundance scrapers	Percent of individuals that scrape or graze upon periphyton.
Functional-Habit	Relative abundance burrowers	Percent of individuals that move between substrate particles (typically finer substrates).
	Percent richness burrowers	Percent of taxa that move between substrate particles (typically finer substrates).
	Relative abundance clingers	Percent of individuals that have fixed retreats or adaptations for attachment to surfaces in flowing water.
	Percent richness clingers	Percent of taxa that have fixed retreats or adaptations for attachment to surfaces in flowing water.
Composition	Number of EPT taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).
	Relative abundance EPT	Percent of individuals in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).
	Relative abundance Ephemeroptera	Percent of individuals that are mayflies.
	Relative abundance Plecoptera	Percent of individuals that are stoneflies (for streams > 1,500 m in elevation).
	Relative abundance Trichoptera	Percent of individuals that are caddisflies.
	Hydroptilidae+ Hydropsychidae: Trichoptera	Percent of Trichopteran individuals in Hydroptilidae plus Hydropsychidae (ratio of tolerant caddisfly abundance to total caddisfly abundance).
	Relative abundance non-insect taxa	Percent of individuals that are not insects.
	Relative abundance Chironomidae	Percent of individuals that are midges.

dominated by Plecopteran (stoneflies) species which made up nearly half of all individuals collected from this site.

In terms of abundance, Ephemeropteran and Chironomid (midges) were the dominant orders, making up 48% and 57% of the individuals collected from samples taken from BANDCAP02 and BANDCAP01 respectively (Figure 8). Plecopterans and Chironomids combined to make up 85% of the individuals in samples collected from BANDCAP03. Predators and Collector-Gatherers were the most sampled functional feeding groups across all sampling reaches (Figure 9). These feeding groups

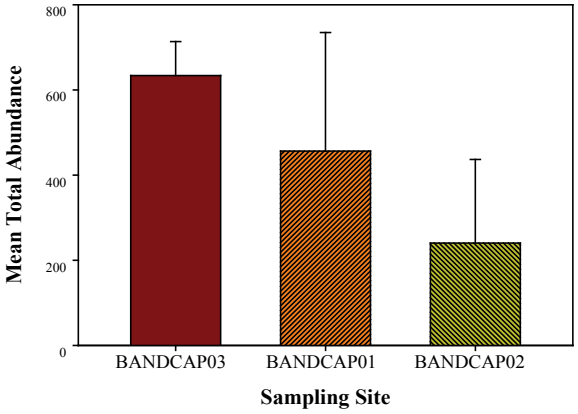

Figure 3. Mean total abundance of macroinvertebrates collected in Capulin Creek in 2007. Abundance is expressed as the mean number of individuals per quantitative targeted riffle habitat..

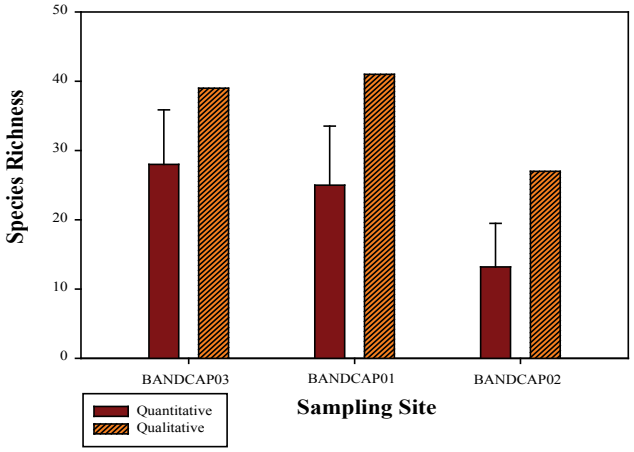

Figure 4. Species richness as defined by the mean number of taxa found in quantitative targeted habitat samples and qualitative multihabitat samples collected in Capulin Creek.

made up 61% of the species collected from BANDCAP03, 57% from BANDCAP01, and 68% from BANDCAP02.

Summary of physical habitat characteristics

At each SCPN aquatic macroinvertebrate monitoring reach on Capulin Creek physical habitat data were collected along all 11 transects and at each of the 5 targeted riffle habitats (Microhabitat) during 2007. A summary of these data are presented in Table 3 and the entire data set is included in Appendix B.

Mean velocity and depth were similar across all sites for transect and riffle habitat data. Wetted channel width was similar across all sites but the active channel was twice as wide at BANDCAP02 as it was at the other two sites. Mean substrate size sampled along riffle habitat was greatest at BANDCAP03 and decreased with distance downstream. Embeddedness of substrate particles was greatest at BANDCAP01 but did not differ greatly among the other sampling reaches.

Riparian cover as described by canopy closure was greatest in the BANDCAP01 reach. The least amount of closure occurred at BANDCAP02.

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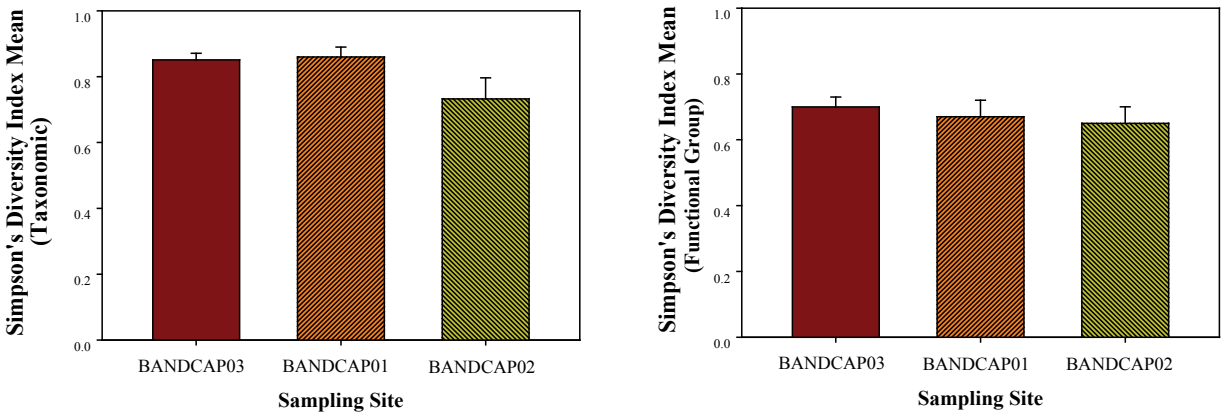

Figure 5. Simpson's Diversity Index for Taxonomic (left) and Functional Feeding Group Diversity (right) calculated for quantitative targeted habitat samples collected in Capulin Creek. Values expressed are means of all samples collected from each site.

Table 2. Summary of macroinvertebrate metrics based on samples collected in three reaches in Capulin Creek. Richness based metrics are expressed as the number of different taxa in a particular sample. Abundance based metrics are expressed as the number of individuals in a sample. Only one qualitative multihabitat was taken from each reach. Five quantitative samples were taken from each reach.

Qualitative Multihabitat

Metric	BANDCAP03	BANDCAP01	BANDCAP02
Taxa Richness	40.00	43.00	27.00
Percent Richness Tolerant Taxa	10.53	9.30	11.54
Percent Richness of Collector-Filterer	10.00	11.63	15.38
Percent Richness of Scrapers	12.50	9.30	3.85
Number of EPT Taxa	15.00	19.00	8.00
Percent Richness of EPT Taxa	37.50	44.19	29.63
Percent Richness of Ephemeroptera	7.50	16.28	7.41
Percent Richness of Plecoptera	7.50	9.30	7.41
Percent Richness of Trichoptera	22.50	18.60	14.81
Percent Richness Non-insect Taxa	5.00	4.65	7.41
Percent Richness of Chironomids	7.50	6.98	11.11

Quantitative Targeted Riffles

	BANDCAP03		BANDCAP01		BANDCAP02	
Metric	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Total Abundance	633.63	79.76	456.30	278.53	240.4	196.25
Taxa Richness	28.2	3.90	24.4	8.26	13.4	7.09
Simpson's Diversity Taxonomic	0.85	0.02	0.86	0.03	0.73	0.06
Simpson's Diversity Func Grp	0.70	0.03	0.67	0.05	0.65	0.05
Dominant Taxa	27.15	3.56	28.95	8.78	43.57	7.79
Relative Abundance Tolerant Taxa	0.50	0.36	2.23	3.78	7.02	9.87
Percent Richness Tolerant Taxa	5.61	1.41	4.61	4.89	10.78	7.25
Relative Abundance Collector-Filterer	35.69	7.93	15.84	3.20	4.85	4.71
Percent Richness of Collector-Filterer	10.82	1.69	14.50	2.97	13.56	10.81
Relative Abundance of Scrapers	10.88	9.59	4.64	2.11	2.59	2.95
Number of EPT Taxa	12.2	0.84	11.4	2.70	4.6	3.05
Relative Abundance of EPT Taxa	59.78	8.29	54.51	12.45	52.33	13.17
Relative Abundance of Ephemeroptera	26.81	7.49	29.10	10.08	1.14	0.92
Relative Abundance of Plecoptera	9.75	5.38	13.80	6.65	49.07	11.56
Relative Abundance of Trichoptera	23.22	7.88	11.60	3.84	2.12	4.02
Percent Tolerant Trichoptera	95.4		69.2		100.00	
Relative Abundance Non-insect Taxa	0.24	0.33	0.69	1.18	1.15	1.52
Relative Abundance of Chironomids	20.52	12.29	27.49	12.60	35.73	17.62

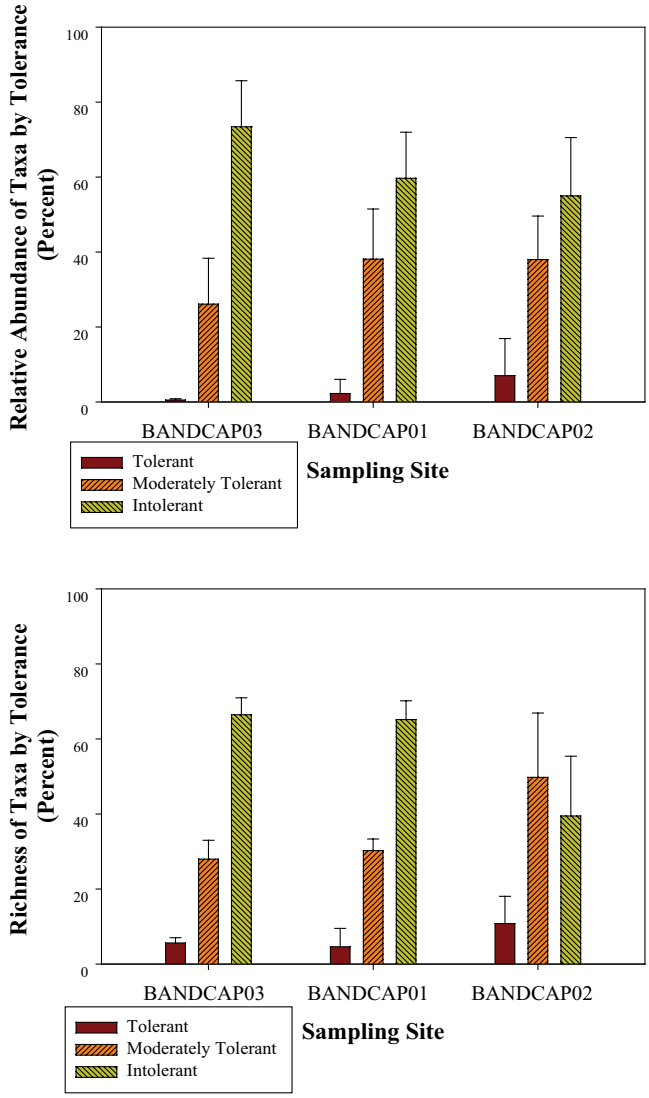

Figure 6. Mean relative abundance (upper) and richness (lower) of taxa based on their tolerance to perturbation.

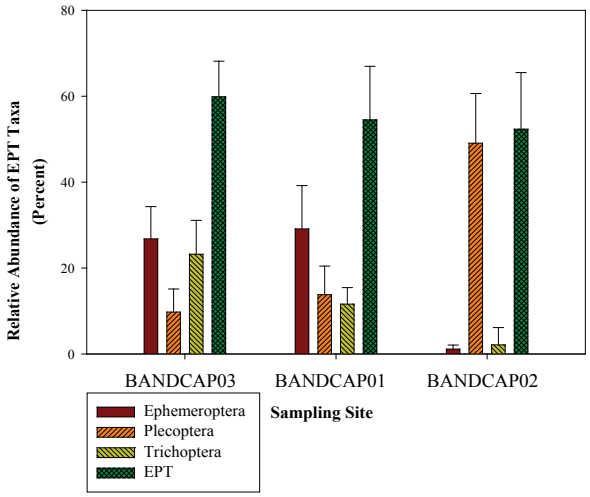

Figure 7. Mean abundance of Ephemeropteran (Mayflies), Plecopteran (Stoneflies), and Trichopteran (Caddisflies) species expressed as a percentage. The last bar for each site (EPT) represents the total relative abundance of all three orders.

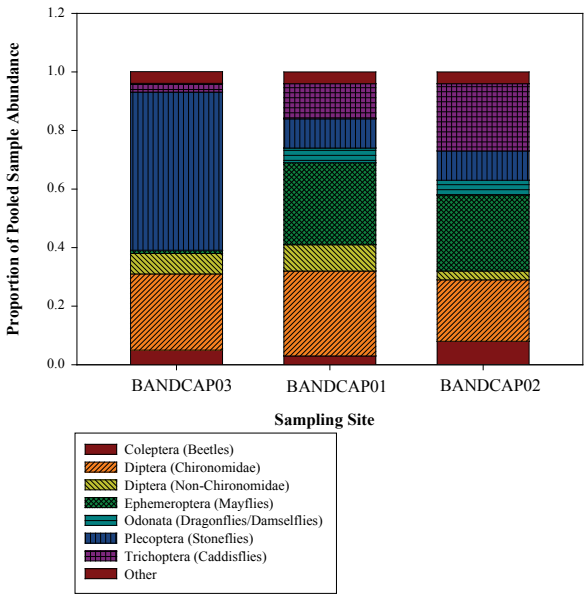

Figure 8. Taxonomic composition proportion of abundance by order found in quantitative targeted riffle samples.

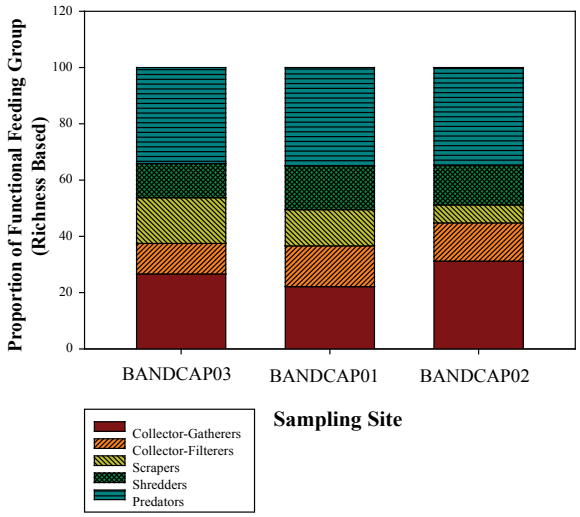

Figure 9. Proportion of taxa by functional feeding groups of quantitative targeted riffle samples.

Table 3. Summary of physical habitat transect data in Capulin Creek, 2007. Measures of Embeddedness, Canopy Closure are described as percentages. Wetted and Active Channels are described as widths.

	BANDCAP03		BANDCAP01		BANDCAP02	
	Mean	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Channel Dimensions						
Velocity (m/s)	0.09	0.14	0.06	0.11	0.04	0.06
Depth (m)	0.05	0.03	0.07	0.06	0.06	0.03
Wetted Channel (m)	1.30	0.37	1.18	0.35	1.75	0.51
Active Channel (m)	2.29	0.87	1.70	0.44	4.02	1.48
Microhabitat						
Velocity (m/s)	0.30	0.17	0.23	0.10	0.19	0.23
Depth (m)	0.07	0.01	0.07	0.02	0.06	0.03
Substrate Size (mm)	4.05	4.78	2.74	5.02	1.60	3.24
Embeddedness (%)	12.02	19.38	13.32	19.80	9.20	14.91
Riparian Cover						
Canopy Closure	83.65	14.10	86.16	13.85	71.49	13.66

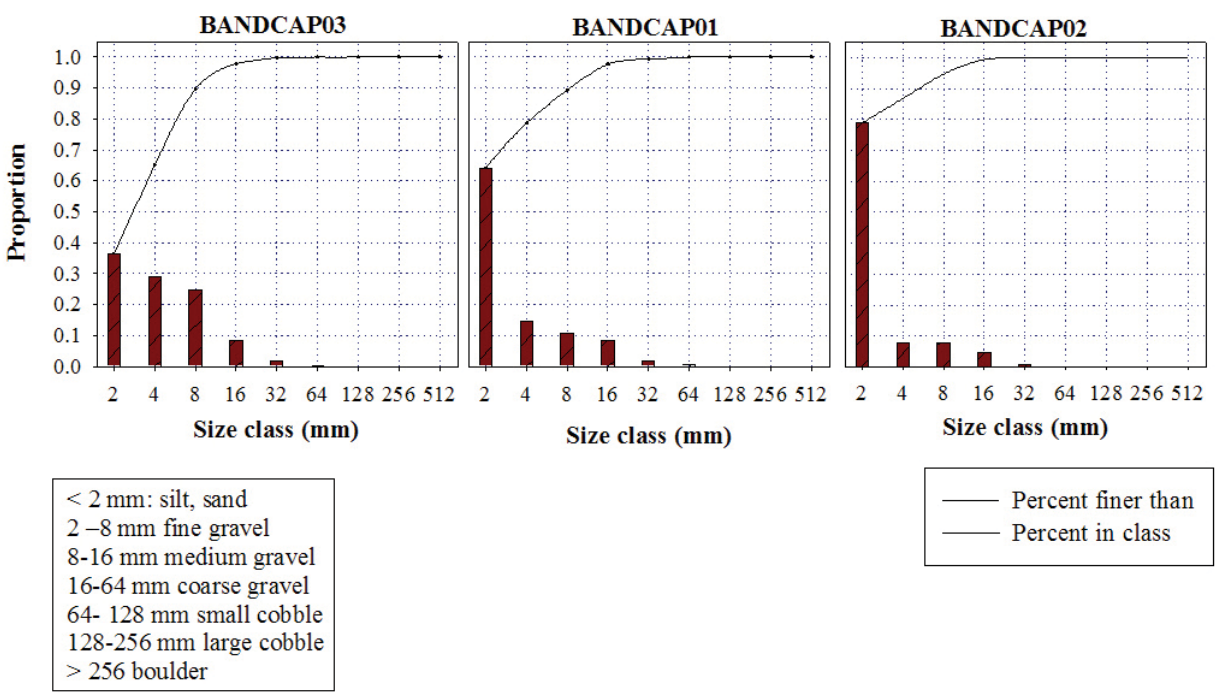

Figure 10. Particle size distribution, based on modified Wolman pebble counts, among macroinvertebrate sampling reaches in Capulin Creek, 2007. Percent finer than shows cumulative proportion of sediments finer than size class.

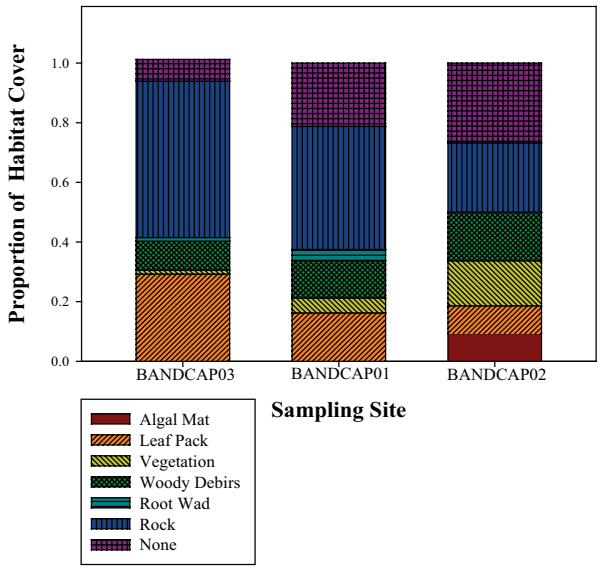

Figure 11. Proportion of macroinvertebrate habitat structures found in sampling reaches along Capulin Creek.

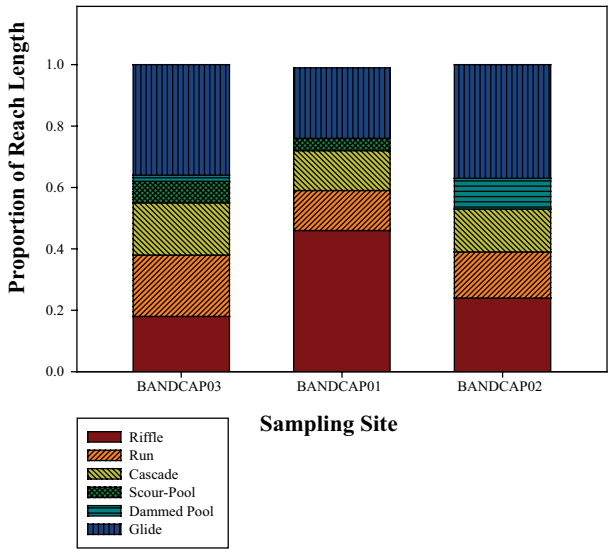

Figure 12. Proportion of each geomorphic channel unit found along the sampling reaches in Capulin Creek.

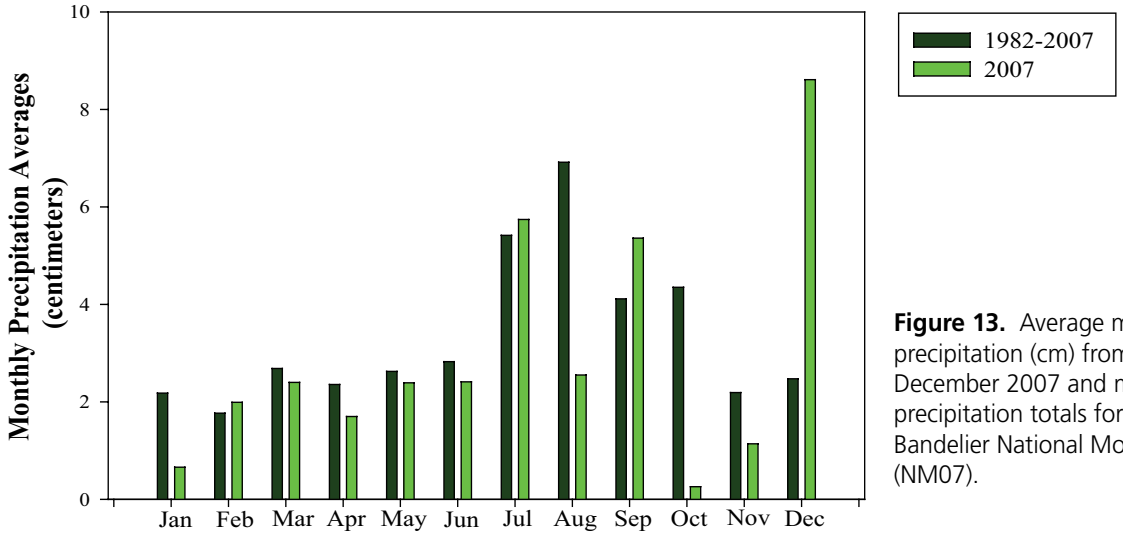

Figure 13. Average monthly precipitation (cm) from July 1982–December 2007 and monthly precipitation totals for 2007 at Bandelier National Monument, NM (NM07).

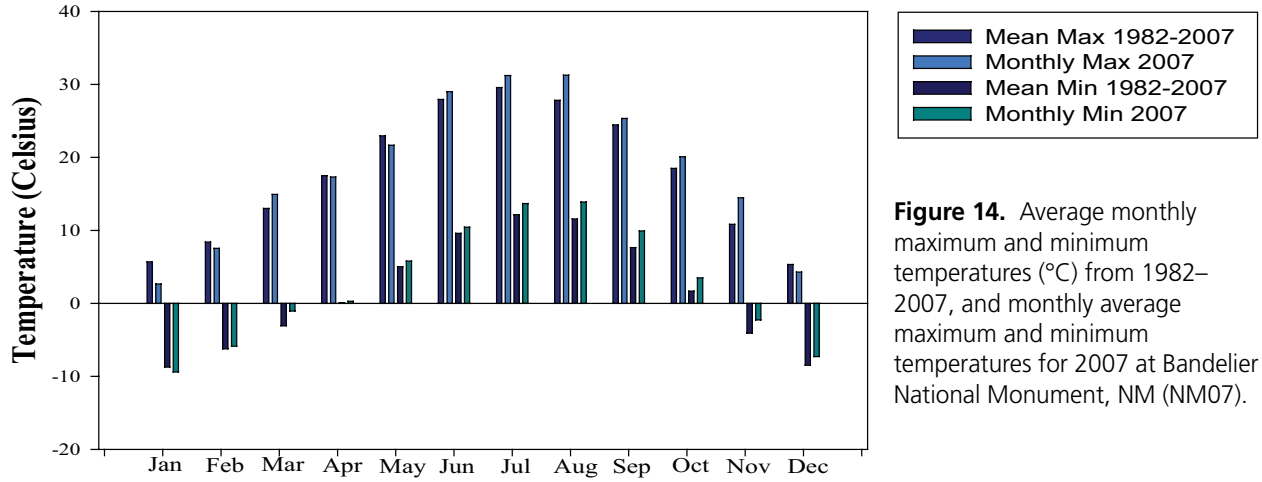

Figure 14. Average monthly maximum and minimum temperatures (°C) from 1982–2007, and monthly average maximum and minimum temperatures for 2007 at Bandelier National Monument, NM (NM07).

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Channel structure dynamics are represented by particle size distributions in Figure 10. Particle size distributions were controlled primarily by finer sediments in all 3 reaches based on modified Wolman pebble counts. The proportion of particles in the sand/silt size class increased from upstream to downstream. There were no sediment particles greater than 62 mm present in any of the sampling reaches.

Macroinvertebrate habitat was dominated by rock in reaches BANDCAP03 and BANDCAP01 (Figure 11). Very little algae existed anywhere in Capulin Creek. BANDCAP02 was the only site where algae was present, making up 9% of the total habitat available.

Riffles and glides were the most abundant Geomorphic Channel Unit (GCU's) found throughout all sampling reaches (Figure 12). In combination these two channel units made up 54% of BANDCAP03, 69% of BANDCAP01, and 61% of BANDCAP02. Riffles accounted for half of the channel units sampled along BANDCAP01 which was twice as much as the other sampling reaches. For a complete description of GCU's see Brasher et al. (2009).

Climate conditions

Streamflow and climate are not monitored at Capulin Creek. The closest weather station, Station Bandelier National Monument (NM07), is located on Frijoles Mesa in the Rito de los Frijoles drainage. The station is located approximately 0.5 km northeast of Bandelier National Monument headquarters and 6.1 km northeast of the Base Camp Cabin at Capulin Creek (National Atmospheric Deposition Program 2009). Monthly precipitation averages for 2007 generally followed trends established over the past 25 years with the exception of the months of August and October, which saw significantly decreased precipitation, and December, which was wetter than the long-term average (Figure 13). No distinct deviations in monthly maximum or minimum temperatures from the 25-year average occurred in 2007 (Figure 14).

Discussion

Data included in this report represent SCPN's first year of aquatic macroinvertebrate monitoring along Capulin Creek. The current conditions at our sampling sites suggest that those sites in the upper reaches of the watershed are the most species rich and provide the greatest sample abundance for both quantitative and qualitative samples. Taxa richness of riffle habitat along Capulin Creek is relatively high. Our richness numbers exceeded both pre-fire and post-fire riffle data collected by Vieria et al. (2004) and MacRury and Clements (2002). However, the SCPN 2007 numbers were lower than those reported in Pippin and Pippin (1981).

Calculations of Simpson's Diversity Index for taxonomic differences in quantitative samples suggest that riffle habitat is quite diverse. These values represent the highest found among any monitoring sites sampled by SCPN during 2007.

Prior to 2006 Capulin Creek was listed on the State of New Mexico's 303(d) list of impaired surface water because of increased sedimentation and turbidity after the 1996 Dome Fire. A 2004 assessment of the watershed resulted in turbidity being removed as a cause of non support for the listing but sedimentation and its resulting effect on the macroinvertebrate community remained a cause of concern. After reassessment in 2006, the State concluded that because the sedimentation was due to "natural causes" it should be removed as a cause of impairment to the stream. The stream was then

removed from the State's 303(d) list (NMED 2008). Our first year of physical habitat data indicate that substrate in the reaches we sampled were dominated by finer sediments as well as showing that the proportion of fine sediments (<2 mm) present in the channel increases in the downstream direction. Additionally we found a decrease in Collector-Filtering species as well as in EPT richness and abundance as we moved downstream. Both groups of organisms are known to be sensitive to instream sedimentation.

Ecological tolerance describes how well a species tolerates disturbance. Aquatic macroinvertebrate taxa can be assigned tolerance values based on their ability to withstand pollution or environmental degradation. Taxa that are considered to beintolerant are expected to decline quickly as water quality degrades. Conversely, tolerant taxa would be expected to persist during times of degraded water quality. As shown in Figure 6, the 2007 data indicate that Capulin Creek is dominated by moderately tolerant and intolerant macroinvertebrate taxa. While a single year of data is insufficient to describe current conditions with a high degree of confidence, if a similar status is reported in future years, this would suggest that the aquatic habitats and macroinvertebrate assemblages are in good condition and are experiencing little disturbance. In addition, this metric could provide useful information if the numbers of moderately tolerant and intolerant species were to decline as the result of any future perturbation or management action occurring in the watershed.

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Appendix A

Aquatic macroinvertebrate taxa collected in Capulin Creek during 2007

Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Annelida	Oligochaeta						Segmented Worms
Arthropoda	Arachnida	Trombidiformes	Trombidiformes				Water Mites
Arthropoda	Arachnida	Trombidiformes	Trombidiformes	Sperchontidae	Sperchon		Water Mites
Arthropoda	Arachnida	Trombidiformes	Trombidiformes	Torrenticolidae	Torrenticola		Water Mites
Arthropoda	Insecta	Coleoptera	Coleoptera	Dryopidae	Helichus		Long-Toed Water Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Dytiscidae	Agabus		Long-Toed Water Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Dytiscidae	Rhantus	binotatus	Long-Toed Water Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Dytiscidae	Rhantus		Long-Toed Water Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Dytiscidae			Long-Toed Water Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Heterlimnius	corpulentus	Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Narpus	concolor	Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Optioservus	divergens	Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Optioservus	quadrimaculatus	Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Optioservus		Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Zaitzevia	parvula	Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae			Riffle-Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Hydrophilidae	Enochrus		Water Scavenger Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Hydrophilidae	Paracymus		Water Scavenger Beetles
Arthropoda	Insecta	Coleoptera	Coleoptera	Hydrophilidae			Water Scavenger Beetles
Arthropoda	Insecta	Diptera	Diptera	Ceratopogonidae	Probezzia		Biting Midges
Arthropoda	Insecta	Diptera	Diptera	Ceratopogonidae			Biting Midges
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges

Appendix A *continued*

Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Arthropoda	Insecta	Diptera	Diptera	Dixidae	Dixa		Meniscus Midges
Arthropoda	Insecta	Diptera	Diptera	Dixidae			Meniscus Midges
Arthropoda	Insecta	Diptera	Diptera	Empididae	Chelifera		Dance Flies
Arthropoda	Insecta	Diptera	Diptera	Muscidae			House Flies
Arthropoda	Insecta	Diptera	Diptera	Psychodidae	Maruina		Moth & Sand Flies
Arthropoda	Insecta	Diptera	Diptera	Psychodidae	Pericoma		Moth & Sand Flies
Arthropoda	Insecta	Diptera	Diptera	Simuliidae	Simulium		Black Flies
Arthropoda	Insecta	Diptera	Diptera	Simuliidae			Black Flies
Arthropoda	Insecta	Diptera	Diptera	Stratiomyidae	Caloparyphus		Soldier Flies
Arthropoda	Insecta	Diptera	Diptera	Tabanidae	Tabanus		Horse Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Antocha	monticola	Crane Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Dicranota		Crane Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Limnophila		Crane Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Pedicia		Crane Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Tipula		Crane Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae			Crane Flies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Ameletidae	Ameletus		Combmouth Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae			Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Centroptilum		Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Acentrella		Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Baetis		Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Fallceon	quilleri	Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Ephemerellidae	Drunella	coloradensis	Spiny Crawler Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Ephemerellidae			Spiny Crawler Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Heptageniidae	Epeorus		Stream Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Heptageniidae			Stream Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Leptohyphidae	Tricorythodes		Tricos Mayflies

Appendix A *continued*

Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Leptophlebiidae			Pronggilled Mayflies
Arthropoda	Insecta	Heteroptera	Heteroptera	Veliidae	Microvelia		Water Striders
Arthropoda	Insecta	Lepidoptera	Lepidoptera	Pyralidae	Petrophila		Pyralid Moth
Arthropoda	Insecta	Odonata	Odonata	Aeshnidae			Darners
Arthropoda	Insecta	Odonata	Odonata	Coenagrionidae	Argia		Narrow-winged Damselfies
Arthropoda	Insecta	Odonata	Odonata	Coenagrionidae			Narrow-winged Damselfies
Arthropoda	Insecta	Plecoptera	Plecoptera				Stoneflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Capniidae			Stoneflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Chloroperlidae			Stoneflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Nemouridae	Zapada	cinctipes	Spring Stoneflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Nemouridae			Spring Stoneflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Perlodidae	Isoperla		Perlodid Stoneflies
Arthropoda	Insecta	Trichoptera	Trichoptera				Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Brachycentridae	Micrasema		Casemaker Caddislies
Arthropoda	Insecta	Trichoptera	Trichoptera	Calamoceratidae	Heteroplectron	californicum	Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Glossosomatidae	Glossosoma		Little Black Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Glossosomatidae			Little Black Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Helicopsychidae	Helicopsyche	borealis	Snail-case Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydropsychidae	Cheumatopsyche		Netspinning Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydropsychidae	Hydropsyche		Netspinning Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydropsychidae			Netspinning Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydroptilidae	Ithytrichia		Microcaddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydroptilidae	Oxyethira		Microcaddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydroptilidae			Microcaddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Lepidostomatidae	Lepidostoma		Bizarre Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Leptoceridae	Oecetis		Longhorned Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Limnephilidae			Northern Caddisflies

Appendix A *continued*

Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Arthropoda	Insecta	Trichoptera	Trichoptera	Sericostomatidae	Gumaga		Bushtailed Caddisflies
Mollusca	Bivalvia	Veneroida	Veneroida	Pisidiidae	Pisidium		Peaclams

Appendix B

Physical Habitat Data Collected at Capulin Creek in 2007

Channel Dimensions	Velocity (m/s)		Depth (m)			
	Mean	Std Dev	Mean	Std Dev	Wetted Channel (m)	Active Channel (m)
BANDCAP03						
1	0.05	0.11	0.12	0.06	1.30	3.65
2	0.09	0.13	0.06	0.02	1.00	1.20
3	0.03	0.07	0.02	0.03	0.85	1.05
4	0.06	0.13	0.02	0.04	1.40	2.50
5	0.04	0.12	0.02	0.03	1.20	2.75
6	0.08	0.11	0.04	0.03	0.80	1.40
7	0.17	0.38	0.02	0.03	1.97	3.00
8	0.05	0.08	0.08	0.07	1.60	1.60
9	0.09	0.10	0.08	0.02	1.05	2.30
10	0.08	0.14	0.02	0.01	1.70	3.20
11	0.23	0.20	0.06	0.03	1.45	2.58
BANDCAP01						
1	0.05	0.09	0.05	0.04	0.95	1.90
2	0.03	0.06	0.16	0.06	1.25	1.50
3	0.09	0.11	0.05	0.04	1.15	1.15
4	0.08	0.11	0.02	0.02	1.15	1.90
5	0.02	0.05	0.04	0.04	0.55	1.20
6	0.04	0.03	0.12	0.06	1.00	1.60
7	0.02	0.05	0.02	0.04	2.00	2.40
8	0.09	0.34	0.14	0.26	1.20	1.50
9	0.05	0.09	0.04	0.07	1.15	1.35
10	0.05	0.06	0.08	0.04	1.45	2.50
11	0.15	0.18	0.03	0.02	1.10	1.70
BANDCAP02						
1	0.03	0.06	0.02	0.02	1.10	4.60
2	0.03	0.03	0.12	0.06	1.65	2.50
3	0.05	0.07	0.09	0.01	2.55	3.45
4	0.04	0.02	0.08	0.03	2.50	5.50
5	0.01	0.05	0.05	0.02	1.65	3.80
6	0.10	0.07	0.04	0.02	1.85	2.75
7	0.02	0.04	0.04	0.02	1.45	3.40
8	0.07	0.11	0.02	0.02	1.80	7.00
9	0.04	0.06	0.07	0.04	1.17	2.20
10	0.00	0.04	0.04	0.04	2.30	5.50
11	0.07	0.08	0.04	0.04	1.25	3.50