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Aquatic Macroinvertebrate and Physical Habitat Monitoring for Mesa Verde National Park

2007 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2009/002

ON THE COVER
Mancos River at Mesa Verde National Park
Photograph by Rebecca Weissinger

Aquatic Macroinvertebrate and Physical Habitat Monitoring for Mesa Verde National Park

2007 Summary Report

Natural Resource Technical Report NPS/SCPN/NRTR—2009/002

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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 of 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). The Mancos River in Mesa Verde National Park (Figure 1) was selected by SCPN for long-term monitoring of aquatic macroinvertebrates, water quality and integrated riparian vital signs.

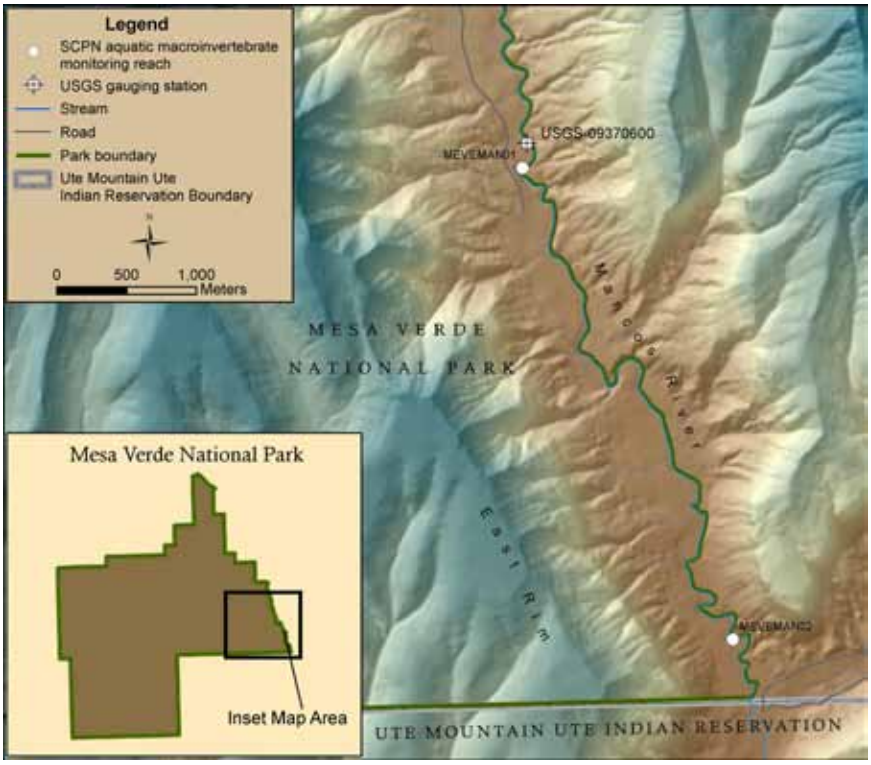

Figure 1. Location map of Mancos River, Mesa Verde National Park, with two sampling reaches.

The Southern Colorado Plateau Network implemented aquatic-macroinvertebrate monitoring at two sites on the Mancos River in 2007. These sites were the Mancos River near stream flow gauge (MEVEMAN01) and Mancos River 0.4 km upstream from southern park boundary (MEVEMAN02). MEVEMAN01 was selected judgmentally and is co-located with a network water quality monitoring site and a streamflow gaging station. Aquatic macroinvertebrates were sampled at this site in 2005 and 2006 by the USGS as part of a pilot study supporting SCPN protocol development (Brasher 2009). MEVEMAN02 was sampled for the first time in 2007. The site was selected using the Generalized Random-Tesselation Stratified (GRTS) design.

The purpose of this report is to (a) document monitoring activities and management actions that have 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 Mancos River makes up approximately 6 km of the park's eastern boundary and is located adjacent to a checkerboard of federal, state, and private lands. The streamflow gaging station USGS 09370600 Mancos River at Anitas Flat below Mancos, CO is 1.69 km south of the park boundary and is operated cooperatively by the National Park Service (NPS) and the USGS. Streamflow gaging station USGS 09371000 Mancos River near Towaoc, CO is 45 km downstream of the park boundary on Ute Indian Reservation. The State of Colorado has a streamflow gaging station (MANMANCO) 15 km upstream of the park, near the town of Mancos. Water is diverted upstream from the park for irrigation and flow in the river has been partially regulated by Jackson Gulch Reservoir since 1949.

Methods

Field methods

Aquatic macroinvertebrate reaches were sampled at two sites on the Mancos River in Mesa Verde National Park, CO. In downstream order these sites were MEVEMAN01 and MEVEMAN02. MEVEMAN01 is just downstream of an active gaging station. The dominant riparian vegetation in this reach is cottonwood (*Populus spp.*), coyote willow (*Salix exigua*) and silver buffaloberry (*Shepherdia argentea*). The lower reach is on a large meander and the vegetation community is primarily coyote willow, juniper (*Juniperus monosperma*), rabbitbrush (*Chrysothamnus spp.*) and narrowleaf cottonwood (*Populus angustifolia*).

Aquatic-macroinvertebrate samples were collected within two 150-m reaches (see Figure 2 for reach layout diagram). Physical habitat surveys were conducted within this same area. Sampling occurred October 3-4, 2007. Sampling was cut short by a storm event that caused the river to rise, and only seven habitat transects were completed at each reach. A detailed description of methods can be found in Brasher et al. (2009).

Two types of macroinvertebrate samples were collected in each reach. Quantitative samples were collected from riffle habitats to provide estimates of organism abundance. Five replicate quantitative macroinvertebrate samples were collected from a 0.25-m^2 area in five riffles using a Slack Sampler. Qualitative samples were collected from all types of habitat present within the reach to provide a comprehensive list of species. One qualitative macroinvertebrate sample was collected using a D-frame Kick Net.

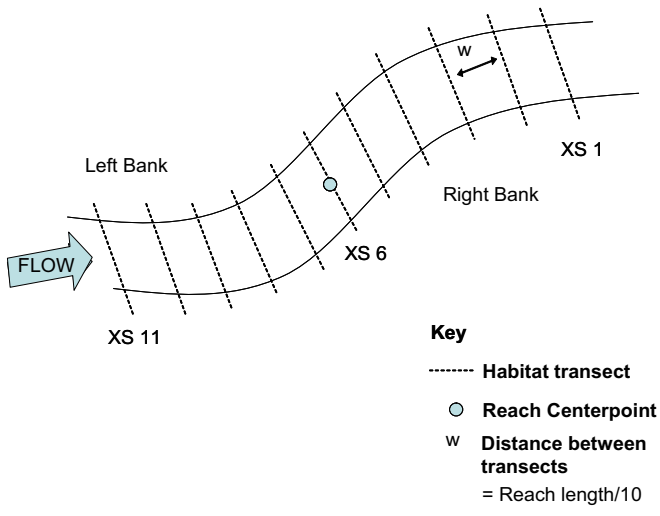

Figure 2. General aquatic-macroinvertebrate reach layout.

Microhabitat measurements, including depth, velocity, substrate size, and substrate embeddedness, were collected at each of the quantitative macroinvertebrate sampling locations. Physical habitat measurements were collected along 7 of 11 transects that were equally spaced throughout the reach (every 15 m). At 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. At

the reach scale, geomorphic channel unit lengths were measured to characterize general habitat heterogeneity. Dominant vegetation and land cover and any disturbances present in the reach were also recorded.

We were unable to collect a complete set of physical habitat data during the 2007 sampling event. A large weather system had been predicted to arrive on our second day of sampling, therefore, in order to ensure we would be able to collect aquatic macroinvertebrate and physical habitat data from both sampling reaches, we reduced the number of physical habitat transects for MEVEMAN02 from 7 of the 11 transects. On our second day of sampling, during our physical habitat sampling at MEVEMAN01, the forecasted storm arrived, preventing us from completing transects 8-11, and all reach characterization measurements.

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 metrics presented here were selected because they are generally considered to be sensitive, reliable indicators of water quality and/or stream health. In addition, these metrics represent a range of ecological characteristics, thus providing a comprehensive assessment of multiple aspects of community structure. The majority of these metrics have previously been used to detect changes in water quality and habitat conditions in streams (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 Index was chosen as a measure of community diversity. Simpson's Index was calculated twice; once using taxonomic data, and once using functional data. Simpson's 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 the sample.

Continued on page 5...

Table 1. Definitions of 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:	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.

Results

Summary of aquatic macroinvertebrate community data

This report includes data describing aquatic macroinvertebrate communities from samples collected at two sites on the Mancos River in Mesa Verde National Park during 2007. A summary of key metrics 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 upstream to downstream positioning along the stream (see Figure 1). Figures located in this section refer to data collected from quantitative targeted riffle habitat unless otherwise noted.

A total of 28 taxa were present in qualitative and quantitative samples collected at the Mancos River (Appendix A). Abundance and taxa richness was highest in samples collected from MEVEMAN02 (Table 2). Total abundance was nearly twice as high at MEVEMAN02 compared to MEVEMAN01 (Figure 3). Species richness was highest in qualitative multihabitat samples. Richness in quantitative targeted riffle samples was greatest at MEVEMAN02 and greatest in qualitative samples from MEVEMAN01 (Figure 4).

Taxonomic diversity as calculated using the Simpson's Diversity Index was slightly higher in samples collected from MEVEMAN01 samples. Functional group diversity was slightly greater in samples collected from MEVEMAN02 (Figure 5).

Ecological tolerance describes how well a taxon tolerates disturbance. Tolerant taxa were collected from only one riffle sample in MEVEMAN02, and were not found in any sample collected from MEVEMAN02. Richness of moderately tolerant and intolerant species did not differ greatly between sites. Abundance was dominated by moderately tolerant organisms. Moderately tolerant organisms made up 82% of the organisms collected from MEVEMAN02, and 76% of MEVEMAN01(Figure 6).

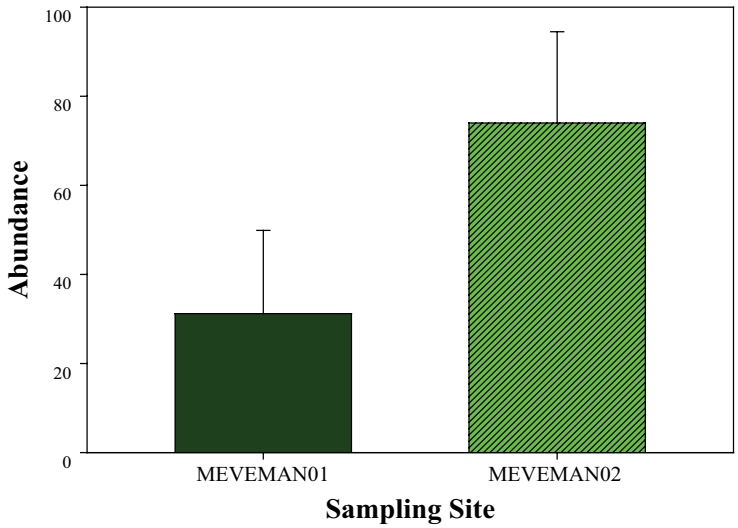

Figure 3. Total abundance of macroinvertebrate samples collected from quantitative samples in the Mancos River. Abundance is expressed as the mean number of individuals per quantitative targeted riffle habitat.

Table 2. Summary of macroinvertebrate metrics based on samples collected in the Mancos River. 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.

Qualitative Multihabitat	MEVEMAN01	MEVEMAN02
Metric		
Taxa Richness	19.00	10.00
Percent Richness of Tolerant Taxa	16.67	11.11
Percent Richness of Filterer-Collectors	16.67	20.00
Percent Richness of Scrapers	0.00	0.00
Number of EPT Taxa	7.00	4.00
Percent Richness of EPT Taxa	36.84	40.00
Percent Richness of Ephemeroptera	21.05	30.00
Percent Richness of Plecoptera	0.00	0.00
Precent Richness of Trichoptera	15.79	10.00
Percent Richness of Non-Insect Taxa	21.05	20.00
Percent Richness of Chironomids	10.53	10.00

Quantitative Targeted Riffle Habitat	Mean	Std Dev	Mean	Std Dev
Total Abundance	24.96	14.93	59.20	16.39
Taxa Richness	5.20	0.84	6.60	1.34
Simpson's Diversity Taxonomic	0.67	0.06	0.61	0.06
Simpson's Diversity Functional Group	0.38	0.07	0.50	0.40
Dominant Taxa	0.56	0.05	0.59	0.06
Relative Abundance Tolerant Taxa	0.00	0.00	0.16	0.36
Percent Richness Tolerant Taxa	0.00	0.00	2.86	6.39
Relative Abundance Filterer-Collector	32.58	25.19	32.95	7.82
Percent Richness of Filterer-Collector	31.33	12.38	31.33	6.39
Relative Abundance of Scrapers	0.00	0.00	0.45	1.02
Number of EPT Taxa	58.00	13.04	52.17	14.04
Relative Abundance of EPT Taxa	73.51	16.87	73.37	12.52
Relative Abundance of Ephemeroptera	59.43	18.82	59.04	8.10
Relative Abundance of Plecoptera	0.00	0.00	3.00	2.17
Relative Abundance of Trichoptera	14.08	4.69	11.33	7.95
Percent Tolerant Trichoptera	100.00		100.00	
Relative Abundance Non-insect Taxa	3.93	4.27	1.43	0.90
Relative Abundance of Chironomids	9.04	7.45	3.13	2.57

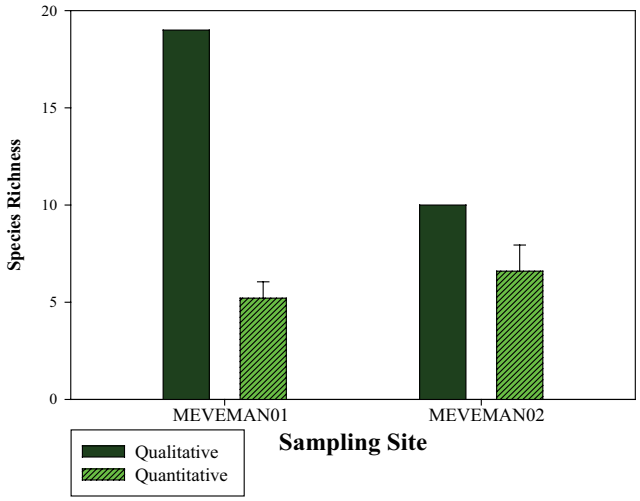

Figure 4. Mean species richness in qualitative multihabitat samples and quantitative targeted riffle samples collected in the Mancos River.

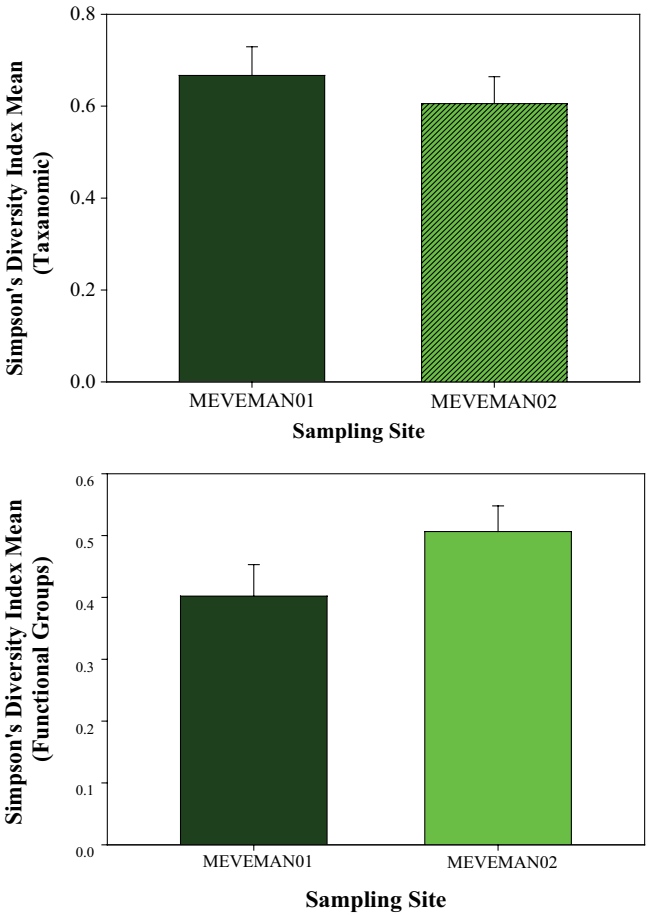

Figure 5. Simpson's Diversity Index for Taxonomic Diversity (upper) and Functional Feeding Diversity (lower) for quantitative targeted riffle samples collected in the Mancos River. Values are expressed as means of all samples collected from each site.

EPT taxa were dominated by Ephemeroptera (mayflies) taxa. Sixty percent of the EPT taxa collected from both sites were Ephemeroptera. Plecopterans (stoneflies) were absent from MEVEMAN01 samples and made up only 3% of MEVEMAN02 samples (Figure 7). In addition, Ephemeropteran taxa were the most abundant taxa of any order found in either sampling site (Figure 8).

Collector-Gatherer taxa were the most abundant functional feeding group sampled at either site. Very few scrapers were present and no shredder taxa were present in samples collected from the Mancos River (Figure 9).

Summary of physical habitat characteristics

The SCPN macroinvertebrate protocol calls for physical habitat data to be collected along 11 transects and at each of the 5 targeted riffle habitats. During the 2007 sampling event we were only able to collect physical habitat data from 7 of the 11 transects at each site because of storm activity in the area. Additionally, the storms resulted in a rapid rise in flow preventing us from collecting reach characterization data from MEVEMAN01 site. A summary of these data are presented in Table 3 and the entire data set is included in Appendix B.

Stream velocity and depth did not differ between sampling reaches. Targeted riffle data suggests that embeddedness increased as we moved from the upstream reach to the downstream reach, increasing by 9 % (Table 3). Both sampling reaches were dominated by particles in the fine sand to small gravel particle size classes. Particles in these size classes accounted for 81% of the substrate sampled from MEVEMAN01 and 77% of the substrate sampled from MEVEMAN02 (Figure 10). We found little diversity among macroinvertebrate habitat cover in either sampling reach. Both sites were dominated by rock (MEVEMAN01 - 85.7%;

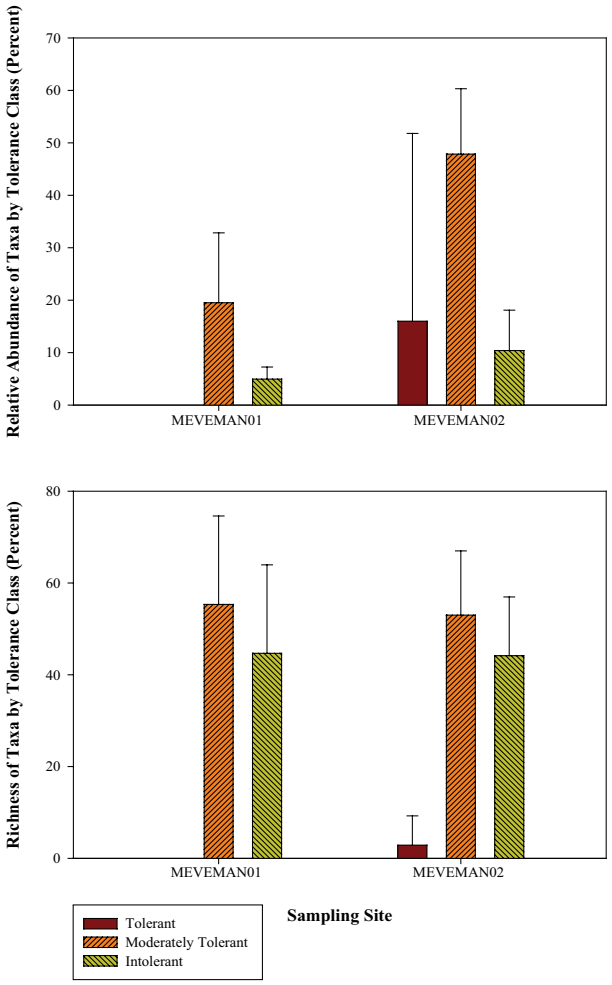

Figure 6. Mean relative abundance (upper figure) and richness (lower figure) of taxa based on taxa tolerance to perturbation.

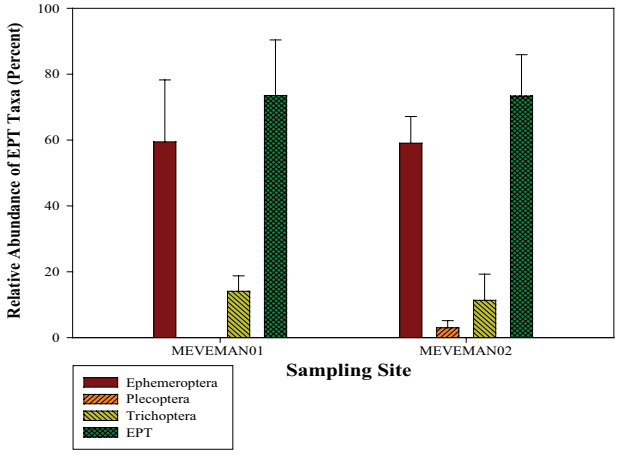

Figure 7. Mean abundance of Ephemeropteran (mayflies), Plecopteran (stoneflies), and Trichopteran (caddisfly) species. The last bar (EPT) represents the total relative abundance of all three orders.

MEVEMAN02 - 71.4%) with a small amount of woody debris (4%) found at MEVEMAN02. Rock was the only suitable habitat cover sampled from MEVEMAN01 (Figure 11).

The MEVEMAN02 sampling reach was dominated by riffles and runs. No other geomorphic channel units (GCU's) were present. For a complete description of GCU's see Appendix D in Brasher et al. (2009).

Streamflow and Climatic conditions

Streamflow data are collected at the USGS gaging station at Anitas Flat just inside the park boundary (Figure 12). Climate data are collected at the town of Mancos, CO, approximately 12.5 km upstream of the gaging station along the Mancos River, and at the Mesa Verde National Park headquarters, approximately 14 km southeast of the gaging station on an escarpment above the river. Precipitation was mostly lower than average through August 2007 at Mancos, CO while precipitation was mostly above average on the Mesa Verde cuesta through spring and summer (Figure 13). Temperatures were close to average at both Mancos and Mesa Verde National Park during the recorded period of 2007 (Figure 14). Precipitation and temperature data are available from the Western Regional Climate Center (www.wrcc.dri.edu).

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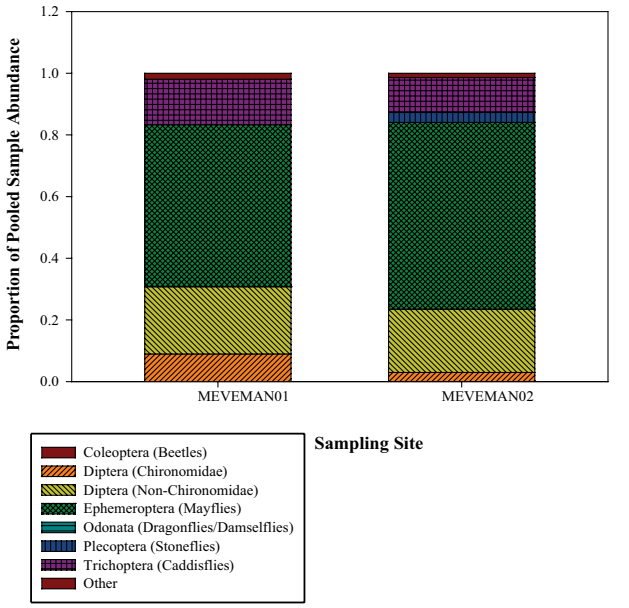

Figure 8. Proportion of individuals (by Order) of quantitative targeted riffle samples collected from the Mancos River.

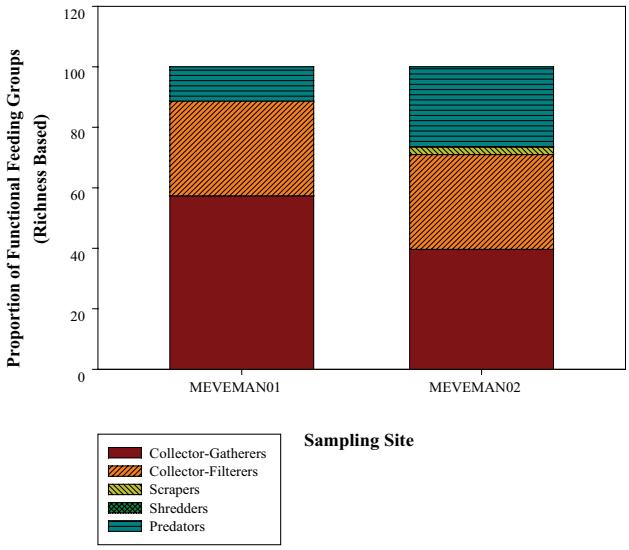

Figure 9. Proportion of functional feeding groups of quantitative targeted riffle samples based on richness.

Table 3. Summary of physical habitat transect data in the Mancos River, 2007**.** Wetted and active channel measurements are expressed as widths. Embeddedness and canopy closure measurements are expressed as percentages. Channel dimension and riparian cover means for both sampling reaches represent transects SCPN staff were able to obtain during the sampling event. It does not represent a complete data set of habitat characteristics as prescribed by SCPN protocols. Microhabitat represents data collected from targeted riffle habitat.

	MEVEMAN01		MEVEMAN02	
	Mean	**Std Dev**	**Mean**	**Std Dev**
Channel Dimensions				
Velocity (m/s)	0.68	0.32	0.63	0.32
Depth (m)	0.30	0.14	0.31	0.14
Wetted Channel (m)	5.71	2.11	6.37	2.35
Active Channel (m)	7.49	2.16	10.28	4.34
Microhabitat				
Velocity (m/s)	0.69	0.27	0.91	0.20
Depth (m)	0.18	0.07	0.15	0.05
Substrate Size (mm)	9.08	3.37	9.19	3.93
Embeddedness	19.20	16.75	28.00	17.32
Riparian Cover				
Canopy Closure	8.96	5.23	14.28	11.91

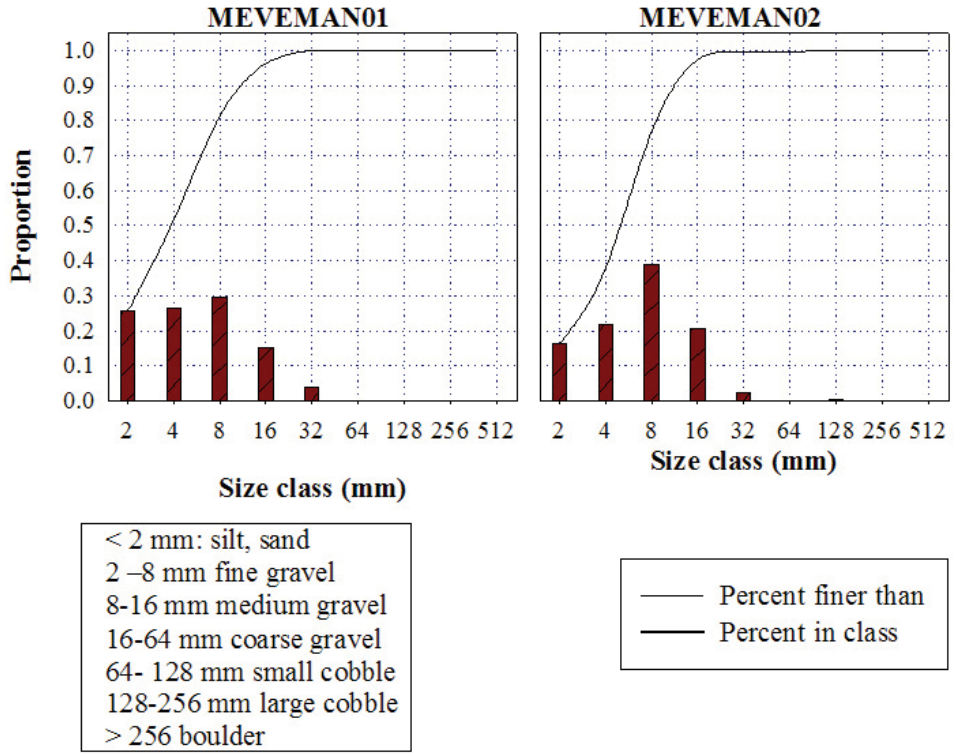

Figure 10. Particle size distribution, based on modified Wolman pebble counts, among macroinvertebrate sampling reaches in the Mancos River, 2007. Percent finer than shows cumulative proportion of sediments finer than size class. Bars represent percent sediments in class.

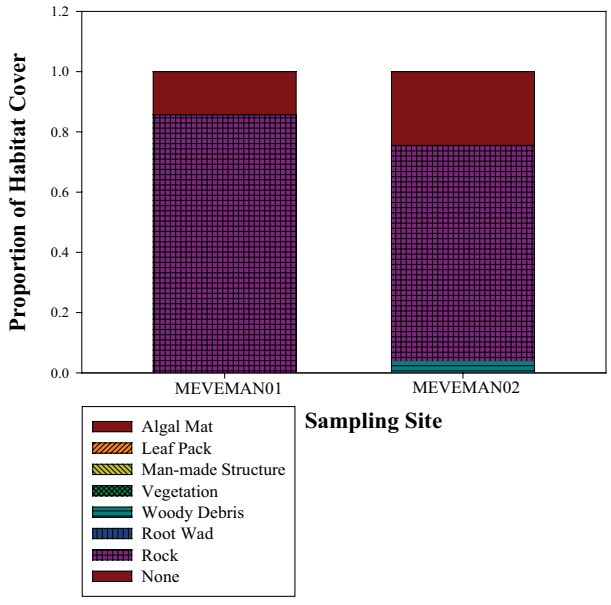

Figure 11. Proportion of macroinvertebrate habitat cover found in sampling reaches along the Mancos River.

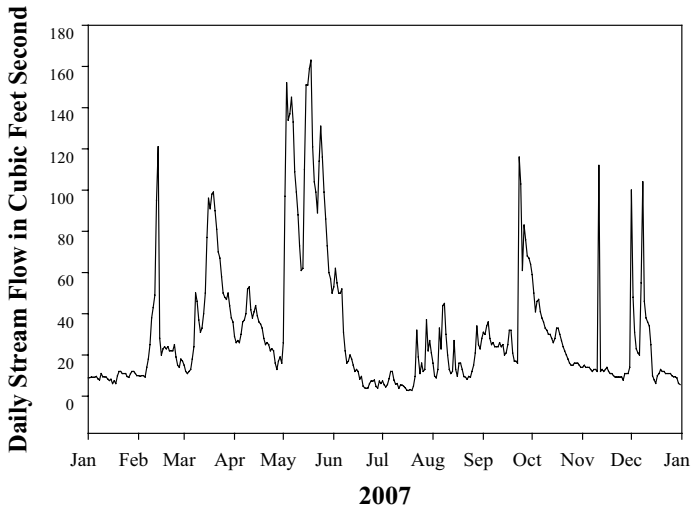

Figure 12. Hydrograph from the streamflow gaging station Mancos River at Anitas Flat, Mesa Verde National Park, CO (09370600) showing streamflow for 2007.

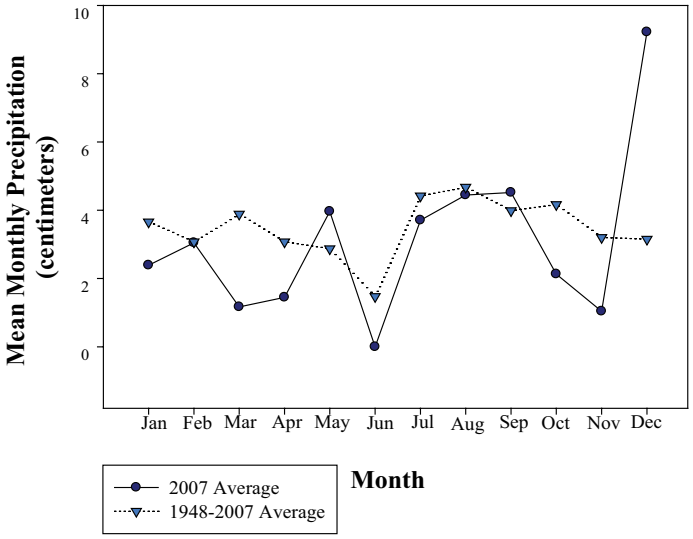

Figure 13. Average monthly precipitation (cm) for 2007 and for the period 1948-2007 at Mancos, CO.

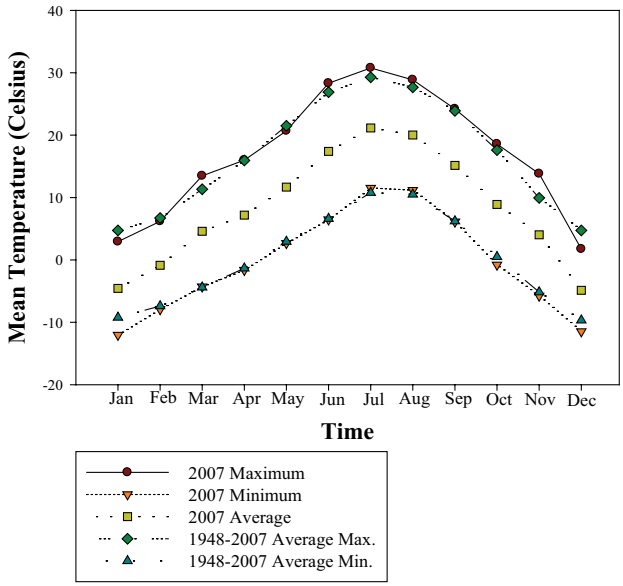

Figure 14. Average monthly temperature. Monthly average maximum and minimum temperatures (°C) from 1948-2007 and monthly minimum, maximum, and average temperature averages for 2007 at Mancos, CO.

Discussion

This report presents data from SCPN's first year of monitoring macroinvertebrates and physical habitat at the Mancos River in Mesa Verde National Park, CO.

Physical habitat data collected at transects in aquatic macroinvertebrate sampling reaches on the Mancos River are incomplete for the 2007 monitoring year. Transects 5, 7, 9, and 11 from MEVEMAN02 were not sampled due to the interruption of sampling efforts by a severe weather system. Transects 8-11 from MEVEMAN01 were not completed due the occurrence of a flash flooding event during sampling.

Data from transects sampled showed very little diversity in macroinvertebrate habitat types or geomorphic channel units within each reach. Mean velocity and depth measurements taken along transects from both reaches differed by 5% and 1 % respectively between sampling reaches, suggesting that the sampling reaches selected are very homogeneous in substrate type and flow. Grain size was more diverse throughout the two sampling reaches, with substrate categories ranging from finer sediments (<2 mm) up to very coarse gravels (32 mm) in both. Microhabitat data suggests that embeddedness increased as we moved from the upstream reach to the downstream reach.

These findings correspond to the findings of Stacey (2007) and Joyal and Anderson (2008), who state that the increase downstream reaches is most likely the result of sediment inflows from nearby tributaries.

Homogeneity in habitat throughout the two sampling reaches may explain the relatively low taxa richness found in both quantitative and qualitative samples. Although taxonomic diversity is relatively high, dominant taxa data suggests that abundance was weighted towards the most dominant taxa found in quantitative samples.

Ecological tolerance describes how well a taxon 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 be intolerant are expected to decline quickly as water quality degrades. Conversely, tolerant taxa would be expected to persist during times of degraded water quality. We found very few tolerant taxa in either the qualitative or quantitative samples (Figure 6). Although richness of moderately tolerant and intolerant taxa was somewhat high, abundance for most was quite low. These data suggest that any disturbance or degradation in water quality has the potential to impact the aquatic community through declines in both diversity and abundance of macroinvertebrate taxa.

Factors potentially affecting aquatic communities

Many factors could be contributing to a depauperate aquatic community in the Mancos River. Upstream management actions in 2007 may have affected conditions along the Mancos River. In 2000 the Bircher Fire burned several thousand acres on the East Escarpment of Mesa Verde within the Mancos River watershed. Stacey (2007) recognized increased sediment loads in the river as a result of the Bircher Fire. Aquatic macroinvertebrate and native fish populations were severely reduced following the fire. A reintroduction program for roundtail chub (*Gila robusta*) is currently underway through a cooperative effort between the Colorado Division of Wildlife, Ute Mountain Ute Tribe, and Mesa Verde National Park. Beginning in 2003 the Colorado Division of Wildlife provided 1,000 round tail chub fingerlings to Mesa Verde National Park to release into the Mancos River; another several thousand of these fish were provided to the Ute Mountain Ute Tribe for release below the park boundary.

Upstream of the park boundary the Mancos River flows through agricultural land where it is diverted for irrigation and is potentially subject to anthropogenic inputs of nutrients and pesticides, which could have a negative effect on the aquatic community (Colyer 2005, unpublished).

The Mancos Conservation District removed Russian olive (*Elaeagnus angustifolia*) from a one mile stretch of river bottom about three river miles upstream from the park boundary, potentially affecting sediment loads and channel morphology. Several irrigation ditches were enclosed in pipelines to decrease ground water salinization, including Beaver Ditch, Sheek Ditch, Bowen Ditch, Number Six Ditch, Coppinger Ditch, Bauer Lake Ditch and Koppenhaffer/Walcott Ditch. Ten river miles were put under conservation easements by private landowners and the Montezuma Land Conservancy. Private preserves were created in two upper forks of the Mancos River to protect new beaver colonies moving into the area (Colyer 2005. unpublished).

Park resource managers have been active within the reach of the Mancos River included within the park. Local ranchers grazed cattle in the park up until 1998. At that time livestock were removed from the Mancos River canyon and fences at the north and south boundaries were repaired to reduce or prevent future entry of cattle to the park. Grazing has not been permitted in the park during the past ten years, however, trespass livestock have been noted within the park during SCPN sampling visits. Any of these factors or combination of factors may be contributing to the poor condition of the macroinvertebrate community.

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Appendix A

Aquatic macroinvertebrate taxa collected in the Mancos River, 2007

Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Annelida	Oligochaeta						Segmented Worms
Arthropoda	Malacostraca	Amphipoda	Amphipoda	Hyalellidae	Hyalella		Gammarid Amphipod
Arthropoda	Insecta	Coleoptera	Coleoptera	Elmidae	Optioservus		Riffle Beetles
Arthropoda	Entognatha	Collembola	Collembola				Springtails and allies
Arthropoda	Malacostraca	Decapoda	Decapoda	Cambaridae			Crayfish
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges
Arthropoda	Insecta	Diptera	Diptera	Chironomidae			Midges
Arthropoda	Insecta	Diptera	Diptera	Empididae	Hemerodromia		Dance Flies
Arthropoda	Insecta	Diptera	Diptera	Empididae	Chelifera		Dance Flies
Arthropoda	Insecta	Diptera	Diptera	Simuliidae	Simulium		Black Flies
Arthropoda	Insecta	Diptera	Diptera	Simuliidae	Simulium	arcticum	Black Flies
Arthropoda	Insecta	Diptera	Diptera	Tabanidae			Horse Flies
Arthropoda	Insecta	Diptera	Diptera	Tipulidae	Hexatoma		Crane Flies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Acentrella		Small Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Acentrella	insignificans	Small Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Baetis		Small Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Baetidae	Fallceon	quilleri	Small Minnow Mayflies
Arthropoda	Insecta	Ephemeroptera	Ephemeroptera	Leptohyphidae	Tricorythodes		Mayfly
Arthropoda	Insecta	Heteroptera	Heteroptera	Leptohyphidae	Microvelia		Mayfly
Arthropoda	Insecta	Heteroptera	Heteroptera	Veliidae	Rhagovelia		Water Striders
Arthropoda	Insecta	Odonata	Odonata	Gomphidae	Ophiogomphus	severus	Clubtailed Dragonflies
Arthropoda	Insecta	Plecoptera	Plecoptera	Perlodidae			Stoneflies
Phylum	Class	Order	SubOrder	Family	Genus	Species	Common Name
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydropsychidae	Hydropsyche		Netspinning Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydropsychidae	Cheumatopsyche		Netspinning Caddisflies
Arthropoda	Insecta	Trichoptera	Trichoptera	Hydroptilidae			Microcaddisflies
Arthropoda	Arachnida	Trombidiformes	Trombidiformes	Sperchontidae	Sperchon		Water Mite

Appendix B

Physical habitat data collected at the Mancos River in 2007.

	Velocity (m/s)		Depth (m)		Wetted	Active
	Mean	**Std Dev**	**Mean**	**Std Dev**	**Channel (m)**	**Channel (m)**
MEVEMAN01						
1	0.61	0.10	0.16	0.06	8.60	10.30
2	0.60	0.11	0.24	0.07	6.80	9.40
3	0.51	0.12	0.20	0.10	7.10	8.50
4	0.45	0.10	0.32	0.16	6.70	8.10
5	0.82	0.26	0.34	0.09	4.10	5.20
6	0.67	0.43	0.45	0.19	2.90	4.60
7	1.12	0.42	0.35	0.13	3.80	6.30
MEVEMAN02						
1	0.92	0.49	0.38	0.18	3.60	8.50
2	0.38	0.27	0.26	0.18	11.00	18.50
3	0.74	0.29	0.24	0.24	5.60	7.80
4	0.67	0.16	0.36	0.08	5.30	7.35
6	0.63	0.13	0.19	0.04	7.61	9.10
8	0.42	0.12	0.47	0.04	5.60	7.30
10	0.64	0.38	0.27	0.05	5.90	13.40