



Aquatic Macroinvertebrate and Physical Habitat Monitoring for the Mancos River in Mesa Verde National Park

2014 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2016/1061



ON THE COVER

The Mancos River in Mesa Verde National Park
Photography by NPS

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Stacy E. Stumpf

National Park Service
Southern Colorado Plateau Network
P.O. Box 5663
Flagstaff, Arizona 86011-5663

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change. Please direct any data requests to the water resources project manager or the SCPN data manager.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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1 Introduction

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a scientific foundation for making decisions and working with other agencies and the public to protect park ecosystems.

Water-related vital signs are the fundamental components defining overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified 7 vital signs pertaining to riparian and spring ecosystems, the first two of which we focus on in this report: 1) aquatic macroinvertebrates, 2) stream water quality, 3) stream flow and depth to groundwater, 4) spring water quality, 5) fluvial geomorphology, 6) riparian vegetation, composition, and structure, and 7) spring ecosystems. These vital signs are closely related and are all included in the Vital Signs Monitoring Plan for the Southern Colorado Plateau Network (Thomas et al. 2006). The context and ecological significance of these vital signs are further explained in Scott et al. (2005).

The Mancos River in Colorado flows along approximately 6 km of Mesa Verde National Park's (MEVE) eastern boundary and is adjacent to a checkerboard of federal, state, and private lands. Water is diverted upstream from the park for irrigation, and flow in the river has been partially regulated by Jackson Gulch Reservoir since 1949. Several streamflow gaging stations are located on the Mancos River in and near MEVE. The U.S. Geological Survey (USGS) streamflow gaging station, #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 the Ute Indian Reservation. The state of Colorado has a streamflow gaging station, MANMANCO, 15 km upstream of the park, near the town of Mancos.

Little information is available describing the condition of Mancos River aquatic ecosystems in MEVE. T-Walk sampling in the early 2000s (Colyer 2005) and a functional assessment of the Mancos River (Stacey 2007) both suggested the river was in poor condition. In 2007 the SCPN implemented annual monitoring of aquatic macroinvertebrates and physical habitat at 2 sites (see Appendix A for list of locations, codes, and common names of monitoring sites) on the Mancos River in MEVE (Stumpf and Monroe 2009).

Mancos River at Gage (MEVEMAN01), identified in this report as MAN01, was first sampled in 2005 and 2006 by the USGS as part of a pilot study designed to support development of the Aquatic Macroinvertebrate Monitoring Protocol for the Southern Colorado Plateau Network (Brasher et al. 2011). The site was established as an index site, valuable for its co-location with a USGS streamflow gaging station (USGS 09370600 in Figure 1). The SCPN water quality monitoring site was later established at the same site.

Mancos River above Downstream Boundary (MEVEMAN02), identified in this report as MAN02, was sampled for the first time in 2007. This site was also established as a Generalized Random Tesselation Stratified (GRTS) site, with the goal of achieving spatial variability along the river, as well as meeting habitat criteria and accessibility considerations. It is located on a large meander bend near the downstream park boundary (Figure 1).

Three main vegetation communities exist along the Mancos River: the Coyote Willow/Mesic Forb Shrubland, located directly along the banks of the Mancos River; the Narrowleaf Cottonwood-Rocky Mountain Juniper Woodland, occurring on the floodplains adjacent to the active river channel; and the Lanceleaf Cottonwood Riparian Woodland, located adjacent to the river in low lying areas. For a detailed description of these vegetation communities, please refer to Thomas et al. (2009).

This report documents SCPN's aquatic macroinvertebrate monitoring activities in the Mancos River at MEVE in 2014, summarizes the data collected, and, where appropriate, places the data in the context of current environmental conditions.

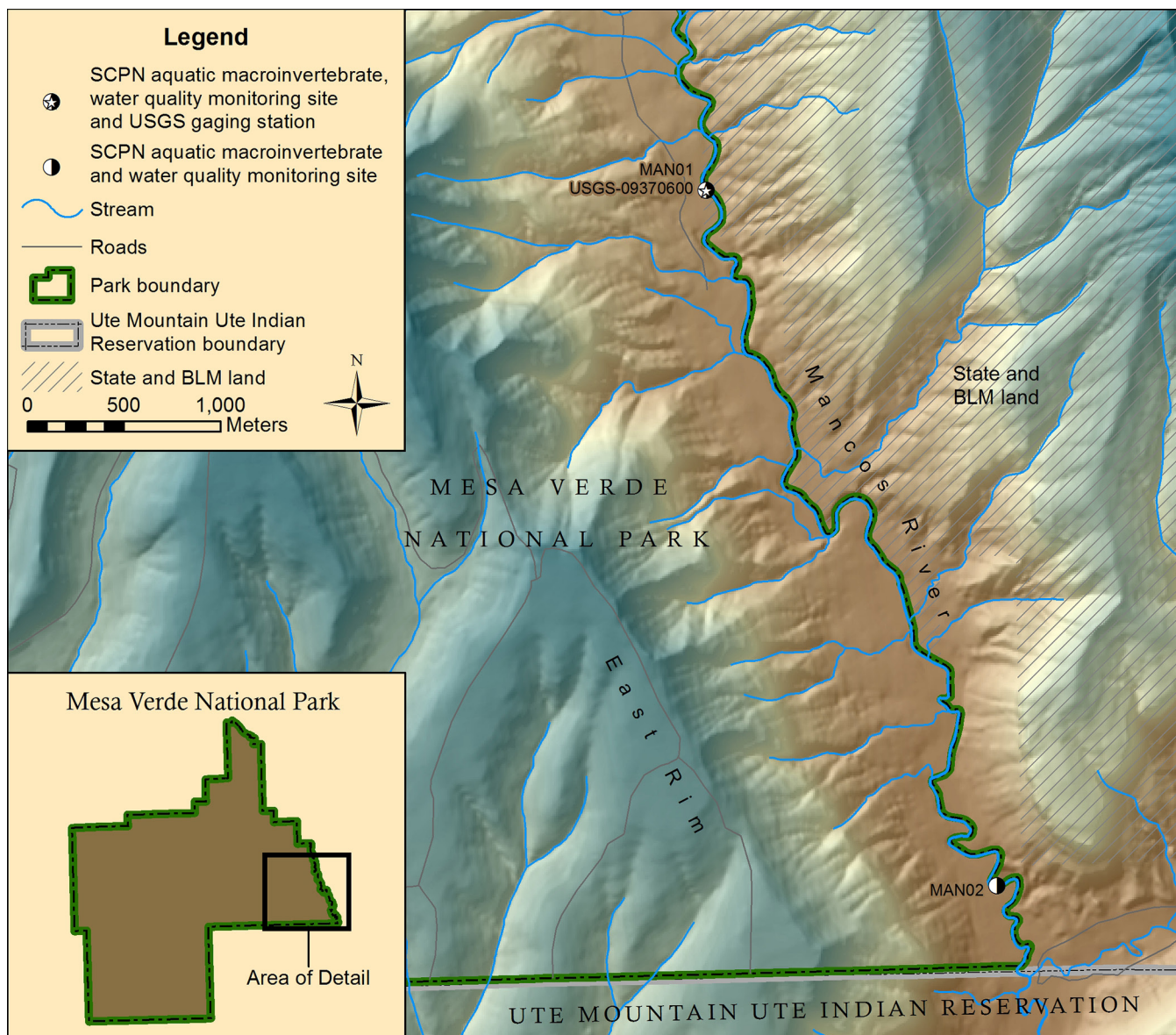


Figure 1. Map of Mesa Verde NP, Colorado, showing the location of the 2 monitoring sites, MAN01 and MAN02, on the Mancos River in 2014.

2 Methods

2.1 Field methods

The state of Colorado recommends collecting aquatic macroinvertebrate samples during baseflow conditions, which typically occur in late summer to fall for mountain streams, but does not provide a recommendation for xeric streams (Colorado Department of Public Health and Environment 2003). Xeric streams in Colorado that are above 1,500 m in elevation are faunistically similar to mountain streams (Paul et al. 2005), and therefore should be sampled during the late summer/early fall.

From 28-29 October 2014, the SCPN water resources field crew collected aquatic macroinvertebrate samples and physical habitat data at 2 monitoring sites—MAN01 and MAN02—on the Mancos River in MEVE. The monitoring sites consist of a 150 m reach, divided into 11 transects that are spaced 15 meters apart (Figure 2). A detailed description of aquatic macroinvertebrate sampling methods can be found in Brasher et al. (2011).

We collected 2 types of aquatic macroinvertebrate samples at MAN01 and MAN02 in 2014:

- Replicate quantitative samples were collected from 5 targeted riffle habitats to provide estimates of abundance of organisms. We used a Slack sampler to collect a timed sample from a 0.25 m² area at each targeted riffle.
- A qualitative sample was collected to develop a comprehensive list of species present at the site. We used a Slack sampler to collect samples from all habitat types within the monitoring site, which we then compiled into one composite sample.

We collected physical habitat data at 3 spatial scales—microhabitat, transect, and reach:

- For each of the targeted riffle microhabitats where quantitative samples are collected we measured
 - depth
 - velocity
 - substrate particle size
 - substrate particle embeddedness

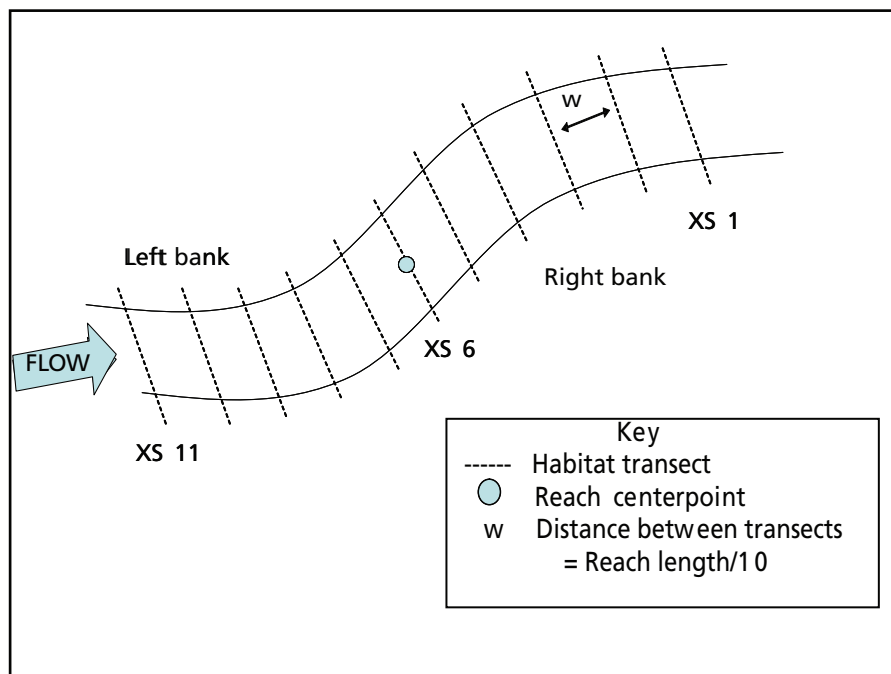


Figure 2. General aquatic macroinvertebrate sampling reach layout.

- For each of the 11 transects, we
 - measured wetted and active channel widths
 - estimated canopy closure at both ends and at the center of each transect
 - measured water depth and velocity at 5 equally spaced points along each transect
 - observed and recorded the presence or absence, and types, of aquatic macroinvertebrate habitats represented by point data (5 points/transect) across the entire site
 - identified and recorded geomorphic channel units (GCU) at 5 equally spaced points along each transect
- For the entire reach, we
 - identified and measured the length of GCUs (the proportion of the reach representing each GCU)
 - identified the dominant vegetation and land cover
 - recorded descriptions of flow conditions
 - recorded weather conditions
 - observed and recorded evidence of anthropogenic or natural disturbances
 - measured NPS core water quality parameters of temperature, specific conductance, pH, dissolved oxygen, turbidity, and stream discharge
 - conducted a zig-zag pebble count measuring the size of a minimum of 400 randomly-selected particles using a modified Wolman pebble count across the length of the entire site (this reach-based pebble count method differs from transect-based methods conducted by SCPN in 2007–2008)

2.2 Hydrologic data collection

In addition to our own SCPN air and water temperature measurements, hydrologic data presented in this report were collected at the USGS streamflow gaging station on the Mancos River, *Mancos River at Anitas Flat* (09370600), for the period 09 February through 23 December 2014 (USGS 2015).

2.3 Laboratory methods

Aquatic macroinvertebrate samples were sent to the National Aquatic Monitoring Center's Bug Lab, a Bureau of Land Management laboratory at Utah State University in Logan, Utah. Samples were sorted under a dissecting scope at 10X magnification, and a 500-organism, fixed-count method was used for subsampling large samples. Ten percent of the sorted samples were re-sorted for quality assurance.

A taxonomist certified by the North American Benthological Society identified all aquatic macroinvertebrates to the family or genus level. To ensure data quality, 10 percent of the identified samples were re-identified by a second certified taxonomist.

Quantitative and qualitative aquatic macroinvertebrate samples will be maintained by the contract aquatic laboratory for at least 5 years to allow for repeat subsampling should any data questions arise. For a more detailed description of laboratory methods, see Brasher et al. (2011).

2.4 Data analysis

In this report we summarize aquatic macroinvertebrate data in terms of community structure and function. Genera were classified into functional feeding guilds using the classifications presented in Barbour et al. (1999). If functional class information was not available for a particular genus, we applied a more generalized, family-level classification.

For quantitative aquatic macroinvertebrate data, we calculate means and standard deviations from the 5 replicate

samples collected. For those parameters measured along transects (such as habitat characterization), we calculate means and standard deviations from the 7 to 11 transect values.

We selected aquatic macroinvertebrate metrics that are generally considered to be sensitive, reliable indicators of water quality and/or stream health (see Appendix B for a table of metrics and their definitions). Most of these metrics have been used to detect changes in water quality and habitat conditions in other streams in the Southern Rocky Mountains ecoregion (Griffith et al. 2005). Also, they enable a comprehensive assessment of multiple aspects of community structure because they represent a range of ecological characteristics. SCPN will periodically evaluate the interpretive value of the listed metrics and may drop or add additional metrics based upon these evaluations.

3 Results

3.1 Aquatic macroinvertebrate community data

We present key metrics calculated from sampling aquatic macroinvertebrate communities on 29 October 2014 at MAN01 and 28 October 2014 at MAN02, with data collected from 2007 to 2012. Data were not collected during 2013 due to the U.S. federal government shutdown from October 1–16. Figures in this section refer to quantitative data unless otherwise noted, and error bars represent one standard deviation from the mean. All corresponding data values are available in Appendix D (Tables D1–D3). Appendix C lists all aquatic macroinvertebrate species detected at the sites, from both quantitative and qualitative methods.

Abundance. Abundance values for targeted riffle habitat samples averaged 299.80 individuals at MAN01 in 2014 (Figure 3). Abundance for samples collected at MAN01 ranged from a low of 197 to a high of 645. Abundance at MAN02 averaged 66.00 individuals, with sample abundances ranging from 38 to 115.

Taxa richness. Richness for quantitative samples collected at MAN01 ranged from 8 to 13 taxa and averaged 10.60 in 2014 (Figure 4). At MAN02, richness for quantitative samples ranged from 8 to 10 taxa and averaged

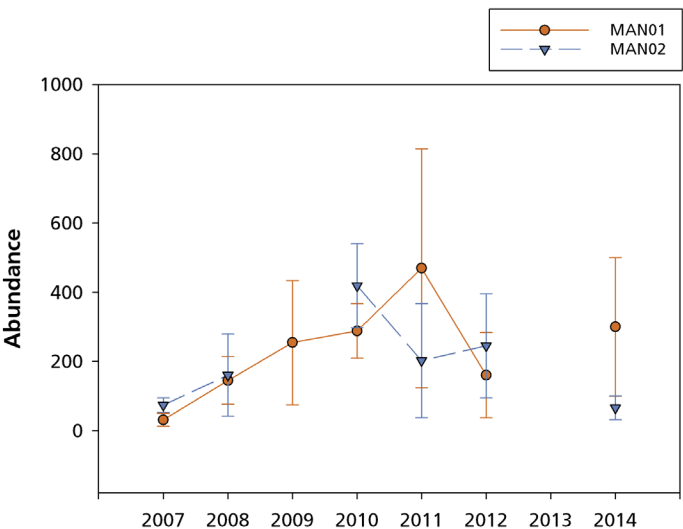


Figure 3. Aquatic macroinvertebrate abundance in quantitative samples from MAN01 and MAN02 at the Mancos River in Mesa Verde NP, 2007–2014. No data were collected at MAN02 in 2009. Error bars represent one standard deviation from the mean.

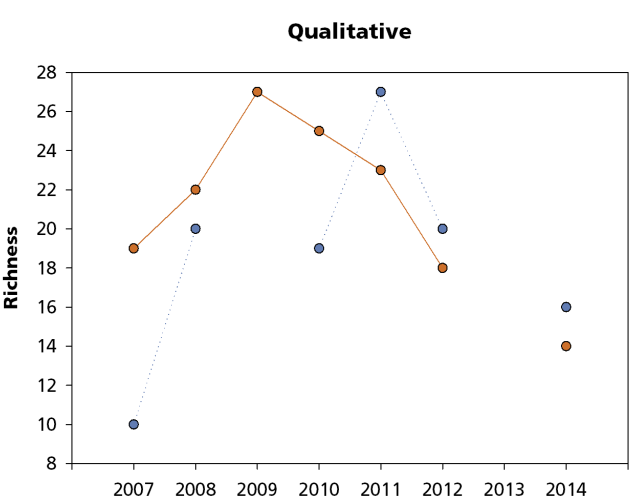
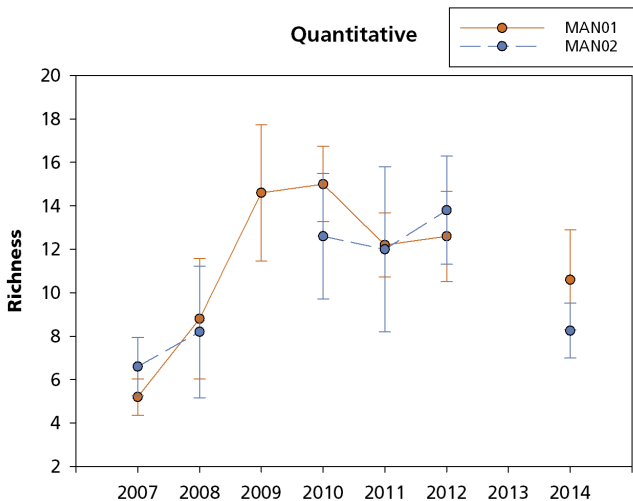


Figure 4. Taxa richness of aquatic macroinvertebrates in quantitative (left) and qualitative samples (right) from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected at MAN02 in 2009, or at either site in 2013. Error bars represent one standard deviation from the mean.

8.25. Richness of qualitative samples was 14 taxa at MAN01 and 16 taxa at MAN02 (Figure 4).

Diversity. We measured taxonomic and functional diversity using the Simpson's Diversity Index. Taxonomic diversity averaged 0.70 at MAN01 and 0.79 at MAN02 in 2014 (Figure 5). Functional diversity averaged 0.54 at MAN01 and 0.62 at MAN02 (Figure 5).

Stress tolerance. Taxa which are moderately tolerant to disturbance dominated the samples collected from MAN01 in 2014, with an average relative abundance of 82.19% (Figure 6). Intolerant individuals were the second most abundant at MAN01, with an average relative abundance of 17.81%. No tolerant individuals were found at MAN01 in 2014.

At MAN02, moderately tolerant individuals were the most abundant in 2014, with relative abundance averaging 70.26% (Figure 6). Intolerant taxa were the next most abundant at MAN02, averaging 29.74% of the individuals per sample. No tolerant taxa were found at MAN02 in 2014.

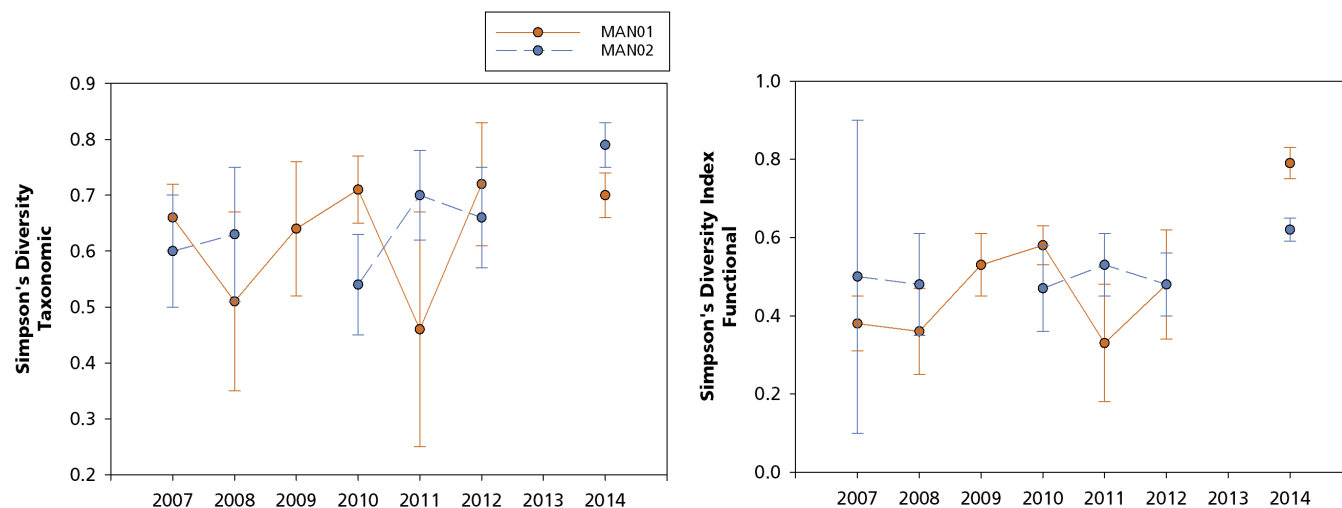


Figure 5. Taxonomic (left) and functional (right) diversity in quantitative samples from MAN01 and MAN02 at the Mancos River, in Mesa Verde NP, 2007–2014. No data were collected at MAN02 in 2009, or at either site in 2013. Error bars represent one standard deviation from the mean.

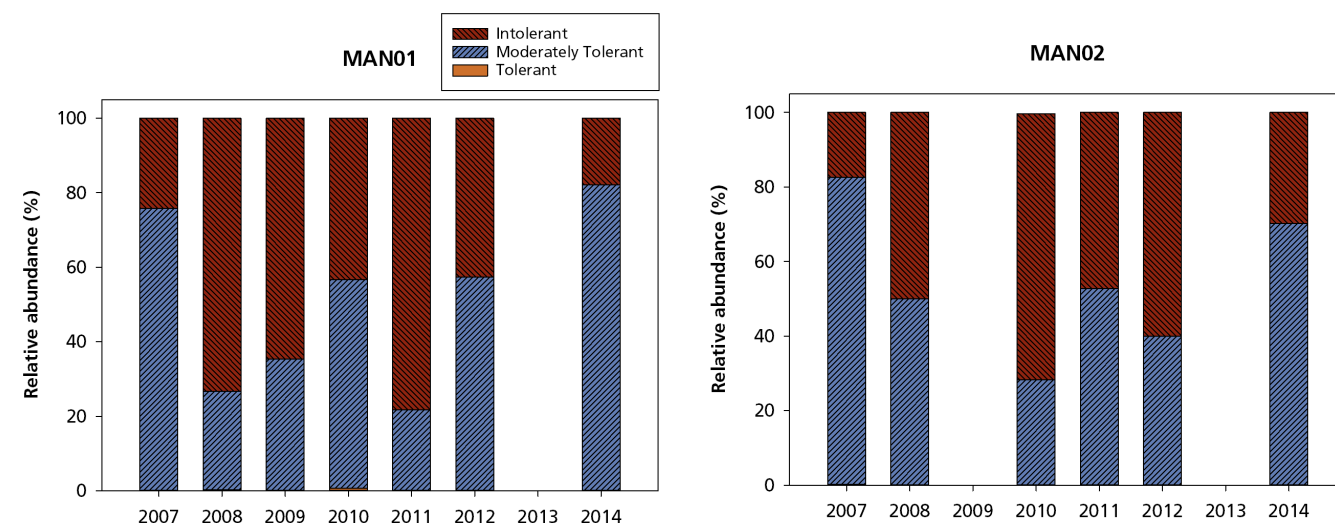


Figure 6. Mean relative abundance of aquatic macroinvertebrates by tolerance group in quantitative samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected at MAN02 in 2009, or at either site in 2013. In all 5 years, tolerant taxa never comprised more than 1% of the samples.

EPT taxa. EPT taxa (Ephemeroptera – mayflies, Plecoptera – stoneflies, and Trichoptera - caddisflies) are sensitive to aquatic degradation. In 2014, Trichoptera had the highest relative abundance of sensitive EPT taxa at MAN01 (Figure 7), averaging 16.44% of the individuals collected from the site. Ephemeroptera were the second most abundant, averaging 10.73%. Few Plecoptera were collected from MAN01, with abundance at 0.81%.

At MAN02, Trichoptera were the most abundant EPT taxa collected in 2014, averaging 18.24% of the individuals collected from quantitative targeted riffle samples (Figure 7). Relative abundance of Ephemeroptera and Plecoptera at MAN02 averaged 11.42% and 10.29%, respectively.

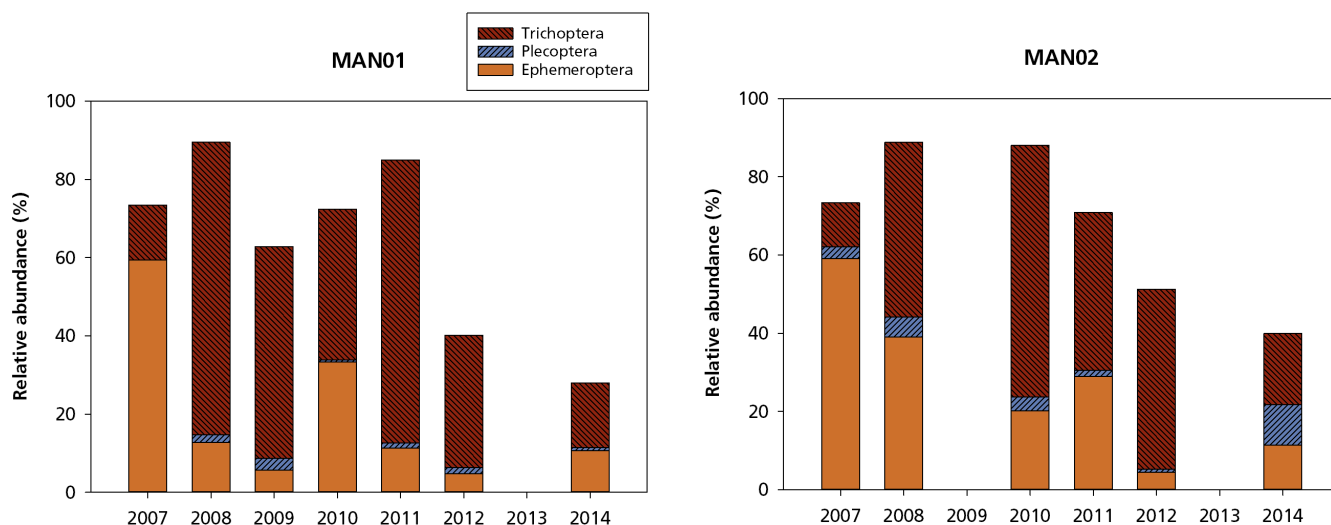


Figure 7. Mean relative abundance of aquatic macroinvertebrates belonging to sensitive EPT orders in quantitative samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected from MAN02 in 2009, or at either site in 2013.

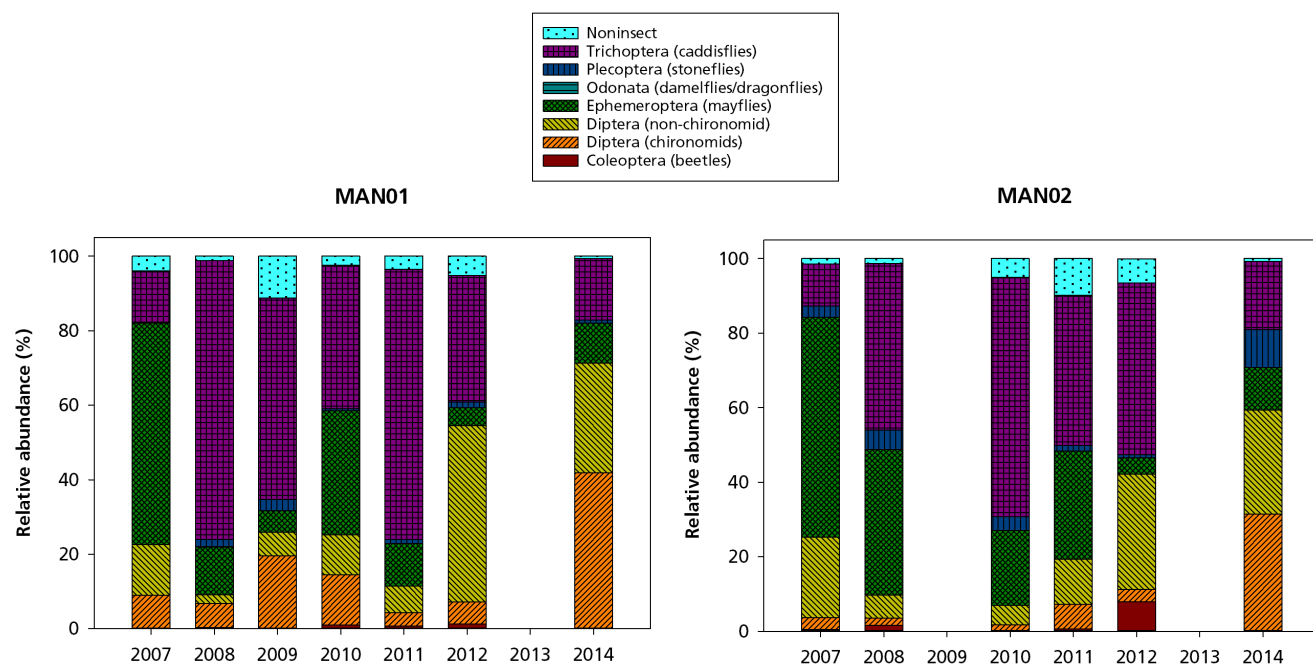


Figure 8. Mean relative abundance by taxonomic order in quantitative aquatic macroinvertebrate samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected from MAN02 in 2009, or at either site in 2013. In all 5 years, Odonates never comprised more than 1% of the samples.

Aquatic macroinvertebrate orders. In 2014, Chironomidae (midges) was the most abundant order at MAN01, at 41.78% of the individuals collected (Figure 8). Non- Chironomidae Diptera (flies) comprised 29.43%, and noninsect taxa 0.66%.

Coleoptera (beetles) was the least abundant order at MAN01, at 0.14%. No individuals in the order Odonata (dragonflies/damselflies) were collected at MAN01 in 2014.

Chironomidae was the most abundant order collected at MAN02 in 2014, at 31.50% of the sample (Figure 8). Non-Chironomidae Diptera was the next most abundant, at 27.81%, followed by non-insect at 0.74%. No individuals from Odonata or Coleoptera were collected at MAN02.

Functional feeding groups. At 52.65%, collector-gatherers were the most abundant functional group at MAN01 in 2014 (Figure 9). Collector-filterers were the second most abundant functional group, averaging 41.67%. Predators averaged 4.96% and shredders averaged 0.72%. No scrapers were found at MAN01 in 2014.

Collector-gatherers were also the most abundant functional group collected at MAN02 in 2014, averaging 42.93% (Figure 9). Collector-filterers were the second most abundant, averaging 39.43%, followed by shredders at 0.9.20% and predators at 8.45%. No scrapers were collected at MAN02 in 2014.

3.2 Physical habitat characteristics

This section presents data describing physical habitat characteristics collected from 2007 to 2014 at MAN01 and MAN02. These data are summarized in Tables D4, D5 of Appendix D; additional transect data can be found in Table D-6.

Microhabitat level. In 2014, velocity at the targeted riffle sampling areas averaged 0.54 m/s at MAN01 and 0.52 m/s at MAN02. Depth averaged 0.12 m at both MAN01 and MAN02. Figure 10 shows the mean particle embeddedness for each riffle sample in 2014. On average, 21.2% of each particle was embedded at MAN01, while 20.0% of each particle was embedded at MAN02. Figure 11 shows the embeddedness of riffle habitat at MAN01 and MAN02 across all years of sampling.

Transect level. In 2014 wetted channel widths averaged 4.4 m at MAN01 and 4.6 m at MAN02. Velocity averaged

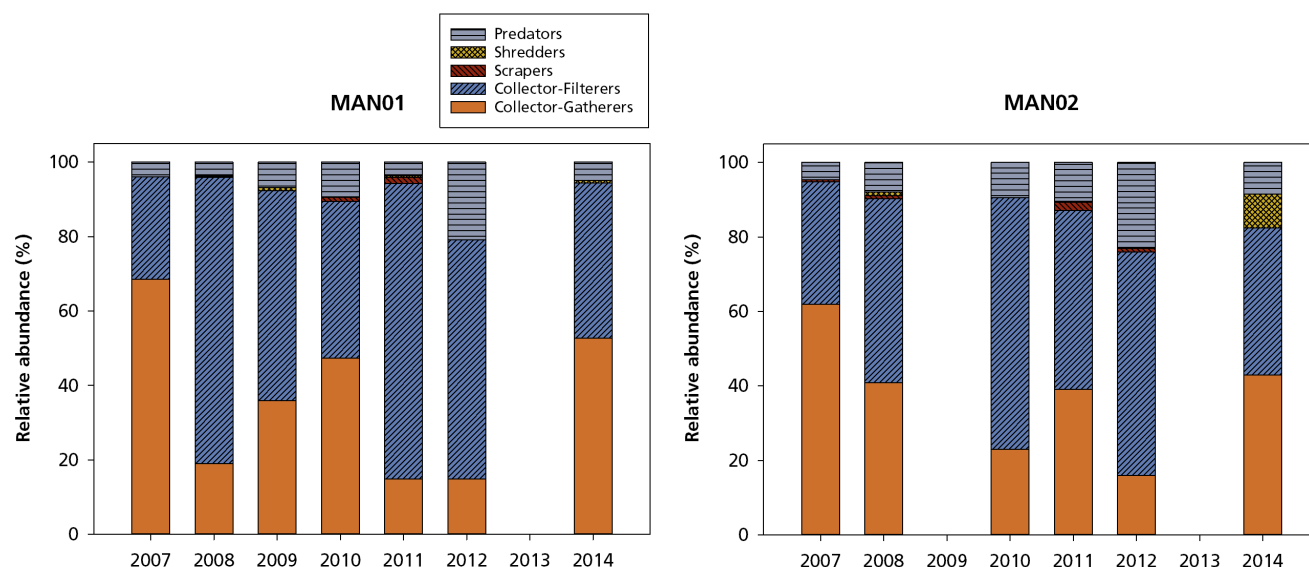


Figure 9. Mean relative abundance by functional feeding group in quantitative aquatic macroinvertebrate samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected from MAN02 in 2009, or at either site in 2013. In all 5 years, shredders never comprised more than 1% of the samples.

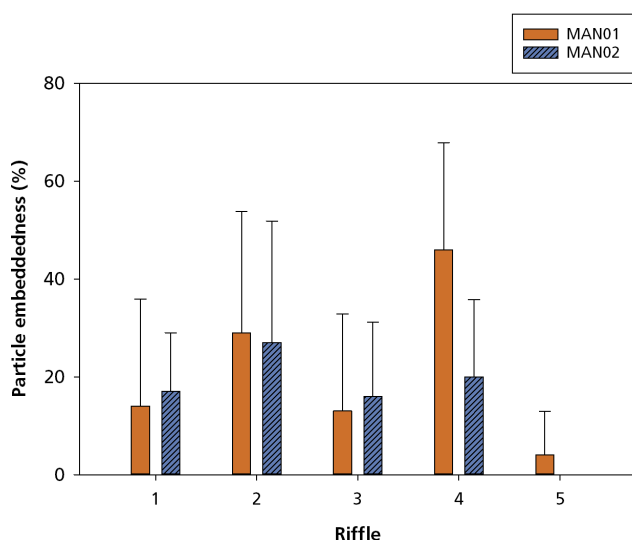


Figure 10. Mean particle embeddedness in samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2014.

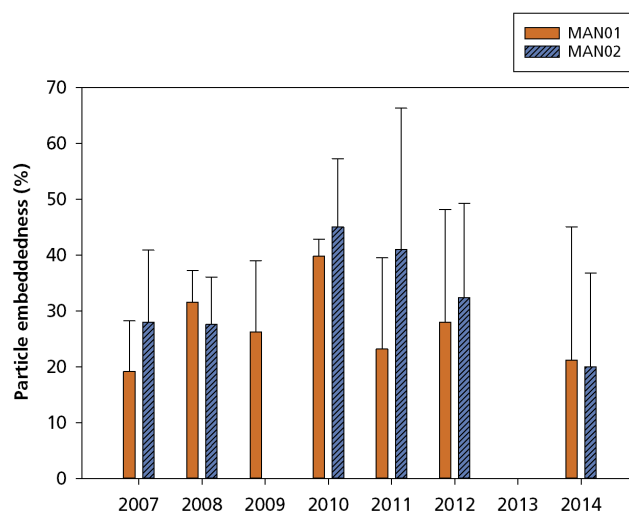


Figure 11. Mean particle embeddedness in samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected at MAN02 in 2009, or from either site in 2013.

0.34 m/s at MAN01 and 0.34 m/s at MAN02. The average depth along transects was 0.20 m at MAN01 and 0.24 m at MAN02. Riparian canopy closure averaged 5.3% at MAN01 and 7.9% at MAN02.

Rock was the dominant habitat type at MAN01, accounting for 53.3% of the habitat sampled in 2014 (Figure 12). Vegetation, found along 6.5% of the sampling reach at MAN01, was the second most frequent habitat type. Leaf packs occurred along 2.6 % of the reach, while woody debris and root wads both occurred along 1.3% of the sampling reach. The category “Absence”, meaning it lacked habitat that we define as appropriate for aquatic macroinvertebrates, occurred along 35.1% of MAN01. No algal mats were found at MAN01 in 2014.

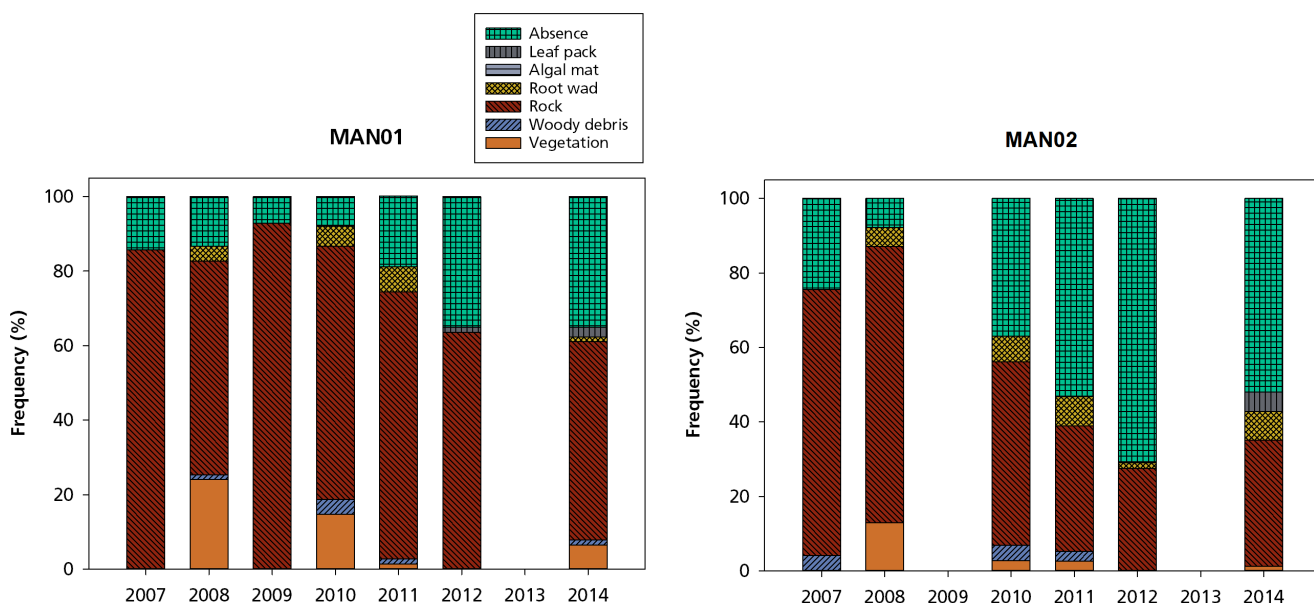


Figure 12. Habitat characterization, expressed as frequency of occurrence, along transects at MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2007–2014. Some habitat structure types were not observed. No data were collected at MAN02 in 2009, or from either site in 2013.

Rock was the dominant habitat type at MAN02, accounting for 33.8% of the habitat sampled in 2014. Root wads accounted for 7.8%, of the habitat sampled. Leaf packs and vegetation were found along 5.2% and 1.3% of the sampling reach, respectively. “Absence” accounted for 52.0% of MAN02. No woody debris or algal mats were found at MAN02 in 2014.

Reach level. Channel structure dynamics for 2014 are represented by particle size distributions in Figure 13. At MAN01, cobbles (65–250 mm) were the dominant particle type, accounting for 38.3% of the particles sampled. Gravel (3–64 mm) and clay & silt (<0.06, gritty) accounted for 25.3% and 9.8%, respectively, of the particles sampled. Sand (0.06–2 mm) was 3.8% , and boulders (251–4000 mm) were 3.0% . Along the reach, 20.0% of the particles were too cemented to measure.

At MAN02, gravels were the dominant particle type in 2014, accounting for 41.8% of the particles measured (Figure 13). Cobble and clay & silt were abundant at MAN02, accounting for 29.3% and 11.3% of the particles sampled. Of the particles sampled, 15.3% were too cemented to measure. Sand and boulder accounted for 2.3% and 0.03% of the particles sampled at MAN02.

Figure 14 shows the proportion of each reach length characterized by different geomorphic channel units (GCU). In 2014, runs were the most abundant GCU at MAN01 (39.3%). Next were riffles, found along 36.7% of the sampling reach at MAN01, followed by glides at 16.3%. Scour pools were found along 7.8% of the sam-

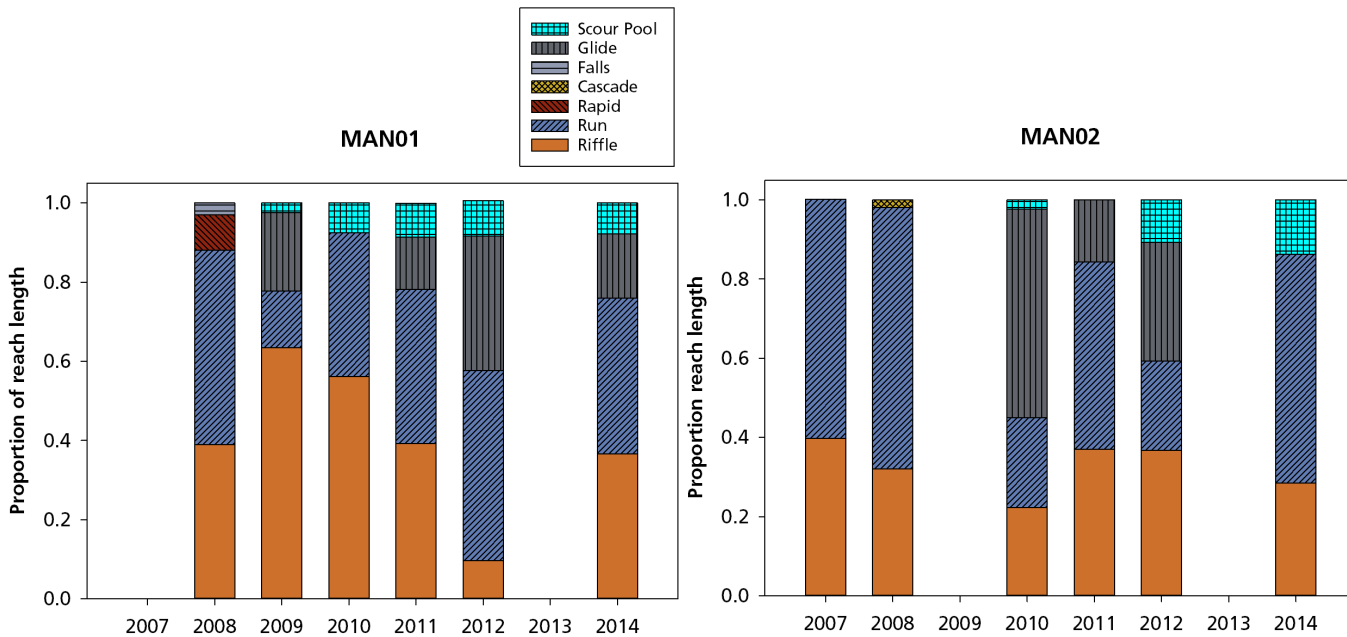


Figure 13. Particle size distribution along the reaches at MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2014. CM represents particles that are completely cemented into the stream channel, which precludes size measurements. No data were collected on the Mancos River in 2013.

Figure 14 shows the proportion of each reach length characterized by different geomorphic channel units (GCU). In 2014, runs were the most abundant GCU at MAN01 (39.3%). Next were riffles, found along 36.7% of the sampling reach at MAN01, followed by glides at 16.3%. Scour pools were found along 7.8% of the sam-

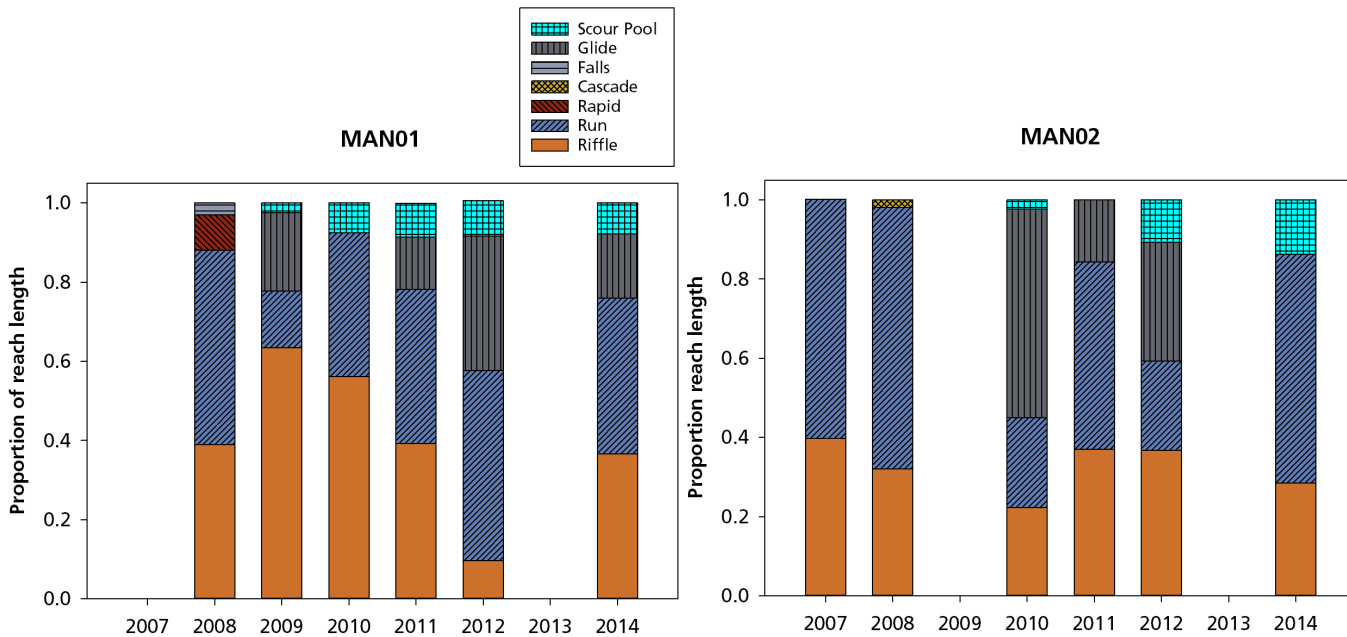


Figure 14. Geomorphic channel unit characterization of MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2007–2014. No data were collected at MAN01 in 2007, or MAN02 in 2009, or at either site in 2013.

pling reach at MAN01. Downstream at MAN02, runs were the dominant GCU, found along 58.8% of the sampling reach. Riffles (28.4%) were the next most frequent GCU, followed by scour pools (13.8%).

3.3 Hydrologic conditions

3.3.1 SCPN water quality core parameter data

We report hydrologic measurements for the Mancos River collected at or near midday on 29 October 2014 for MAN01 and 28 October for MAN02. Data from all years of sampling at the Mancos River are available in Tables D4, D5 of Appendix D. In 2014, the midday water temperature at MAN01 was 6.2°C. Specific conductance was 1398 $\mu\text{S}/\text{cm}$, and pH was 8.3. Dissolved oxygen was 103.0% saturation and 10.2 mg/L. Turbidity was 6.5 NTU and stream discharge was 8.0 cfs. At MAN02, the midday water temperature was 7.0°C. Specific conductance and pH were 1351 $\mu\text{S}/\text{cm}$ and 8.5, respectively. Dissolved oxygen was 100.7% saturation and 9.8 mg/L. Stream discharge measured 8.5 cfs. We were unable to collect turbidity from MAN02 in 2014.

Water and air temperatures were taken every 15 minutes at MAN01 in 2014 (Figure 15). The average water temperature was 10.0°C. A low water temperature of -0.1°C was recorded on several days during the year, typically

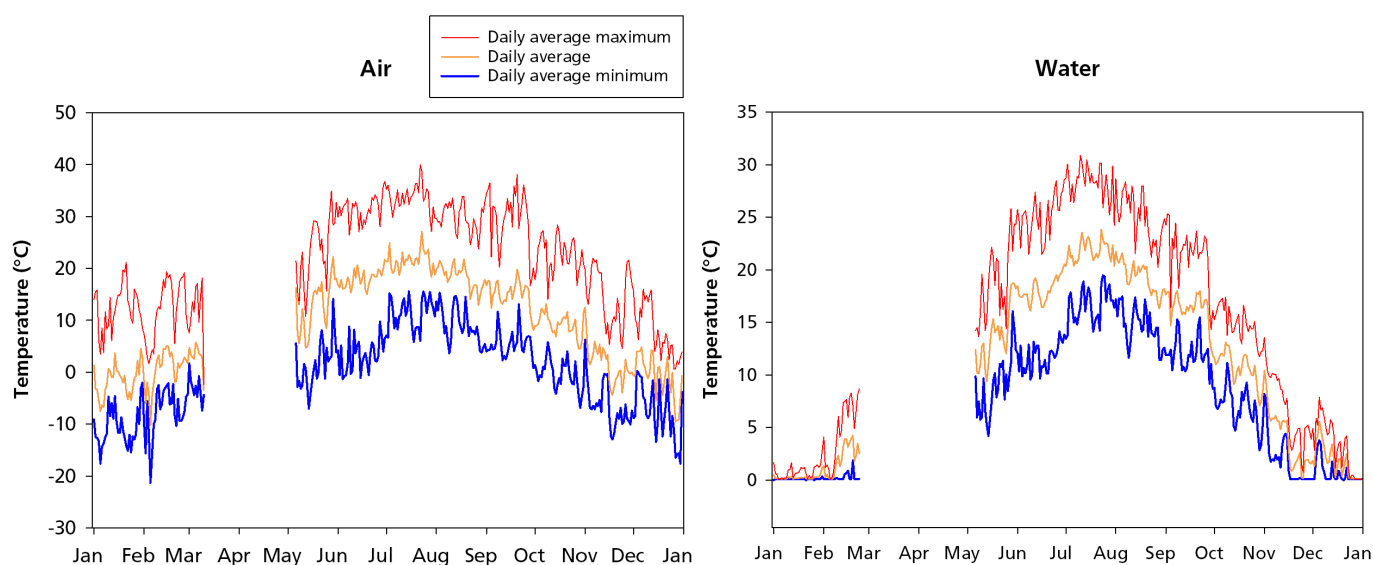


Figure 15. Air (left) and water (right) temperatures for MAN01 at Mesa Verde NP, recorded at 15 minute intervals in 2014.

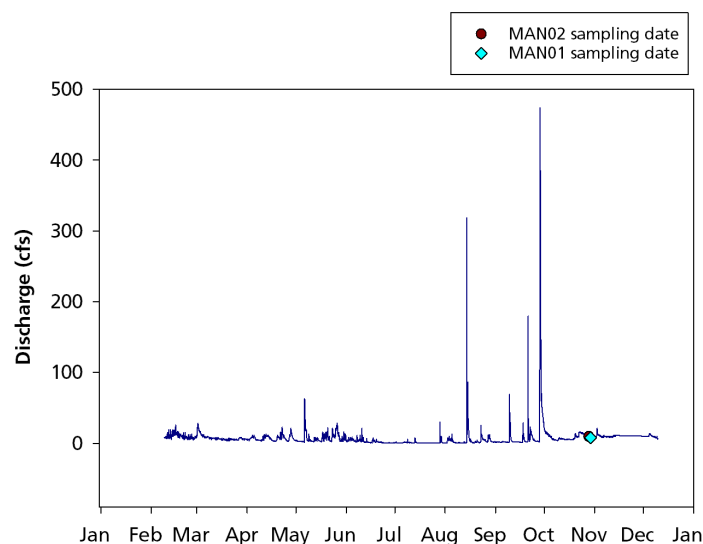


Figure 16. Discharge for the Mancos River in 2014 from USGS streamflow gaging station #09370600, near MAN01 at Mesa Verde NP. MAN01 was sampled on 29 October and MAN02 was sampled on 28 October.

when a surface freeze had occurred. A high water temperature of 31.1°C was recorded on 1 July. The average air temperature at MAN01 was 8.8°C. A low air temperature of -26.2°C was recorded on 20 December. A high of 0.02°C was recorded on 27 July.

3.3.2 USGS streamflow data

Figure 16 shows a hydrograph from the USGS streamflow gaging station Mancos River at Anitas Flat (09370600) for the period 9 February through 23 December 2014 (USGS 2015). Streamflow during winter is affected by ice and the USGS does not provide usable data for early January. The hydrograph for 2014 shows spikes occurring in August-September during the typical monsoon season. A very large flow event occurred in late September. Maximum discharge reached 474.0 cfs and occurred on 28 September. Minimum discharge was 0.6 cfs on 6 October.

4 Discussion

This report presents data from SCPN's seventh year of monitoring aquatic macroinvertebrates and physical habitat on the Mancos River in Mesa Verde National Park, Colorado. We stress that any differences between sampling years and locations should not be interpreted as ecologically significant trends, as trends cannot be determined by a few years of sampling data.

Differences can be attributed to multiple factors, including ecological variability and sampling error, or may be a result of observer bias. SCPN attempts to minimize such error by thoroughly training crew members in the proper field techniques prior to each sampling season.

The data in this report should be viewed as a snapshot of conditions existing within the aquatic community at the time of our visit. Data and analyses in this report are provisional and are subject to change. When sufficient data are available, SCPN plans to produce an interpretive report including trend analysis of aquatic macroinvertebrate metrics and physical habitat data for the Mancos River.

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Appendix A: Southern Colorado Plateau Network aquatic macroinvertebrate monitoring sites in Mesa Verde National Park, Colorado, 2014

Table A1. SCPN aquatic macroinvertebrate sites on the Mancos River in Mesa Verde NP, 2014. Sites are listed in upstream to downstream order,

Site code	Common name	Report name	UTM Easting	UTM Northing	Elevation (m)
MEVEMAN01	Mancos River at Gage	MAN01	734375	4126163	1933
MEVEMAN02	Mancos River above down- stream boundary	MAN02	735878	4122566	1882

Note: Horizontal coordinates are reported in Universal Transverse Mercator (UTM) Projection, Zone 12, North American Datum of 1983 (NAD 83). Vertical (elevation) coordinates are referenced to the North American Vertical Datum of 1988 (NAVD 88).

Appendix B: Selected aquatic macroinvertebrate metrics

Table B1. List of selected aquatic macroinvertebrate metrics and their definitions.

Metric type	Metric	Definition
Abundance/Richness/ Diversity	Total abundance	Total number of individuals.
	Taxa richness	Total number of taxa (measures the overall variety of aquatic macroinvertebrates in a sample).
	Simpson's diversity	A measure of the variety of taxa that takes into account the relative abundance of each taxon. $D = \sum(n_i(n_i - 1)/N(N-1))$
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 sensitive to perturbation.
	Percent richness of tolerant taxa	Percent of taxa considered to be sensitive to perturbation.
Functional-Feeding	Relative abundance collector-filterers	Percent of individuals that filter fine particulate organic matter from the water column.
	Percent richness collector-filterers	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 fine substrates).
	Percent richness burrowers	Percent of taxa that move between substrate particles (typically fine 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 noninsect taxa	Percent of individuals that are not insects.
	Relative abundance Chironomidae	Percent of individuals that are midges.

Source: Data from Brasher et al. (2011)

Appendix C: Aquatic macroinvertebrate species list from aquatic macroinvertebrate monitoring sites on the Mancos River in Mesa Verde National Park, Colorado, 2014

Table C1. List of aquatic macroinvertebrate species found in quantitative and qualitative samples taken from monitoring sites MAN01 and MAN02 on the Mancos River in Mesa Verde National Park in 2014.

Class	Order	Family	SubFamily	Genus	Species	Common name	Functional group	Tolerance group	MAN01 ^a	MAN02 ^a
Arachnida	Trombidiformes	Sperchonidae		<i>Sperchon</i> sp.		water mites	predator	tolerant	x	x
Arachnida	Trombidiformes	Sperchonidae		<i>Sperchonopsis</i> sp.		water mites	predator	tolerant		x
Insecta	Coleoptera	Elmidae		<i>Microcylloepus</i>	<i>pusillus</i>	riffle beetles	collector-gatherer	intolerant	x	
Insecta	Coleoptera	Gyrinidae		<i>Gyrinus</i> sp.		whirligig beetles	predator	intolerant	x	
Insecta	Coleoptera	Hydrophilidae	Hydrophilinae	<i>Tropisternus</i> sp.		water scavenger and clown beetles	predator	tolerant		new
Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	<i>Probezzia</i> sp.		biting midges	predator	moderately tolerant	x	x
Insecta	Diptera	Ceratopogonidae				biting midges	predator	moderately tolerant	x	x
Insecta	Diptera	Chironomidae	Chironominae			midges	collector-gatherer	moderately tolerant	x	x
Insecta	Diptera	Chironomidae	Orthoclaadiinae			midges	collector-gatherer	moderately tolerant	x	x
Insecta	Diptera	Chironomidae	Tanypodinae			midges	predator	tolerant	x	
Insecta	Diptera	Chironomidae				midges	collector-gatherer	moderately tolerant	x	x
Insecta	Diptera	Empididae	Hemerodromiinae	<i>Hemerodromia</i> sp.		dance flies	collector-gatherer	moderately tolerant	x	x
Insecta	Diptera	Empididae		<i>Neoplasta</i> sp.		dance flies	predator	moderately tolerant	x	x
Insecta	Diptera	Empididae				dance flies	predator	moderately tolerant		x
Insecta	Diptera	Simuliidae	Simuliinae	<i>Simulium</i> sp.		black flies	collector-filterer	moderately tolerant	x	x
Insecta	Diptera	Simuliidae				black flies	collector-filterer	moderately tolerant		x
Insecta	Diptera	Tipulidae		<i>Hexatoma</i> sp.		crane flies	predator	intolerant	x	

a "new" under the site column denotes a new record for this SCPN monitoring site.

Table C1. (continued) List of aquatic macroinvertebrate species found in qualitative samples taken from monitoring sites MAN01 and MAN02 on the Mancos River in Mesa Verde National Park in 2014.

Class	Order	Family	SubFamily	Genus	Species	Common name	Functional group	Tolerance group	MAN01 ^a	MAN02 ^a
Insecta	Diptera	Tipulidae				crane flies	shredder	intolerant	x	
Insecta	Diptera					flies	n/a	tolerant		x
Insecta	Ephemeroptera	Baetidae		<i>Baetis</i> sp.		small minnow mayflies	collector-gatherer	moderately tolerant	x	x
Insecta	Ephemeroptera	Baetidae		<i>Fallceon</i>	<i>quilleri</i>	small minnow mayflies	collector-gatherer	n/a	x	
Insecta	Ephemeroptera	Baetidae		<i>Fallceon</i> sp.		small minnow mayflies	collector-gatherer	n/a		new
Insecta	Hemiptera	Corixidae				water boatmen	predator	tolerant	new	new
Insecta	Plecoptera	Capniidae	Capniinae			small winter stoneflies	shredder	intolerant	new	x
Insecta	Plecoptera	Perlodidae	Isoperlinae	<i>Isoperla</i> sp.		green-winged stoneflies	predator	intolerant	x	
Insecta	Plecoptera	Perlodidae		<i>Isogenoides</i> sp.		green-winged stoneflies	predator	intolerant		x
Insecta	Plecoptera	Perlodidae				green-winged stoneflies	predator	intolerant	x	x
Insecta	Plecoptera	Taeniopterygidae				winter stoneflies	shredder	intolerant	x	x
Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	<i>Cheumatopsyche</i> sp.		net-spinning caddisflies	collector-filterer	moderately tolerant	x	
Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	<i>Hydropsyche</i> sp.		net-spinning caddisflies	collector-filterer	intolerant	x	x
Insecta	Trichoptera	Hydropsychidae				net-spinning caddisflies	collector-filterer	intolerant	x	x
Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	<i>Hydroptila</i> sp.		microcaddisflies	scraper	moderately tolerant		new
Insecta	Trichoptera	Limnephilidae				northern caddisflies	shredder	intolerant	x	
Malacostraca	Decapoda	Cambaridae	Cambarinae	<i>Orconectes</i> sp.		crayfish	shredder/predator	intolerant	new	new

a "new" under the site column denotes a new record for this SCPN monitoring site.

Appendix D: Aquatic macroinvertebrate community and physical habitat data from aquatic macroinvertebrate monitoring sites on the Mancos River in Mesa Verde National Park, Colorado, 2007–2014

Table D1. Quantitative aquatic macroinvertebrate community metrics from MAN01 on the Mancos River in Mesa Verde NP. For a given order, tolerance or functional feeding group, abundance-based metrics are the percentage of individuals in the group, while richness-based metrics for all years are the percentage of taxa in the group. Data were not collected in 2013 due to the U.S. federal government shutdown. N=5 for all years. SD = standard deviation.

Quantitative metric	2007		2008		2009		2010		2011		2012		2014	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Abundance	31.20	18.66	145.00	68.52	254.60	179.83	288.20	78.72	469.40	345.12	160.40	123.27	299.80	200.27
Total Richness	5.20	0.84	8.80	2.77	14.60	3.13	15.00	1.73	12.20	1.48	12.60	2.07	10.60	2.30
Simpson's Diversity-Taxonomic	0.66	0.06	0.51	0.16	0.64	0.12	0.71	0.06	0.46	0.21	0.72	0.11	0.70	0.04
Simpson's Diversity-Functional Group	0.38	0.07	0.36	0.11	0.53	0.08	0.58	0.05	0.33	0.15	0.48	0.14	0.54	0.02
Dominant Taxa	55.83	4.41	67.89	12.07	53.65	13.56	43.96	7.47	70.83	16.28	44.70	12.81	43.17	2.78
Relative Abundance-Tolerant Taxa	0.00	0.00	0.27	0.60	0.00	0.00	0.67	0.74	0.00	0.00	0.00	0.00	0.00	0.00
Relative Abundance-Moderately Tolerant Taxa	75.79	9.88	26.47	9.81	35.34	9.51	55.99	8.81	21.72	13.27	57.32	13.52	82.19	10.26
Relative Abundance-Intolerant Taxa	24.21	9.88	73.26	9.95	64.66	9.51	43.33	8.99	78.28	13.27	42.68	13.52	17.81	10.26
Richness-Tolerant Taxa (%)	0.00	0.00	3.33	7.45	0.00	0.00	7.13	5.12	0.00	0.00	0.00	0.00	0.00	0.00
Richness- Moderately Tolerant Taxa (%)	55.33	19.27	58.73	9.83	58.09	7.21	56.78	8.07	49.11	14.28	61.67	7.45	65.69	12.71
Richness- Intolerant Taxa (%)	44.67	19.27	37.94	8.92	41.91	7.21	36.09	5.51	50.89	14.28	38.33	7.45	31.31	12.71
Relative Abundance- Collector-Filterers	27.61	25.19	76.88	8.45	56.35	12.99	42.11	9.23	79.46	11.29	64.34	17.46	41.67	6.07
Relative Abundance- Collector-Gatherers	68.47	22.86	19.03	7.82	35.93	12.78	47.39	8.53	14.85	8.21	14.83	2.45	52.65	4.68
Relative Abundance- Scrapers	0.00	0.00	0.24	0.36	0.04	0.08	1.04	0.50	1.57	2.53	0.00	0.00	0.00	0.00
Relative Abundance- Shredders	0.00	0.00	0.18	0.41	0.85	0.59	0.06	0.13	0.37	0.41	0.00	0.00	0.72	0.62
Relative Abundance- Predators	3.93	4.27	3.65	0.93	6.83	1.31	9.40	5.65	3.76	2.11	20.83	16.64	4.96	2.74
Richness- Collector-Filterers (%)	31.33	12.38	33.35	7.49	16.66	3.72	13.78	1.13	26.37	5.92	18.19	3.55	25.86	9.26
Richness- Collector-Gatherers (%)	57.33	7.23	36.41	9.92	30.71	8.10	39.66	3.67	33.49	7.65	39.23	5.95	29.51	7.20
Richness- Scrapers (%)	0.00	0.00	3.54	4.91	1.00	2.24	6.89	0.56	9.22	6.54	0.00	0.00	0.00	0.00
Richness- Shredders (%)	0.00	0.00	2.50	5.59	5.63	3.39	1.18	2.63	5.36	4.96	0.00	0.00	8.84	5.67

Table D1. (continued) Quantitative aquatic macroinvertebrate community metrics from MAN01 on the Mancos River in Mesa Verde NP. For a given order, tolerance or functional feeding group, abundance-based metrics are the percentage of individuals in the group, while richness-based metrics for all years are the percentage of taxa in the group. Data were not collected in 2013 due to the U.S. federal government shutdown. N=5 for all years. SD = standard deviation.

Quantitative metric	2007		2008		2009		2010		2011		2012		2014	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Richness- Predators (%)	11.33	10.43	24.20	5.86	45.99	8.37	38.49	3.99	25.56	9.41	42.59	3.34	35.79	10.26
Number of EPT Taxa	3.00	0.71	4.40	0.89	5.60	0.55	4.40	1.52	5.20	1.10	4.00	1.00	4.60	1.14
Relative Abundance of EPT Taxa	73.51	16.87	89.52	3.86	62.88	13.64	72.39	10.56	85.01	9.90	40.21	12.55	27.98	11.05
Relative Abundance of Ephemeroptera	59.43	18.82	12.76	6.57	5.72	2.60	33.38	14.58	11.38	5.95	4.81	1.47	10.73	4.52
Relative Abundance of Plecoptera	0.00	0.00	1.99	2.10	3.04	0.62	0.46	0.48	1.20	1.28	1.50	2.35	0.81	0.69
Relative Abundance of Trichoptera	14.08	4.69	74.77	8.82	54.12	14.17	38.56	8.99	72.42	15.40	33.90	12.94	16.44	10.42
Relative Abundance of non-Insect Taxa	3.93	4.27	1.23	0.95	11.21	10.13	2.40	1.65	3.57	3.88	5.24	2.67	0.66	0.86
Relative Abundance of Chironomid Dipterans	9.04	7.44	6.53	2.99	19.41	5.20	13.45	6.95	3.58	4.48	5.91	2.15	41.78	6.50
Relative Abundance of Non Chironomid Dipterans	13.53	22.31	2.37	1.46	6.39	2.27	10.70	3.38	7.06	7.33	47.33	11.69	29.43	13.50
Relative Abundance of Coleoptera	0.00	0.00	0.27	0.41	0.11	0.25	0.99	0.81	0.79	1.02	1.32	1.90	0.14	0.31
Relative Abundance of Odonata	0.00	0.00	0.09	0.20	0.00	0.00	0.06	0.13	0.00	0.00	0.00	0.00	0.00	0.00

Table D2. Quantitative aquatic macroinvertebrate community metrics from MAN02 on the Mancos River in Mesa Verde NP. For a given order, tolerance or functional feeding group, abundance-based metrics are the percentage of individuals in the group, while richness-based metrics for all years are the percentage of taxa in the group. Data were not collected in 2013 due to the U.S. federal government shutdown. N=5 for all years. "nd" indicates that no data were collected. SD = standard deviation.

Quantitative metric	2007		2008		2009		2010		2011		2012		2014	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Abundance	74.00	20.48	106.40	118.73	nd	nd	419.20	121.49	202.40	164.62	245.40	150.75	66.00	34.24
Total Richness	6.60	1.34	8.20	3.03	nd	nd	12.60	2.88	12.00	3.08	13.80	2.49	8.25	1.26
Simpson's Diversity-Taxonomic	0.60	0.10	0.63	0.12	nd	nd	0.54	0.09	0.70	0.08	0.66	0.09	0.79	0.04
Simpson's Diversity-Functional Group	0.50	0.40	0.48	0.13	nd	nd	0.47	0.11	0.53	0.08	0.48	0.08	0.62	0.03
Dominant Taxa	56.79	6.00	56.03	13.19	nd	nd	63.16	9.58	49.73	7.16	54.79	9.06	33.91	9.57
Relative Abundance-Tolerant Taxa	0.25	0.56	0.00	0.00	nd	nd	0.05	0.11	0.09	0.19	0.00	0.00	0.00	0.00
Relative Abundance-Moderately Tolerant Taxa	82.43	9.77	50.00	20.42	nd	nd	28.27	6.24	52.63	21.67	39.95	22.01	70.26	12.23
Relative Abundance-Intolerant Taxa	17.32	9.87	50.00	20.42	nd	nd	71.69	6.31	47.29	21.59	60.05	22.01	29.74	12.23
Richness-Tolerant Taxa (%)	2.86	6.39	0.00	0.00	nd	nd	1.43	3.19	1.82	4.07	0.00	0.00	0.00	0.00
Richness- Moderately Tolerant Taxa (%)	53.00	13.98	50.59	5.02	nd	nd	53.24	9.85	60.02	16.44	57.22	12.04	54.61	16.92
Richness- Intolerant Taxa (%)	44.14	12.80	49.41	5.02	nd	nd	45.34	11.01	38.16	14.85	42.78	12.04	45.39	16.92
Relative Abundance- Collector-Filterers	32.95	7.82	49.46	28.85	nd	nd	67.48	11.19	47.96	21.46	59.99	22.64	39.43	15.76
Relative Abundance- Collector-Gatherers	61.92	6.65	40.82	26.81	nd	nd	23.02	6.06	39.15	22.32	15.95	5.43	42.93	12.16
Relative Abundance- Scrapers	0.45	1.02	0.80	1.40	nd	nd	0.08	0.11	2.21	2.37	0.97	0.86	0.00	0.00
Relative Abundance- Shredders	0.00	0.00	0.93	1.46	nd	nd	0.00	0.00	0.26	0.41	0.00	0.00	9.20	4.76
Relative Abundance- Predators	4.68	1.86	7.98	3.07	nd	nd	9.43	6.16	10.41	4.38	23.08	22.53	8.45	8.70
Richness- Collector-Filterers (%)	31.33	6.39	31.36	13.41	nd	nd	21.39	6.79	22.14	5.85	19.15	4.05	24.64	3.52
Richness- Collector-Gatherers (%)	39.67	6.25	33.24	8.28	nd	nd	28.23	4.99	40.24	11.10	30.83	6.12	33.84	7.91
Richness- Scrapers (%)	2.50	5.59	4.86	6.82	nd	nd	2.92	4.06	6.43	3.82	7.97	5.13	0.00	0.00
Richness- Shredders (%)	0.00	0.00	4.17	5.89	nd	nd	0.00	0.00	2.76	3.79	0.00	0.00	19.02	9.14
Richness- Predators (%)	26.50	8.79	26.38	4.94	nd	nd	47.46	5.00	28.43	7.36	42.05	3.36	22.50	19.47
Number of EPT Taxa	3.40	0.89	4.80	1.64	nd	nd	4.80	1.30	4.80	1.30	4.20	1.48	4.50	1.29
Relative Abundance of EPT Taxa	73.37	12.52	88.81	3.28	nd	nd	88.04	5.34	70.82	26.08	51.28	22.70	39.95	12.73

Table D2. (continued) Quantitative aquatic macroinvertebrate community metrics from MAN02 on the Mancos River in Mesa Verde NP. For a given order, tolerance or functional feeding group, abundance-based metrics are the percentage of individuals in the group, while richness-based metrics for all years are the percentage of taxa in the group. Data were not collected in 2013 due to the U.S. federal government shutdown. N=5 for all years. "nd" indicates that no data were collected. SD = standard deviation.

[illegible]

Table D3. Qualitative aquatic macroinvertebrate community metrics from MAN01 and MAN02 on the Mancos River in Mesa Verde NP. Richness-based metrics are expressed as the percentage of taxa in a given order, tolerance or functional feeding group. Site ordering from left to right in the table corresponds to upstream to downstream position. Data were not collected in 2013 due to the U.S. federal government shutdown. "nd" indicates that no data were collected.

	MAN01							MAN02						
Qualitative metric	2007	2008	2009	2010	2011	2012	2014	2007	2008	2009	2010	2011	2012	2014
Taxa richness	19	22	27	25	23	18	14	10	20	nd	19	27	20	16
Tolerance group														
Richness of tolerant taxa (%)	16.67	15.00	16.00	0.00	5.26	18.75	7.14	11.11	11.11	nd	11.11	4.17	16.67	12.50
Richness of moderately tolerant taxa (%)	44.44	50.00	52.00	63.64	57.89	56.25	42.86	55.56	44.44	nd	55.56	54.17	55.56	50.00
Richness of intolerant taxa (%)	38.89	35.00	32.00	36.36	36.84	25.00	50.00	33.33	44.44	nd	33.33	41.67	27.78	37.50
Functional group														
Richness of collector-filterers (%)	16.67	19.05	14.81	12.50	14.29	17.65	14.29	20.00	15.79	nd	11.11	11.54	10.00	12.50
Richness of collector-gatherers (%)	50.00	38.10	37.04	33.33	28.57	41.18	35.71	50.00	36.84	nd	33.33	30.77	50.00	31.25
Richness of scrapers (%)	0.00	9.52	7.41	8.33	4.76	0.00	0.00	0.00	5.26	nd	11.11	7.69	0.00	6.25
Richness of shredders (%)	0.00	9.52	7.41	12.50	4.76	0.00	14.29	0.00	5.26	nd	11.11	7.69	0.00	12.50
Richness of predators (%)	33.33	23.81	33.33	33.33	47.62	41.18	35.71	30.00	36.84	nd	33.33	42.31	40.00	37.50
Taxonomic group														
Number of EPT taxa	7	7	9	9	9	3	6	4	6	nd	5	8	6	7
Richness of EPT taxa (%)	36.84	31.82	33.33	36.00	39.13	16.67	42.86	40.00	30.00	nd	26.32	29.63	30.00	43.75
Richness of Ephemeroptera (%)	21.05	18.18	11.11	20.00	13.04	5.56	14.29	30.00	15.00	nd	15.79	18.52	20.00	12.50
Richness of Plecoptera (%)	0.00	4.55	11.11	4.00	8.70	0.00	14.29	0.00	5.00	nd	5.26	3.70	5.00	18.75
Richness of Trichoptera (%)	15.79	9.09	11.11	12.00	17.39	11.11	14.29	10.00	10.00	nd	5.26	7.41	5.00	12.50
Richness of noninsect ^a taxa (%)	26.32 ^a	31.82 ^a	22.20	16.00	21.74	22.22	7.14	30.00 ^a	15.00	nd	15.79	18.52	20.00	12.50
Richness of Chironomidae Diptera (%)	10.53	13.64	11.11	8.00	13.04	16.67	21.43	10.00	15.00	nd	15.79	11.11	15.00	12.50
Richness of non-Chironomidae Diptera (%)	21.05	13.64	25.93	20.00	17.39	27.78	21.43	20.00	15.00	nd	31.58	25.93	30.00	25.00
Richness of Coleoptera (%)	0.00	9.10	3.70	12.00	8.70	11.11	7.14	0.00	15.00	nd	10.53	11.11	5.00	6.25
Richness of Odonata (%)	5.26	0.00	3.70	8.00	0.00	5.56	0.00	0.00	10.00	nd	0.00	3.70	0.00	0.00

^a Pre-2009 reports labeled the "noninsect" category as "Other". The "Other" category was less inclusive of species, resulting in a different richness count.

Table D4. Physical habitat and hydrologic data from MAN01 on the Mancos River in Mesa Verde NP. Data were not collected in 2013 due to the U.S. federal government shutdown. "nd" indicates that no data were collected. SD = standard deviation.

	2007		2008		2009		2010		2011		2012		2014	
Physical habitat metric	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Microhabitat level (n = 5)														
Velocity (m/s)	0.69	0.27	0.63	0.13	0.55	0.36	0.47	0.17	0.68	0.37	0.33	0.13	0.54	0.19
Depth (m)	0.18	0.07	0.13	0.04	0.11	0.05	0.14	0.05	0.18	0.04	0.06	0.02	0.12	0.04
Embeddedness (%)	19.2	9.0	31.6	5.6	26.3	12.7	39.8	3.0	23.2	10.6	28.0	11.4	21.2	16.5
Transect level (n = 11)														
Channel dimensions														
Velocity (m/s)	0.68	0.23	0.50	0.23	0.42	0.06	0.49	0.16	0.41	0.15	0.09	0.08	0.34	0.17
Depth (m)	0.30	0.10	0.30	0.15	0.12	0.05	0.21	0.08	0.18	0.07	0.07	0.06	0.20	0.10
Wetted channel width (m)	5.7	2.1	5.6	1.8	6.2	1.1	4.9	1.9	4.7	1.5	3.5	1.3	4.4	1.8
Active channel width (m)	7.5	2.2	9.4	3.3	10.0	3.0	8.4	2.0	15.7	5.9	>50.0	0.0	5.1	1.8
Riparian cover														
Canopy closure (%)	9.0	12.9	19.3	25.8	4.8	6.9	0.0	0.0	16.6	25.2	18.5	29.7	7.4	18.5
Reach level (n = 1)														
Water quality														
Temperature (°C)	10.8		17.4		8.9		14.2		14.0		8.5		6.2	
Specific conductivity (µS/cm)	nd		945		1514		1288		1315		2180		1398	
pH	nd		8.5		8.4		8.4		8.3		8.2		8.3	
Dissolved oxygen (% saturation)	nd		106.0		91.3		104.2		103.1		104.6		103.0	
Dissolved oxygen (mg/L)	nd		10.2		8.2		8.3		8.5		9.7		10.2	
Turbidity (NTU)	nd		12.0		17.0		9.8		8.7		1.7		6.5	
Discharge (cfs)	46.0 ^a		19.0 ^a		10.0		11.5		9.7		0.6		8.0	

^a Mean daily discharge based on gauging station results—note that this represents a different collection method than later years.

Table D5. Physical habitat and hydrologic data from MAN02 on the Mancos River in Mesa Verde NP. Data were not collected in 2013 due to the U.S. federal government shutdown. "nd" indicates that no data were collected. SD = standard deviation.

	2007		2008		2009		2010		2011		2012		2014	
Physical habitat metric	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Microhabitat level (n = 5)														
Velocity (m/s)	0.91	0.20	0.39	0.12	nd	nd	0.77	0.32	0.47	0.37	0.11	0.03	0.52 ^a	0.27
Depth (m)	0.15	0.05	0.05	0.01	nd	nd	0.14	0.07	0.11	0.05	0.10	0.02	0.12 ^a	0.03
Embeddedness (%)	28.0	12.9	27.6	8.5	nd	nd	48.4	12.9	41.0	15.6	32.4	11.7	20.0 ^a	5.0
Transect level (n = 11)														
Channel dimensions														
Velocity (m/s)	0.63	0.19	0.45	0.19	nd	nd	0.39	0.19	0.39	0.18	0.10	0.06	0.34	0.12
Depth (m)	0.31	0.10	0.25	0.07	nd	nd	0.19	0.07	0.21	0.08	0.11	0.07	0.24	0.09
Wetted channel width (m)	6.4	2.4	5.4	0.9	nd	nd	5.4	1.7	5.2	1.0	3.2	1.0	4.6	1.3
Active channel width (m)	10.3	4.2	10.0	2.6	nd	nd	8.0	2.8	44.4	9.8	>50.0	0	5.4	1.3
Riparian cover														
Canopy closure (%)	14.3	26.8	23.0	33.4	nd	nd	1.3	4.6	20.2	26.2	16.9	33.0	7.9	21.8
Reach level (n = 1)														
Water quality														
Temperature (°C)	11.2		16.9		nd		13.1		14.4		8.9		7.0	
Specific conductivity (µS/cm)	nd		993		nd		1326		1283		1980		1351	
pH	nd		8.5		nd		8.3		8.4		8.4		8.5	
Dissolved oxygen (% saturation)	nd		104.9		nd		106.1		103.3		102.1		100.7	
Dissolved oxygen (mg/L)	nd		10.2		nd		8.6		8.5		9.4		9.8	
Turbidity (NTU)	nd		16.8		nd		17.6		9.0		3.1		nd	
Discharge (cfs)	41.0 ^b		19.0 ^b		nd		10.4		10.8		0.8		8.5	

a Only 4 riffles were available to be sampled in 2014.

b Mean daily discharge based on gauging station results—note that this represents a different collection method than later years.

Table D6. Stream velocity and channel characteristics of aquatic macroinvertebrate sites MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2014. SD = standard deviation.

Transect	Depth (m) (n = 5)		Velocity (m/s) (n = 5)		Wetted channel width (m)	Active channel width (m)
	Mean	SD	Mean	SD		
MAN01						
1	0.09	0.08	0.28	0.23	7.60	8.40
2	0.12	0.06	0.24	0.20	5.71	6.52
3	0.12	0.05	0.27	0.07	7.19	7.40
4	0.27	0.08	0.18	0.06	4.71	6.50
5	0.35	0.13	0.18	0.08	3.47	3.53
6	0.16	0.04	0.77	0.35	2.40	4.10
7	0.23	0.06	0.34	0.23	2.88	3.00
8	0.18	0.10	0.50	0.44	2.87	3.54
9	0.38	0.11	0.23	0.28	2.80	3.50
10	0.18	0.07	0.34	0.08	4.50	4.80
11	0.15	0.03	0.38	0.05	4.61	4.80
MAN02						
1	0.23	0.08	0.28	0.11	4.09	4.17
2	0.23	0.07	0.32	0.18	3.79	4.65
3	0.21	0.06	0.39	0.06	4.26	5.15
4	0.22	0.02	0.62	0.46	2.95	3.90
5	0.26	0.1	0.30	0.07	3.78	4.10
6	0.23	0.22	0.37	0.46	7.18	7.76
7	0.48	0.2	0.12	0.20	5.70	7.00
8	0.26	0.07	0.30	0.14	3.94	4.88
9	0.19	0.06	0.41	0.23	3.52	4.70
10	0.12	0.03	0.35	0.16	6.23	6.69
11	0.16	0.05	0.29	0.10	5.65	6.40

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