



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

2015 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2017/1111



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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Abstract

Water-related vital signs are fundamental components defining overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified aquatic macroinvertebrates as one of seven key vital signs used to determine the condition and long-term status of aquatic ecosystems in park streams. This report provides a summary of the aquatic macroinvertebrate community and physical habitat data collected from the Mancos River in Mesa Verde National Park, Colorado in 2015. The data presented in this report represent a snapshot of the aquatic macroinvertebrate community and physical stream attributes for 2015. We stress that any differences between sampling years and locations should not be interpreted as an ecologically significant trend, as trends cannot be determined with confidence by a few years of sampling data. These data will be used to analyze long-term trend at a future date when the appropriate amount of data have been collected. Differences between years in the data presented in this report may be attributed to multiple factors, including ecological variability, sampling error, and observer bias. SCPN attempts to minimize sampling error and observer bias by thoroughly training crew members in the proper field techniques prior to each sampling season.

1 Introduction

The National Park Service (NPS) 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 abuts 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 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 on the Mancos River in MEVE (Stumpf and Monroe 2009). See Appendix A for list of locations, codes, and common names of the SCPN monitoring sites in MEVE.

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). SCPN established a water quality monitoring site here in 2009.

Mancos River above Downstream Boundary (MEVEMAN02), identified in this report as MAN02, was sampled for the first time in 2007. SCPN established this site 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 2015, summarizes the data collected, and, where appropriate, places the data in the context of current environmental conditions.

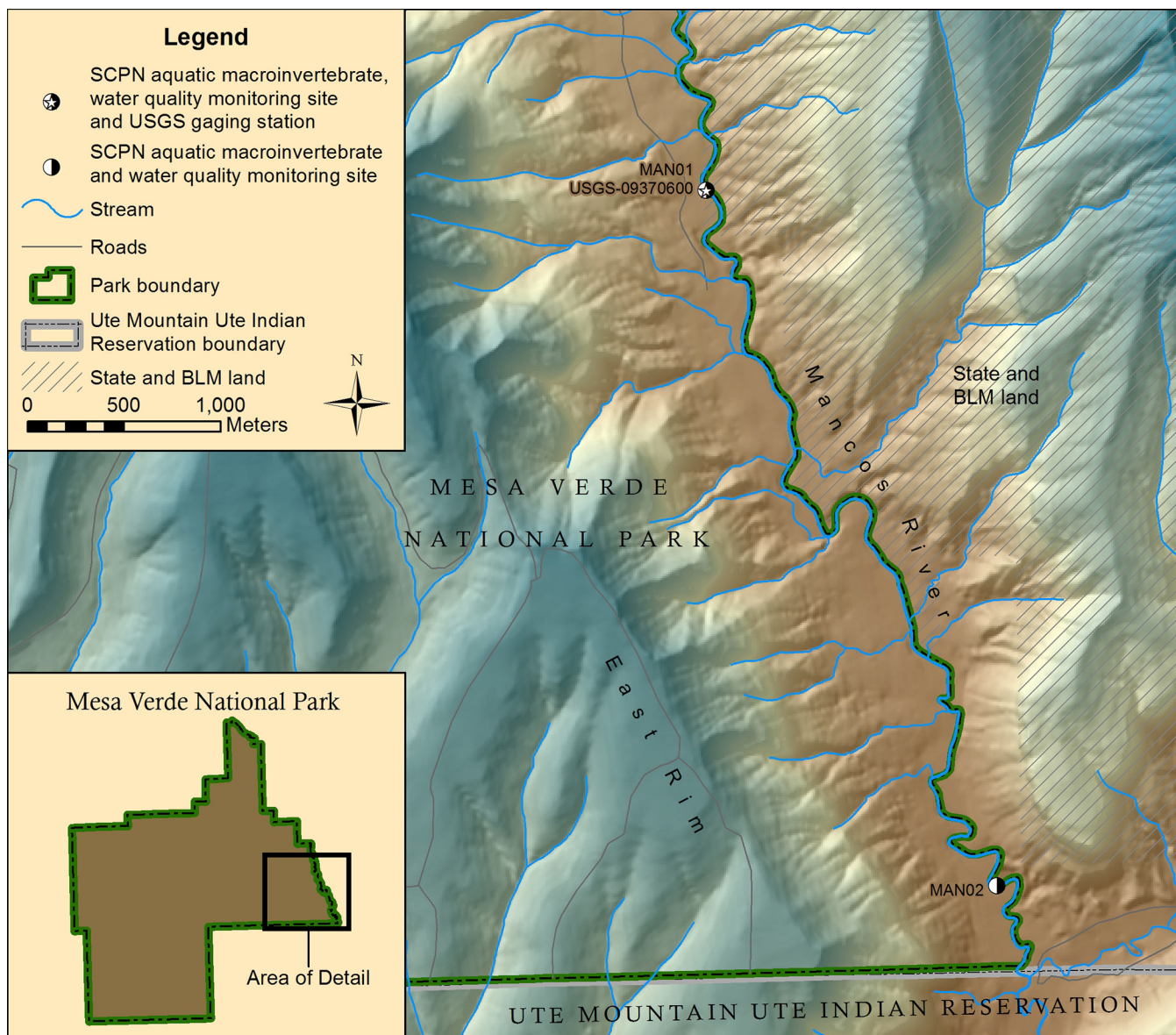


Figure 1. Map of Mesa Verde NP, Colorado, showing the location of the 2 Southern Colorado Plateau Network monitoring sites, MAN01 and MAN02, on the Mancos River in 2015.

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 24–25 October 2015, 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 2015:

- 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

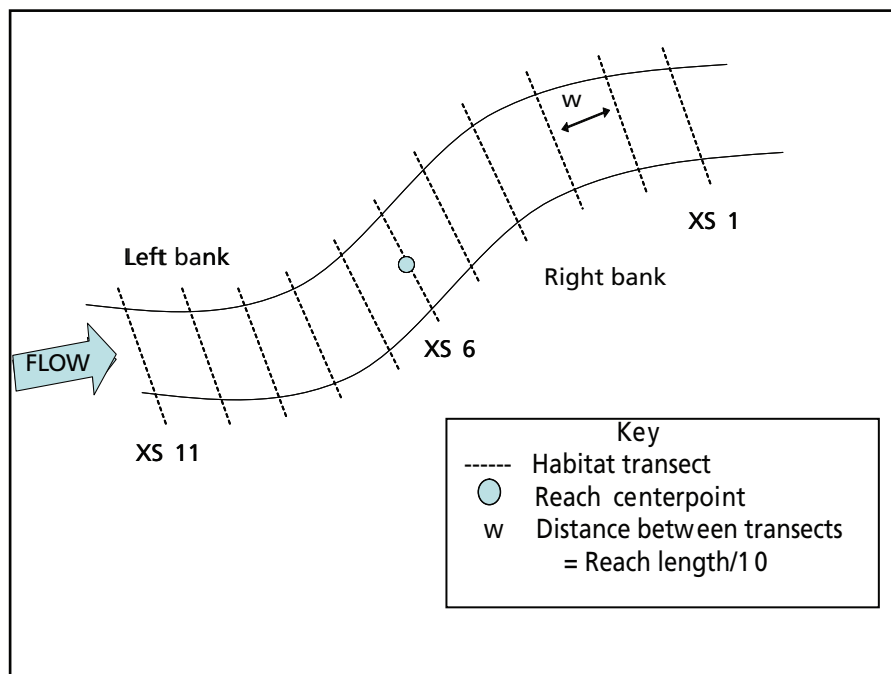


Figure 2. General aquatic macroinvertebrate sampling reach layout used by SCPN.

- 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 SCPN air and water temperature measurements, we collected hydrologic data at the USGS stream-flow gaging station on the Mancos River, *Mancos River at Anitas Flat* (09370600), for the period 28 January through 11 November 2015 (USGS 2016).

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 calculated means and standard deviations from the 5 rep-

licate samples collected. For those parameters measured along transects (such as habitat characterization), we calculated 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). They also 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 at MAN01 on 25 September and at MAN02 on 24 September 2015, with data collected at both sites from 2010 to 2014. Although data collection at these sites began in 2007, SCPN will present the current year's data and only the previous 5 year's data in summary reports. Data extending beyond these 6 years can be found in previous reports, or obtained by contacting the project lead. Data were not collected at MEVE 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 all corresponding data values are available in Appendix D (Tables D1–D3). Appendix C lists all aquatic macroinvertebrate species detected at MAN01 and MAN02 in 2015 from both quantitative and qualitative methods.

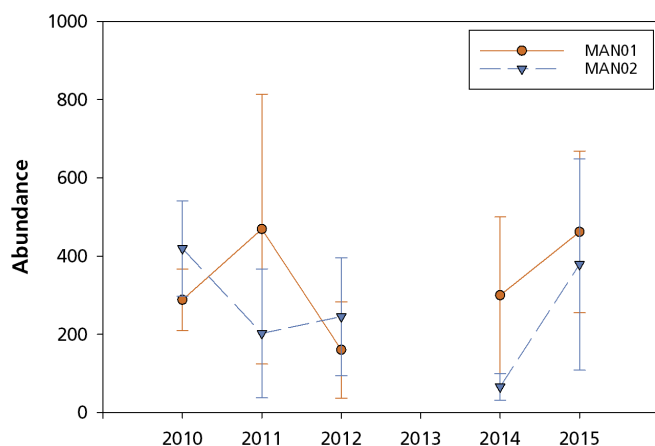


Figure 3. Aquatic macroinvertebrate abundance in quantitative samples from MAN01 and MAN02 at the Mancos River in Mesa Verde NP, 2010–2015. No data were collected in 2013 due to the U.S. federal government shutdown. Error bars represent one standard deviation from the mean.

Abundance. Abundance values for targeted riffle habitat samples averaged 462.00 individuals at MAN01 (Figure 3). Abundance for samples collected at MAN01 ranged from a low of 186 to a high of 750. Abundance at MAN02 averaged ranged from 49 to 761, with an average of 378.60 individuals.

Taxa richness. Richness for quantitative samples collected at MAN01 ranged from 7 to 11 taxa and averaged 9.40 (Figure 4). At MAN02, richness for quantitative samples ranged from 6 to 8 taxa and averaged 7.20. Richness of qualitative samples was 20 taxa at MAN01. We were unable to collect a complete qualitative sample from MAN02 in 2015.

Diversity. We measured taxonomic and functional diversity using the Simpson's Diversity Index. Taxonomic diversity averaged 0.51 at MAN01 and 0.43 at MAN02 (Figure 5). Functional diversity averaged

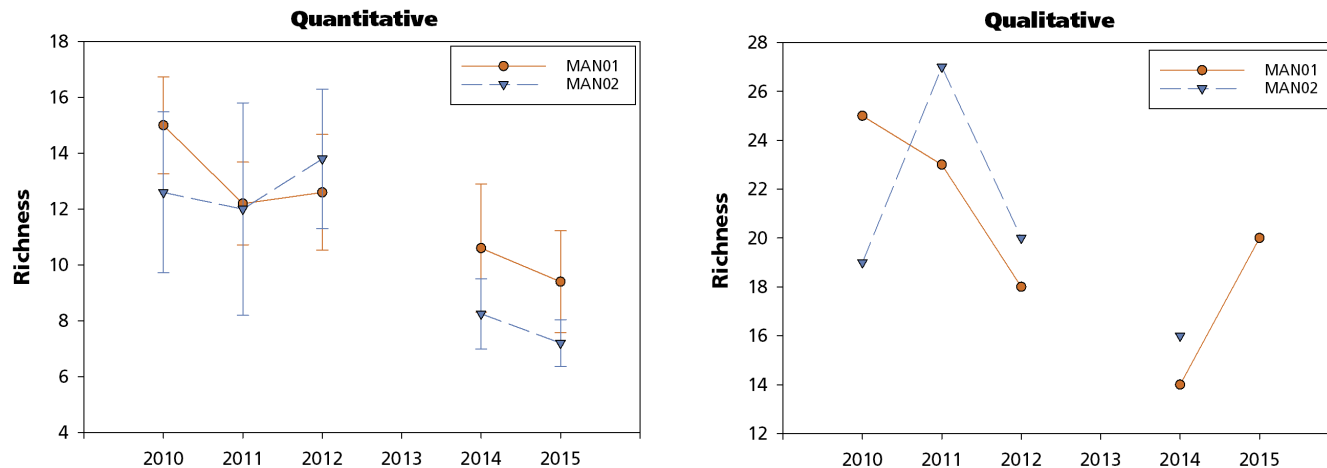


Figure 4. Taxa richness of aquatic macroinvertebrates in quantitative (left) and qualitative samples (right) from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected in 2013 due to the U.S. federal government shutdown. Qualitative data were not reported for MAN02 in 2015 due to an incomplete sample collection. Error bars represent one standard deviation from the mean.

0.43 at MAN01 and 0.30 at MAN02.

Stress tolerance. Taxa which are intolerant to disturbance dominated the samples collected from MAN01, with an average relative abundance of 65.41% (Figure 6). Moderately tolerant individuals were the second most abundant at MAN01, with an average relative abundance of 34.59%. No tolerant individuals were found at MAN01 in 2015.

At MAN02, moderately tolerant individuals were the most abundant in 2015, with relative abundance averaging 84.82% (Figure 6). Intolerant taxa were the next most abundant at MAN02, averaging 14.98% of the individuals per sample. Tolerant taxa averaged 0.20%.

EPT taxa. EPT taxa (Ephemeroptera – mayflies, Plecoptera – stoneflies, and Trichoptera – caddisflies) are sensitive to aquatic degradation. In 2015, Trichoptera had the highest relative abundance of sensitive EPT taxa at MAN01 (Figure 7), averaging 64.28% of the individuals collected from the site. Ephemeroptera were the second

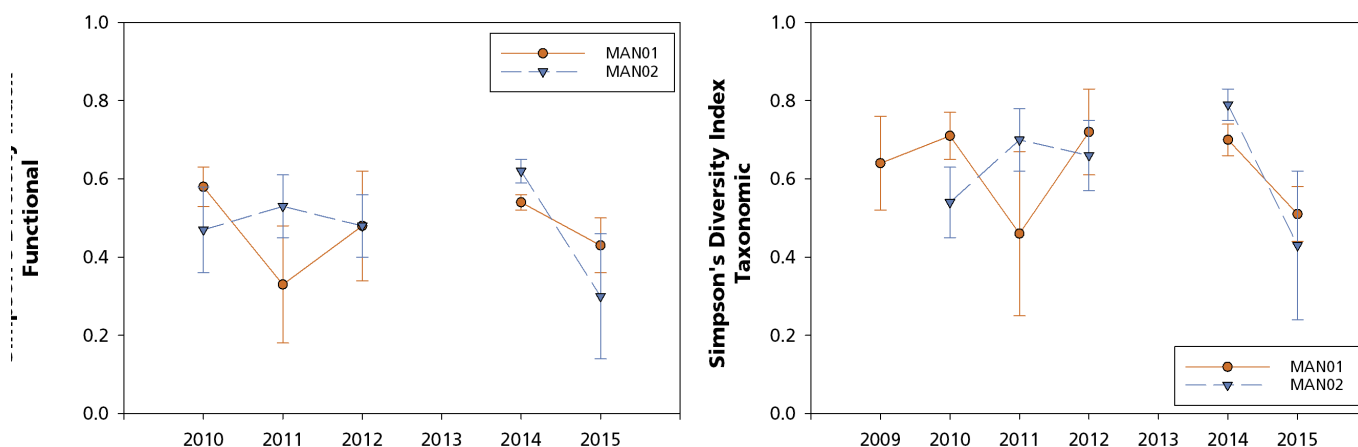


Figure 5. Taxonomic (left) and functional (right) diversity in quantitative samples from MAN01 and MAN02 at the Mancos River, in Mesa Verde NP, 2010–2015. No data were collected at either site in 2013 due to the U.S. federal government shutdown. Error bars represent one standard deviation from the mean.

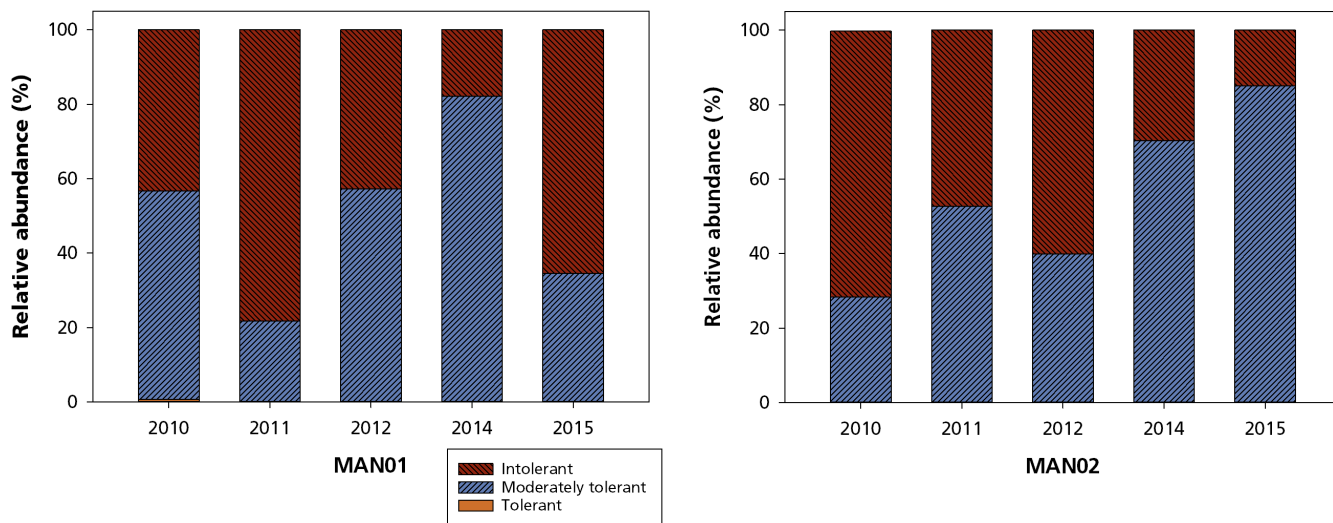


Figure 6. Mean relative abundance of aquatic macroinvertebrates by tolerance group in quantitative samples from MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected at either site in 2013 due to the U.S. federal government shutdown. In all 5 years, tolerant taxa never comprised more than 1% of the samples.

most abundant, averaging 16.16%. Few Plecoptera were collected from MAN01, with abundance at 0.26%.

At MAN02, Ephemeroptera was the most abundant EPT taxa collected in 2015, averaging 27.30% of the individuals collected from quantitative targeted riffle samples (Figure 7). Relative abundance of Trichoptera and Plecoptera at MAN02 averaged 13.50% and 0.14%, respectively.

Aquatic macroinvertebrate orders. In 2015, Trichoptera was the most abundant order at MAN01, at 64.28% of the individuals collected (Figure 8). Chironomidae (midges) averaged 13.64, non-Chironomidae Diptera (flies)

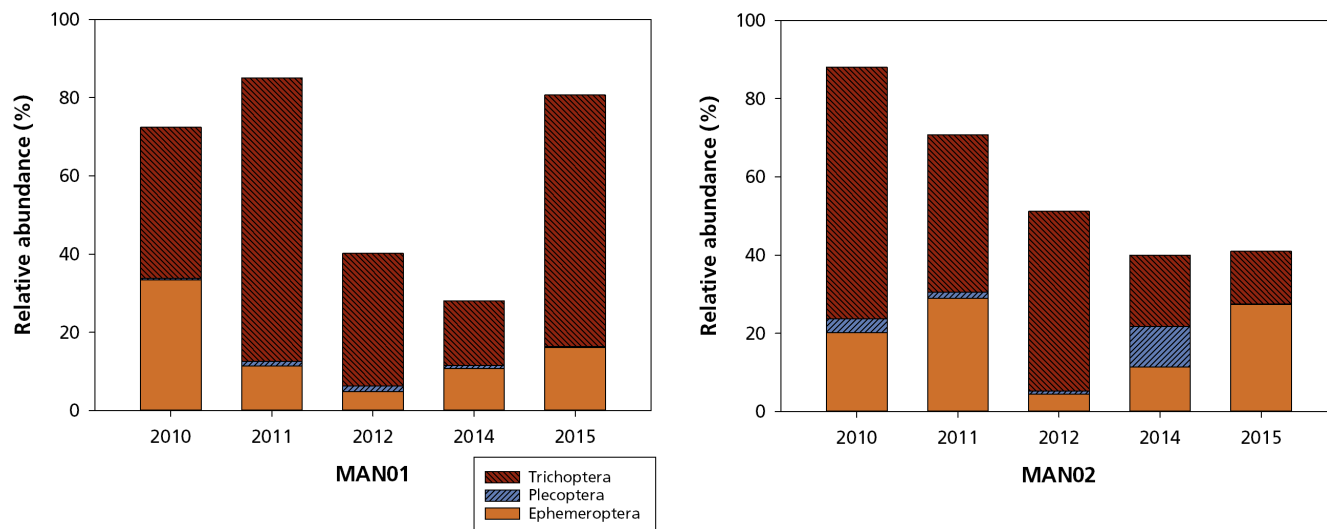


Figure 7. Mean relative abundance of aquatic macroinvertebrates belonging to sensitive EPT orders in quantitative samples from MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected from either site in 2013 due to the U.S. federal government shutdown.

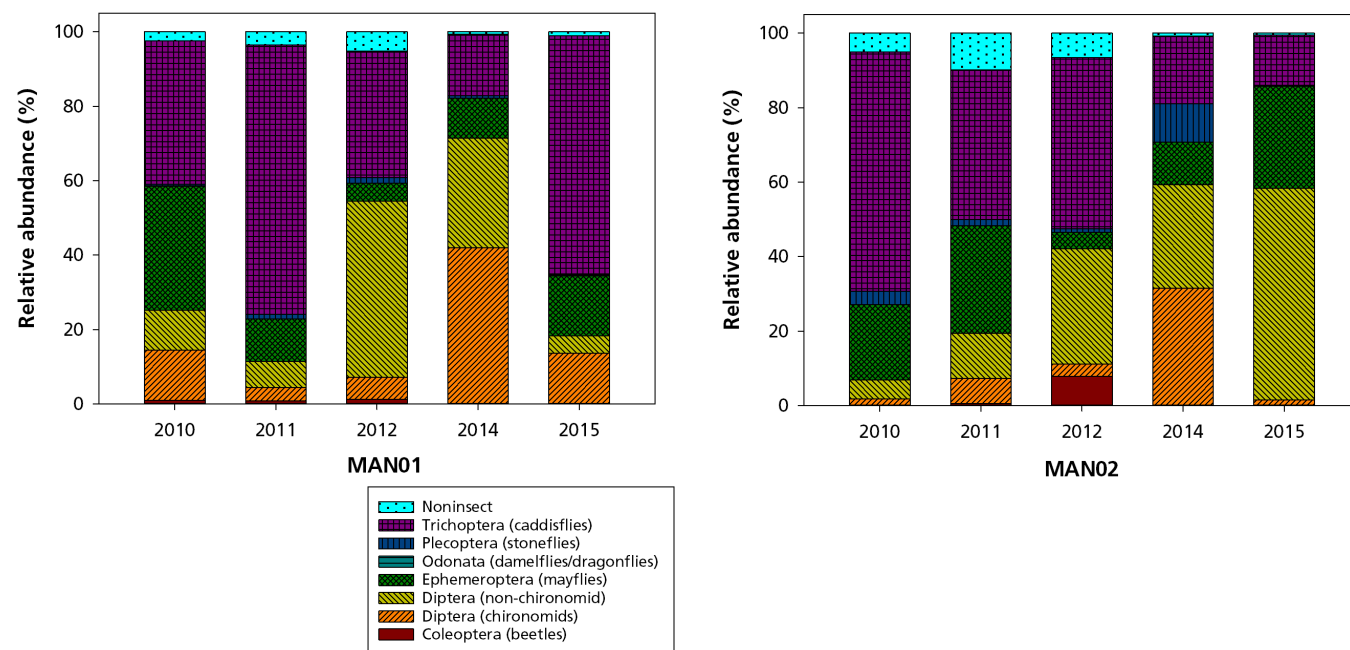


Figure 8. Mean relative abundance by taxonomic order in quantitative aquatic macroinvertebrate samples from MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected from either site in 2013 due to the U.S. federal government shutdown. In all 6 years, Odonates never comprised more than 1% of the samples.

comprised 4.57%, and noninsect taxa 1.01%. Coleoptera (beetles) and odonata (damselflies/dragonflies) both averaged <1.0% of the samples collected from MAN01.

Non-chironmid dipterans were the most abundant order collected at MAN02 in 2015, at 56.84% of the sample (Figure 8). Ephemeroptera (27.32%) and Trichoptera (13.50%) were the next most abundant orders, followed by Chironomids and non-insect at 1.55% and 0.54% respectively. Odonates averaged 0.11%. No individuals from the order Coleoptera were collected at MAN02.

Functional feeding groups. At 68.13%, collector-filterers were the most abundant functional group at MAN01 (Figure 9). Collector-gatherers were the second most abundant functional group, averaging 30.14%. Predators averaged 1.60% and scrapers averaged 0.14%. No shredders were found at MAN01 in 2015.

Collector-filterers were also the most abundant functional group collected at MAN02, averaging 69.92% (Figure 9). Collector-gatherers were the second most abundant, averaging 29.14%, followed by predators at 0.94. No scrapers or shredders were collected at MAN02 in 2015.

3.2 Physical habitat characteristics

This section presents data describing physical habitat characteristics collected from 2010 to 2015 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 2015, velocity at the targeted riffle sampling areas averaged 0.49 m/s at MAN01 and 0.82 m/s at MAN02. Depth averaged 0.14 m at MAN01 and 0.13 m at MAN02. Figure 10 shows the mean particle embeddedness for each riffle sample in 2015. On average, 26.8% of each particle was embedded at MAN01, while 22.8% 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 2015 wetted channel widths averaged 4.4 m at MAN01 and 5.5 m at MAN02. Velocity averaged 0.28 m/s at MAN01 and 0.33 m/s at MAN02. The average depth along transects was 0.27 m at MAN01 and 0.25 m at MAN02. Riparian canopy closure averaged 25.7% at MAN01 and 22.8% at MAN02.

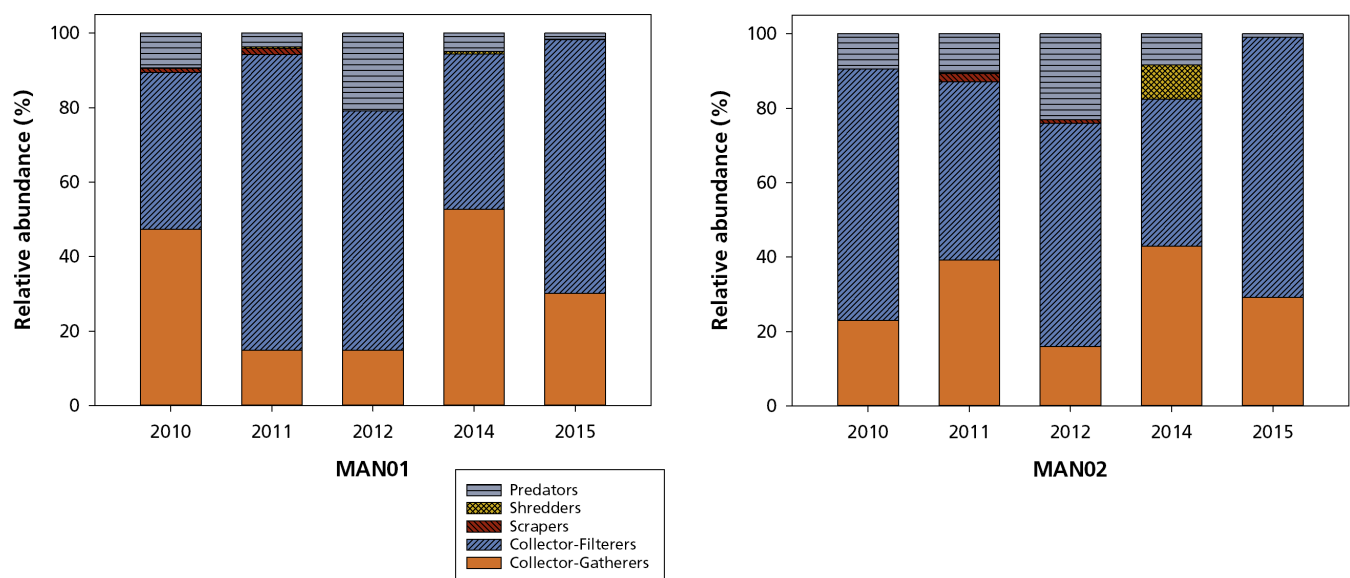


Figure 9. Mean relative abundance by functional feeding group in quantitative aquatic macroinvertebrate samples from MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected from either site in 2013 due to the U.S. federal government shutdown. In all 5 years, shredders never comprised more than 1% of the samples.

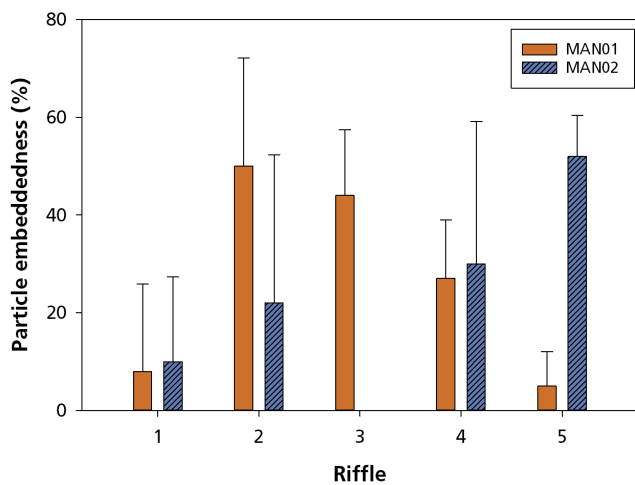


Figure 10. Mean particle embeddedness in samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2015.

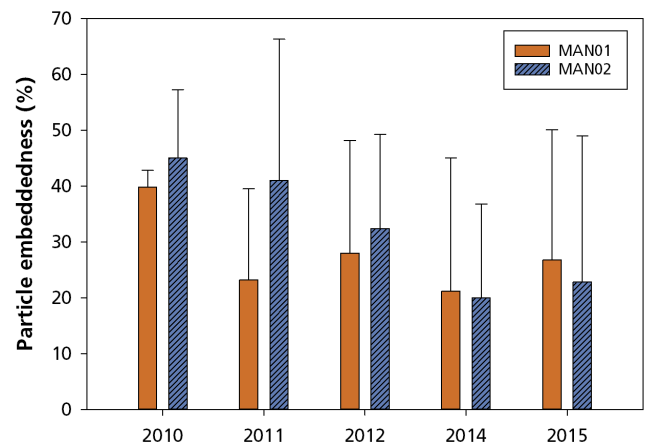


Figure 11. Mean particle embeddedness in samples from MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected from either site in 2013 due to the U.S. federal government shutdown.

Rock was the dominant habitat type at MAN01, accounting for 55.8% of the habitat sampled (Figure 12). Vegetation, found along 3.9% of the sampling reach at MAN01, was the second most frequent habitat type. Root wads occurred along 2.6 % of the reach, while both woody debris and root wads occurred along 1.6% of the sampling reach. The category “Absence”, (lacking habitat that we defined as appropriate for aquatic macroinvertebrates), occurred along 36.4% of MAN01. No algal mats or leaf packs were found at MAN01 in 2015.

Rock was the dominant habitat type at MAN02, accounting for 31.8% of the habitat sampled. Root wads accounted for 8.1%, and vegetation 4.1. “Absence” comprised 56.8% of the habitat sampled. No woody debris, leaf packs, or algal mats were found at MAN02 in 2015.

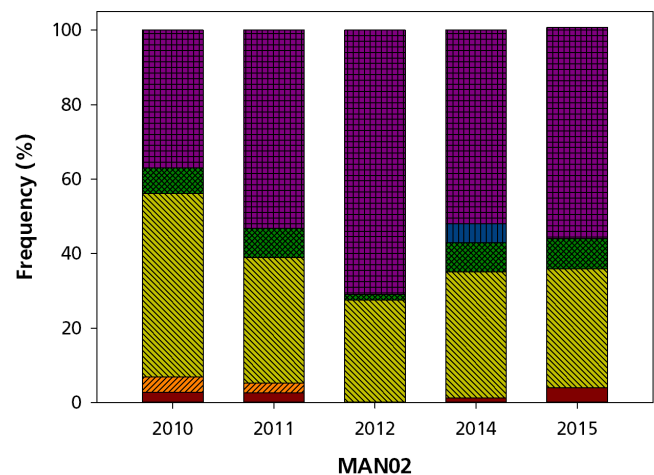
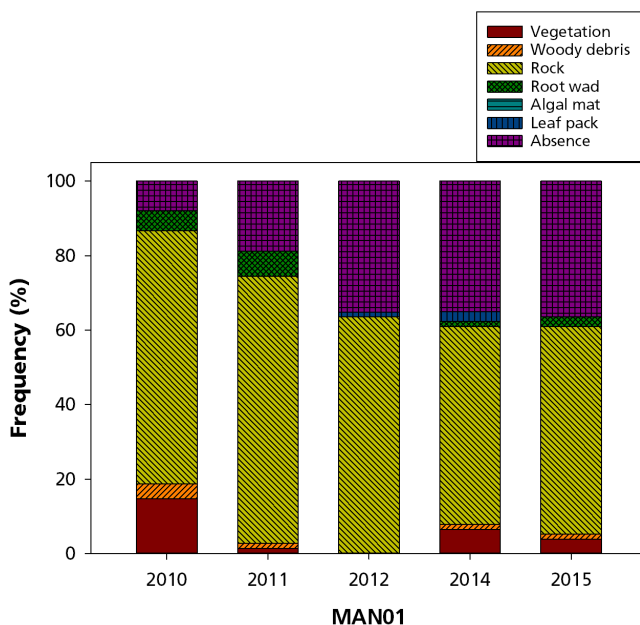


Figure 12. Habitat characterization, expressed as frequency of occurrence, along transects at MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. Some habitat structure types were not observed. No data were collected from either site in 2013 due to the U.S. federal government shutdown.

Reach level. Channel structure dynamics are represented by particle size distributions in Figure 13. At MAN01, cobbles (65–250 mm) were the dominant particle type, accounting for 34.5% of the particles sampled. Gravel (3–64 mm) and clay & silt (<0.06, gritty) comprised 31.3% and 7.8%, respectively, of the particles sampled. Sand (0.06–2 mm) was 7.5% , and boulders (251–4000 mm) 2.0% . Bedrock was <1.0%. Along the sampling reach, 16.5% of the particles were too cemented to measure.

At MAN02, gravels were the dominant particle type in 2015, comprising 41.5% of the particles measured (Figure 13). Cobble, and clay& silt were abundant at MAN02 at 35.0% and 9.8% respectively. Boulder accounted 0.5% of the particles sampled, and 13.3% were too cemented to measure.

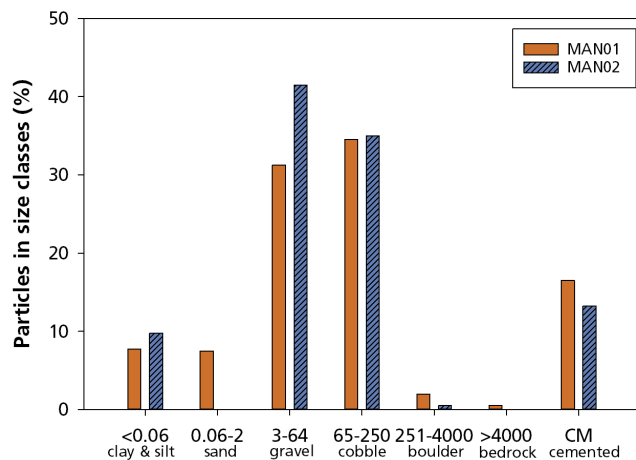


Figure 13. Particle size distribution along the reaches at MAN01 and MAN02 on the Mancos River in Mesa Verde NP, 2015. CM represents particles that are completely cemented into the stream channel, which precludes size measurements. No data were collected on the Mancos River in 2013 due to the U.S. federal government shut-down.

Figure 14 shows the proportion of each reach length characterized by different geomorphic channel units (GCU). In 2015, runs were the most abundant GCU at MAN01 (38.4%). Next were riffles, found along 31.9% of the sampling reach, and scour pools at 29.8%. Downstream at MAN02, runs were the dominant GCU, at 43.0% of the sampling reach, then riffles (36.0%), followed by scour pools (11.0%) and glides (10.0%).

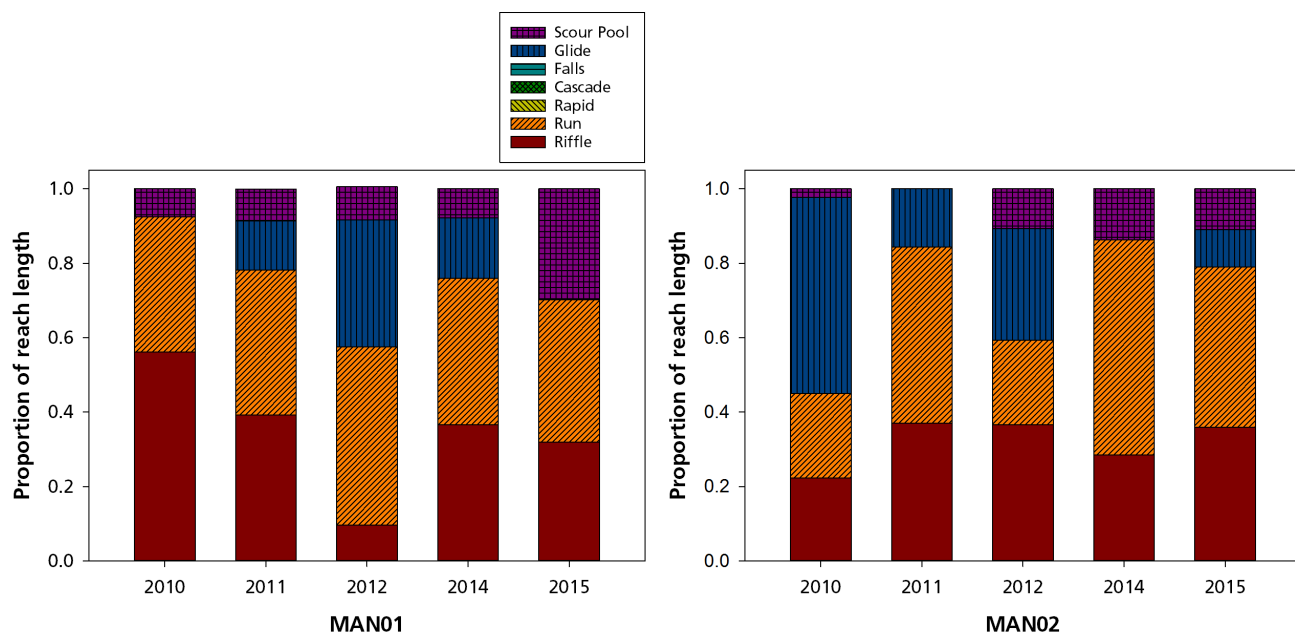


Figure 14. Geomorphic channel unit characterization of MAN01 (left) and MAN02 (right) on the Mancos River in Mesa Verde NP, 2010–2015. No data were collected at either site in 2013 due to the U.S. federal government shutdown.

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 25 September 2015 for MAN01 and 24 September 2015 for MAN02. Data from sampling years 2010–2015 at the Mancos River are available in Tables D4, D5 of Appendix D. At MAN01, the midday water temperature was 15.1°C. Specific conductance was 1488 $\mu\text{S}/\text{cm}$, and pH was 8.4. Dissolved oxygen was 99.5% saturation and 8.0 mg/L. Turbidity was 5.6 NTU and stream discharge was 8.0 cfs. At MAN02, the midday water temperature was 14.8°C. Specific conductance and pH were 1387 $\mu\text{S}/\text{cm}$ and 8.4, respectively. Dissolved oxygen was 101.3% saturation and 8.2 mg/L. Turbidity was 12.0 NTU and stream discharge measured 9.9 cfs.

Water and air temperatures were taken every 15 minutes at MAN01 in 2015 (Figure 15). The average water temperature was 8.5°C. A low water temperature of 0.121°C was recorded on several days during the year, typically when a surface freeze had occurred. A high water temperature of 27.2°C was recorded on 16 August. Due to sensor failure, the record for air temperature data for 2015 is incomplete. For the data we were able to collect the average air temperature at MAN01 was 5.7°C. A low air temperature of -25.1°C was recorded on 27 December. A high of 37.4°C was recorded on 27 July.

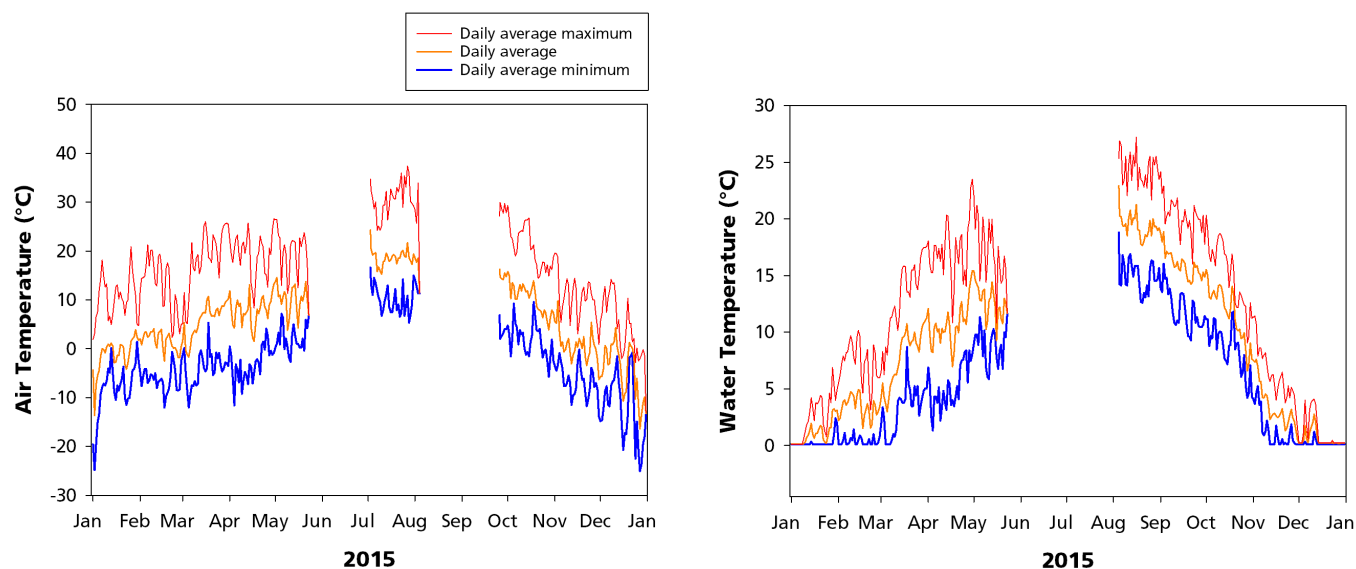


Figure 15. Air (left) and water (right) temperatures for MAN01 at Mesa Verde NP, recorded at 15 minute intervals in 2015.

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 28 January through 18 November 2015 (USGS 2016). Streamflow during winter is affected by ice and the USGS does not provide usable data for early January. The hydrograph for 2015 shows spikes occurring in June–September during the typical monsoon season. A very large flow event occurred on 11 June and reached a maximum discharge of 489.0 cfs. A second large flow event occurred on 4 September, with a maximum discharge of 427 cfs.

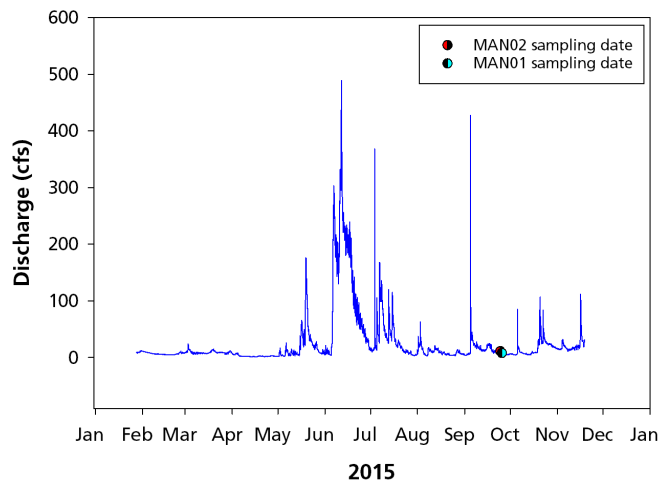


Figure 16. Discharge for the Mancos River in 2015 from USGS streamflow gaging station #09370600, near MAN01 at Mesa Verde NP.

4 Discussion

This report presents data from SCPN's eighth 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, 2015

Table A1. SCPN aquatic macroinvertebrate sites on the Mancos River in Mesa Verde NP, 2015. 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 Downstream 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, 2015

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 2015.

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	Functional group	Tolerance group	MAN01 ^a	MAN02 ^a
Annelida							segmented worms	collector-gatherer	n/a	x	x
Arthropoda	Arachnida	Trombidi-formes	Sperchonidae		<i>Sperchon</i> sp.		water mites	predator	tolerant	x	
Arthropoda	Arachnida	Trombidi-formes					water mites	predator	tolerant	x	x
Arthropoda	Entognatha	Collembola					springtails	collector-gatherer	tolerant		x
Arthropoda	Insecta	Coleoptera	Elmidae		<i>Microcylloepus</i> sp.	pusillus	rifle beetles	collector-gatherer	intolerant	x	
Arthropoda	Insecta	Coleoptera	Elmidae		<i>Optioservus</i> sp.		rifle beetles	scrapers	intolerant	x	
Arthropoda	Insecta	Coleoptera	Elmidae		<i>Zaitzevia</i>	<i>parvulus</i> (Horn)	rifle beetles	collector-gatherer	intolerant	x	
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	<i>Probezzia</i> sp.		biting midges	predator	moderately tolerant	x	
Arthropoda	Insecta	Diptera	Ceratopogonidae				biting midges	predator	moderately tolerant		x
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae			midges	collector-gatherer	moderately tolerant	x	x
Arthropoda	Insecta	Diptera	Chironomidae	Orthocla-diinae			midges	collector-gatherer	moderately tolerant	x	x
Arthropoda	Insecta	Diptera	Chironomidae				midges	collector-gatherer	moderately tolerant	x	x
Arthropoda	Insecta	Diptera	Empididae	Hemero-dromiinae	<i>Chelifera</i> sp.		dance flies	collector-gatherer	moderately tolerant	x	
Arthropoda	Insecta	Diptera	Empididae	Hemero-dromiinae	<i>Hemerodromia</i> sp.		dance flies	collector-gatherer	moderately tolerant	x	x
Arthropoda	Insecta	Diptera	Empididae		<i>Neoplasta</i> sp.		dance flies	predator	moderately tolerant	x	
Arthropoda	Insecta	Diptera	Empididae				dance flies	predator	moderately tolerant	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 2015.

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	Functional group	Tolerance group	MAN01 ^a	MAN02 ^a
Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	<i>Simulium</i> sp.		black flies	collector-filterer	moderately tolerant	x	x
Arthropoda	Insecta	Diptera	Simuliidae				black flies	collector-filterer	moderately tolerant		x
Arthropoda	Insecta	Diptera	Tipulidae		<i>Hexatoma</i> sp.		crane flies	predator	intolerant	x	x
Arthropoda	Insecta	Diptera					flies	n/a	tolerant		x
Arthropoda	Insecta	Ephemeroptera	Baetidae		<i>Baetis</i> sp.		small minnow mayflies	collector-gatherer	moderately tolerant	x	x
Arthropoda	Insecta	Ephemeroptera	Baetidae		<i>Fallceon</i> sp.		small minnow mayflies	collector-gatherer	n/a	x	x
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae		<i>Tricorythodes</i> sp.		little stout crawler mayflies	collector-gatherer	moderately tolerant	x	
Arthropoda	Insecta	Hemiptera	Veliidae	Microveliinae	<i>Microvelia</i> sp.		small water striders	predator	moderately tolerant	new	
Arthropoda	Insecta	Odonata	Coenagrionidae		<i>Argia</i> sp.		narrow-winged damselflies	predator	moderately tolerant	x	
Arthropoda	Insecta	Odonata	Coenagrionidae				narrow-winged damselflies	predator	tolerant	x	x
Arthropoda	Insecta	Odonata	Gomphidae				clubtail dragonflies	predator	intolerant	x	
Arthropoda	Insecta	Plecoptera	Perlodidae	Isoperlinae	<i>Isoperla</i> sp.		green-winged stoneflies	predator	intolerant	x	
Arthropoda	Insecta	Plecoptera	Perlodidae				green-winged stoneflies	predator	intolerant	x	x
Arthropoda	Insecta	Plecoptera					stoneflies	predator	tolerant		x
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	<i>Cheumatopsyche</i> sp.		net-spinning caddisflies	collector-filterer	moderately tolerant	x	
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	<i>Hydropsyche</i> sp.		net-spinning caddisflies	collector-filterer	intolerant	x	x
Arthropoda	Insecta	Trichoptera	Hydropsychidae				net-spinning caddisflies	collector-filterer	intolerant	x	x
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilinae	<i>Hydroptila</i> sp.		microcaddisflies	scraper	moderately tolerant	x	
Arthropoda	Insecta	Trichoptera	Hydroptilidae				microcaddisflies	n/a	intolerant	x	
Arthropoda	Malacostraca	Amphipoda	Hyalellidae		<i>Hyalella</i> sp.		amphipods	collector-gatherer	tolerant	x	
Nemata							roundworms	n/a	n/a		x

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, 2010–2015

Table D1. Quantitative aquatic macroinvertebrate community metrics from MAN01 on the Mancos River in Mesa Verde NP, 2010–2015. 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	2010		2011		2012		2014		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Abundance	288.20	78.72	469.40	345.12	160.40	123.27	299.80	200.27	462.00	207.01
Total Richness	15.00	1.73	12.20	1.48	12.60	2.07	10.60	2.30	9.40	1.82
Simpson's Diversity-Taxonomic	0.71	0.06	0.46	0.21	0.72	0.11	0.70	0.04	0.51	0.07
Simpson's Diversity-Functional Group	0.58	0.05	0.33	0.15	0.48	0.14	0.54	0.02	0.43	0.07
Relative Abundance-Tolerant Taxa	0.67	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Relative Abundance-Moderately Tolerant Taxa	55.99	8.81	21.72	13.27	57.32	13.52	82.19	10.26	34.59	9.72
Relative Abundance-Intolerant Taxa	43.33	8.99	78.28	13.27	42.68	13.52	17.81	10.26	65.41	9.72
Richness-Tolerant Taxa (%)	7.13	5.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Richness- Moderately Tolerant Taxa (%)	56.78	8.07	49.11	14.28	61.67	7.45	65.69	12.71	64.22	10.20
Richness- Intolerant Taxa (%)	36.09	5.51	50.89	14.28	38.33	7.45	34.31	12.71	35.78	10.20
Relative Abundance- Collector-Filterers	42.11	9.23	79.46	11.29	64.34	17.46	41.67	6.07	68.13	10.83
Relative Abundance- Collector-Gatherers	47.39	8.53	14.85	8.21	14.83	2.45	52.65	4.68	30.14	10.75
Relative Abundance- Scrapers	1.04	0.50	1.57	2.53	0.00	0.00	0.00	0.00	0.14	0.13
Relative Abundance- Shredders	0.06	0.13	0.37	0.41	0.00	0.00	0.72	0.62	0.00	0.00
Relative Abundance- Predators	9.40	5.65	3.76	2.11	20.83	16.64	4.96	2.74	1.60	0.70
Richness- Collector-Filterers (%)	13.78	1.13	26.37	5.92	18.19	3.55	25.86	9.26	25.78	6.96
Richness- Collector-Gatherers (%)	39.66	3.67	33.49	7.65	39.23	5.95	29.51	7.20	36.00	7.96
Richness- Scrapers (%)	6.89	0.56	9.22	6.54	0.00	0.00	0.00	0.00	6.22	5.70
Richness- Shredders (%)	1.18	2.63	5.36	4.96	0.00	0.00	8.84	5.67	0.00	0.00
Richness- Predators (%)	38.49	3.99	25.56	9.41	42.59	3.34	35.79	10.26	32.00	7.30
Number of EPT Taxa	4.40	1.52	5.20	1.10	4.00	1.00	4.60	1.14	3.80	1.10

Table D1. (*continued*) Quantitative aquatic macroinvertebrate community metrics from MAN01 on the Mancos River in Mesa Verde NP 2010–2015. 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.

[illegible]

Table D2. Quantitative aquatic macroinvertebrate community metrics from MAN02 on the Mancos River in Mesa Verde NP, 2010–2015. 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. Data were not collected at MAN02 in 2009 due to inclement weather. N=5 for all years. “nd” indicates that no data were collected. SD = standard deviation.

Quantitative metric	2010		2011		2012		2014		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Abundance	419.20	121.49	202.40	164.62	245.40	150.75	66.00	34.24	378.60	270.20
Total Richness	12.60	2.88	12.00	3.08	13.80	2.49	8.25	1.26	7.20	0.84
Simpson's Diversity-Taxonomic	0.54	0.09	0.70	0.08	0.66	0.09	0.79	0.04	0.43	0.19
Simpson's Diversity-Functional Group	0.47	0.11	0.53	0.08	0.48	0.08	0.62	0.03	0.30	0.16
Relative Abundance-Tolerant Taxa	0.05	0.11	0.09	0.19	0.00	0.00	0.00	0.00	0.20	0.22
Relative Abundance-Moderately Tolerant Taxa	28.27	6.24	52.63	21.67	39.95	22.01	70.26	12.23	84.82	9.34
Relative Abundance-Intolerant Taxa	71.69	6.31	47.29	21.59	60.05	22.01	29.74	12.23	14.98	9.53
Richness-Tolerant Taxa (%)	1.43	3.19	1.82	4.07	0.00	0.00	0.00	0.00	10.67	9.83
Richness- Moderately Tolerant Taxa (%)	53.24	9.85	60.02	16.44	57.22	12.04	54.61	16.92	62.00	7.30
Richness- Intolerant Taxa (%)	45.34	11.01	38.16	14.85	42.78	12.04	45.39	16.92	27.33	8.30
Relative Abundance- Collector-Filterers	67.48	11.19	47.96	21.46	59.99	22.64	39.43	15.76	69.92	29.26
Relative Abundance- Collector-Gatherers	23.02	6.06	39.15	22.32	15.95	5.43	42.93	12.16	29.14	28.40
Relative Abundance- Scrapers	0.08	0.11	2.21	2.37	0.97	0.86	0.00	0.00	0.00	0.00
Relative Abundance- Shredders	0.00	0.00	0.26	0.41	0.00	0.00	9.20	4.76	0.00	0.00
Relative Abundance- Predators	9.43	6.16	10.41	4.38	23.08	22.53	8.45	8.70	0.94	0.95
Richness- Collector-Filterers (%)	21.39	6.79	22.14	5.85	19.15	4.05	24.64	3.52	30.48	2.61
Richness- Collector-Gatherers (%)	28.23	4.99	40.24	11.10	30.83	6.12	33.84	7.91	51.90	14.33
Richness- Scrapers (%)	2.92	4.06	6.43	3.82	7.97	5.13	0.00	0.00	0.00	0.00
Richness- Shredders (%)	0.00	0.00	2.76	3.79	0.00	0.00	19.02	9.14	0.00	0.00
Richness- Predators (%)	47.46	5.00	28.43	7.36	42.05	3.36	22.50	19.47	17.62	15.58
Number of EPT Taxa	4.80	1.30	4.80	1.30	4.20	1.48	4.50	1.29	2.80	0.84
Relative Abundance of EPT Taxa	88.04	5.34	70.82	26.08	51.28	22.70	39.95	12.73	40.96	34.50
Relative Abundance of Ephemeroptera	20.12	5.45	28.97	18.39	4.44	2.29	11.42	2.90	27.32	27.34
Relative Abundance of Plecoptera	3.61	1.07	1.61	1.89	0.86	0.74	10.29	5.60	0.14	0.21

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. Data were not collected at MAN02 in 2009 due to inclement weather. 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, 2010–2015. 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. Data for 2015 for MAN02 are not reported as the sample was incomplete.

	MAN01					MAN02			
Qualitative metric	2010	2011	2012	2014	2015	2010	2011	2012	2014
Taxa richness	25	23	18	14	20	19	27	20	16
Tolerance group									
Richness of tolerant taxa (%)	0.00	5.26	18.75	7.14	5.56	11.11	4.17	16.67	12.50
Richness of moderately tolerant taxa (%)	63.64	57.89	56.25	42.86	61.11	55.56	54.17	55.56	50.00
Richness of intolerant taxa (%)	36.36	36.84	25.00	50.00	33.33	33.33	41.67	27.78	37.50
Functional group									
Richness of collector-filterers (%)	12.50	14.29	17.65	14.29	15.79	11.11	11.54	10.00	12.50
Richness of collector-gatherers (%)	33.33	28.57	41.18	35.71	42.11	33.33	30.77	50.00	31.25
Richness of scrapers (%)	8.33	4.76	0.00	0.00	5.26	11.11	7.69	0.00	6.25
Richness of shredders (%)	12.50	4.76	0.00	14.29	0.00	11.11	7.69	0.00	12.50
Richness of predators (%)	33.33	47.62	41.18	35.71	36.84	33.33	42.31	40.00	37.50
Taxonomic group									
Number of EPT taxa	9	9	3	6	6	5	8	6	7
Richness of EPT taxa (%)	36.00	39.13	16.67	42.86	30.00	26.32	29.63	30.00	43.75
Richness of Ephemeroptera (%)	20.00	13.04	5.56	14.29	15.00	15.79	18.52	20.00	12.50
Richness of Plecoptera (%)	4.00	8.70	0.00	14.29	5.00	5.26	3.70	5.00	18.75
Richness of Trichoptera (%)	12.00	17.39	11.11	14.29	10.00	5.26	7.41	5.00	12.50
Richness of noninsect ^a taxa (%)	16.00	21.74	22.22	7.14	15.00	15.79	18.52	20.00	12.50
Richness of Chironomidae Diptera (%)	8.00	13.04	16.67	21.43	10.00	15.79	11.11	15.00	12.50
Richness of non-Chironomidae Diptera (%)	20.00	17.39	27.78	21.43	25.00	31.58	25.93	30.00	25.00
Richness of Coleoptera (%)	12.00	8.70	11.11	7.14	15.00	10.53	11.11	5.00	6.25
Richness of Odonata (%)	8.00	0.00	5.56	0.00	5.00	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, 2010–2015. Data were not collected in 2013 due to the U.S. federal government shutdown. “nd” indicates that no data were collected. SD = standard deviation.

Physical habitat metric	2010		2011		2012		2014		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Microhabitat level (n = 5)										
Velocity (m/s)	0.47	0.17	0.68	0.37	0.33	0.13	0.54	0.19	0.49	0.13
Depth (m)	0.14	0.05	0.18	0.04	0.06	0.02	0.12	0.04	0.14	0.06
Embeddedness (%)	39.8	3.0	23.2	10.6	28.0	11.4	21.2	16.5	26.8	20.4
Transect level (n = 11)										
Channel dimensions										
Velocity (m/s)	0.49	0.16	0.41	0.15	0.09	0.08	0.34	0.17	0.28	0.14
Depth (m)	0.21	0.08	0.18	0.07	0.07	0.06	0.20	0.10	0.27	0.13
Wetted channel width (m)	4.9	1.9	4.7	1.5	3.5	1.3	4.4	1.8	4.4	1.2
Active channel width (m)	8.4	2.0	15.7	5.9	>50.0	0.0	5.1	1.8	4.63	1.2
Riparian cover										
Canopy closure (%)	0.0	0.0	16.6	25.2	18.5	29.7	7.3	18.5	25.7	27.3
Reach level (n = 1)										
Water quality										
Temperature (°C)	14.2		14.0		8.5		6.2		15.1	
Specific conductance (µS/cm)	1288		1315		2180		1398		1488	
pH	8.4		8.3		8.2		8.3		8.4	
Dissolved oxygen (% saturation)	104.2		103.1		104.6		103.0		99.5	
Dissolved oxygen (mg/L)	8.3		8.5		9.7		10.2		8.0	
Turbidity (NTU)	9.8		8.7		1.7		6.5		5.6	
Discharge (cfs)	11.5		9.7		0.6		8.0		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, 2010–2015. Data were not collected in 2013 due to the U.S. federal government shutdown. “nd” indicates that no data were collected. SD = standard deviation.

Physical habitat metric	2010		2011		2012		2014		2015	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Microhabitat level (n = 5)										
Velocity (m/s)	0.77	0.32	0.47	0.37	0.11	0.03	0.52 ^a	0.27	0.82	0.37
Depth (m)	0.14	0.07	0.11	0.05	0.10	0.02	0.12 ^a	0.03	0.13	0.06
Embeddedness (%)	48.4	12.9	41.0	15.6	32.4	11.7	20.0 ^a	5.0	22.8	19.9
Transect level (n = 11)										
Channel dimensions										
Velocity (m/s)	0.39	0.19	0.39	0.18	0.10	0.06	0.34	0.12	0.33	0.13
Depth (m)	0.19	0.07	0.21	0.08	0.11	0.07	0.24	0.09	0.25	0.12
Wetted channel width (m)	5.4	1.7	5.2	1.0	3.2	1.0	4.6	1.3	5.5	2.4
Active channel width (m)	8.0	2.8	44.4	9.8	>50.0	0	5.4	1.3	5.9	2.9
Riparian cover										
Canopy closure (%)	1.3	4.6	20.2	26.2	16.9	33.0	7.9	21.8	22.8	29.7
Reach level (n = 1)										
Water quality										
Temperature (°C)	13.4		14.4		8.9		7.0		14.8	
Specific conductance (µS/cm)	1326		1283		1980		1351		1387	
pH	8.3		8.4		8.4		8.5		8.4	
Dissolved oxygen (% saturation)	106.1		103.3		102.1		100.7		101.3	
Dissolved oxygen (mg/L)	8.6		8.5		9.4		9.8		8.2	
Turbidity (NTU)	17.6		9.0		3.1		nd		12.0	
Discharge (cfs)	10.4		10.8		0.8		8.5		9.9	

^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, 2015. 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	0.16	0.03	0.14	0.22	5.80	5.75
2	0.10	0.05	0.30	0.11	7.28	7.25
3	0.41	0.15	0.25	0.37	5.09	5.60
4	0.40	0.04	0.20	0.05	3.50	3.55
5	0.45	0.11	0.15	0.12	3.57	3.84
6	0.21	0.05	0.45	0.25	3.04	3.15
7	0.23	0.10	0.25	0.12	4.22	4.55
8	0.20	0.08	0.55	0.44	4.00	4.35
9	0.27	0.04	0.32	0.15	3.75	3.80
10	0.45	0.08	0.11	0.16	3.67	3.77
11	0.15	0.06	0.32	0.22	4.74	5.35
MAN02						
1	0.16	0.03	0.44	0.12	4.26	4.35
2	0.20	0.06	0.43	0.13	3.95	4.18
3	0.14	0.04	0.51	0.26	4.73	4.70
4	0.27	0.01	0.29	0.07	4.17	4.22
5	0.36	0.14	0.32	0.31	4.10	4.15
6	0.13	0.17	0.20	0.25	11.75	13.60
7	0.51	0.1	0.12	0.09	7.61	8.40
8	0.35	0.11	0.24	0.07	3.93	4.17
9	0.30	0.15	0.26	0.23	3.99	4.18
10	0.12	0.04	0.52	0.16	5.65	5.90
11	0.17	0.06	0.27	0.16	6.30	6.90

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1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

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