Rapid River Assessment of the Uncompahgre Watershed

Ouray, Montrose, and Delta County Colorado

June 22, 2012

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The Uncompahgre Watershed Partnership

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Acknowledgements

This study was made possible by funding through the Colorado Healthy River Fund of the Colorado Water Conservation Board. The Colorado Healthy Rivers Fund is financed by the Colorado check-off program which provides tax payers the opportunity to contribute a portion of their tax return or to make a donation to assist locally-based conservation groups in their efforts to protect our land and water resources.

We would like to thank the Uncompahgre Watershed Partnership (UWP) stakeholders for their feedback, advice and input into both the creation of this study and our evaluation of its results. This study was designed to be a tool for the UWP to use in their efforts to understand, protect and restore the Uncompahgre River and its watershed.

We would like to thank Jeff Crane, Bill Coughlin, Steve Boyle, and Sue McIntosh for their help in the design of this study. Your generous and expert advice was of immense value.

We would also like to thank the Western Hardrock Watershed Team for providing the Uncompahgre Watershed Partnership with outstanding AmeriCorps OSM/VISTA volunteers, Rachel Boothby and Matthew Jurjonas Your volunteers have provided an invaluable service to the UWP, Uncompahgre Watershed, communities in Ouray County, and the state-wide watershed community. The AmeriCorps OSM/VISTA volunteers were not only instrumental in all aspects of this study: design, implementation, volunteer coordination, outreach, and report writing. A special thank you is alos extended to the AmeriCorps OSM/VISTA volunteers who traveled from other parts of the state to participate in this study.

We would especially like to thank the volunteers who assisted with this study. Each of the 23 volunteers donated twelve hours of their time over a beautiful October weekend to conduct the Rapid River Assessment of the Uncompahgre Watershed. We could not have done this study without them. Thank you to Adam Petry, Anna Santo, Adrian Uzurnian, Andrew Madison, Arlene Crawford, Bill Brueggeman, Brad Stewart, Brett Fletcher, Casey Carrigan, Dale Rolfson, Dave Grobecker, Jeff Litteral, Larry Hudnall, Lynn Hoyt, Maureen Briggs, Mick Graff, Kathy Graff, Ronald Ewing, Scott Scarborough, Sheena Broussard, Susan Mills, Sheelagh Williams, Scott Williams.

Executive Summary

The Uncompahgre Watershed is characterized by high and low gradient streams, riparian zones that are structurally and biologically diverse, and multiple land uses and resource management practices. The riparian systems in this watershed provide many benefits to water quality and quantity, wildlife and biological diversity, and human quality of life. Riparian zones are transitional areas between upland habitats and bodies of water including creeks, streams, rivers, wetlands, lakes and often times, irrigation ditches. High aboveground production, vegetation structural diversity, accumulation of organic material and proximity to water make riparian zones excellent wildlife habitats. They have been considered "keystone nodes" within landscapes as they are utilized by aquatic and terrestrial species: invertebrates, amphibians, reptiles, fish, migratory birds, and large mammals, especially ungulates. The vegetation and root systems of riparian zones trap sediment, stabilize stream banks and reduce erosion. Healthy riparian ecosystems are also effective in removing pollutants such as sediment and nutrients from uplands.

Riverine ecosystems are complex systems that frequently change under dynamic hydrologic conditions. The riparian zones within the Uncompahgre watershed are at various states of equilibrium and in need of assessment to identify impairments as well as priorities for restoration or protection. The Rapid River Assessment of the Uncompahgre Watershed was designed to provide baseline data on aquatic and riparian habitat quality, water quality, in-stream habitat, channel physical attributes, riparian vegetation structure and cover, and aquatic macroinvertebrates. The watershed was divided into 4 regions (headwaters to confluence with the Gunnison River). Four to 5 sites were selected within each region for a total of 17 sampling sites. Recommendations for future monitoring and restoration were summarized into 3 areas:

Upper Watershed (Headwaters to Ouray)

Recommendations for improvements include:

- mitigation of acid mine drainage and mine reclamation to reduce anthropogenic heavy metal loading into streams,
- channel restoration/engineering efforts that include pools and in-stream structures,
- restoration of sediment transport dynamic above the hydrodam or removal of sediment trapped by the dam to improve natural geomorphic processes above the dam,
- better understanding of downstream impacts from flushing potentially heavy metal-laden sediment from the dam.

Monitoring recommendations include:

- addition of sampling sites in the headwaters of the Uncompahgre River upstream of Red Mountain Creek-Uncompahgre River to identify potential impairments from abandoned mines,
- addition of a sampling site just below the tributary junction of Red Mountain Creek-Uncompahgre River to collect baseline data before remediation of Red Mountain Creek,
- continued sampling of sites included in Region 1 of this assessment,
- collection of water quality data (pH, DO, metal loading, discharge) in addition to habitat metrics,

- addition of macroinvertebrate sampling site (especially above the Red Mountain Creek-Uncompahgre River tributary junction) to establish a baseline data set.

Middle Watershed (Ouray to Ridgway Reservoir)

Recommendations for improvements include:
- reduction of iron and other metals in the river (this might be mitigated by reductions of metal loading in the Upper Watershed),
- planting of riparian hardwoods to stabilize river banks, provide stream canopy cover, terrestrial nutrient inputs, and large wood recruitment into streams,
- improvements to in-stream habitat structure through creation of pools, backwaters or wetlands; this should be especially considered as part of other riparian active restoration projects,
- stabilization of river banks to mitigate flooding where necessary to protect private property or infrastructure (these efforts should include in-stream structures for aquatic habitats).

Monitoring recommendations include:
- addition of at least one more sampling site between the KOA and Ridgway because land use is different along this stretch of the watershed and additional sources of point or non-point source pollution might exist,
- continued sampling of sites included in Region 2 of this assessment,
- collection of water quality data (pH, DO, metal loading, discharge) in addition to river assessment habitat metrics,
- macroinvertebrate sampling to generate a baseline data set to monitor change over time.

Lower Watershed (Ridgway Reservoir to Confluence)

Monitoring recommendations include:
- projects to increase in-stream structure (planting of riparian willows and cottonwoods could be a surrogate for pools and in-stream structure because over-hanging vegetation and undercut banks and root crowns in these regions have been shown to provide fish habitat),
- creation of pools and aquatic habitats (i.e. rock veins, backwater channels, wetlands) should be part of active restoration and stream engineering projects especially in public use areas,
- bank stabilization in high use areas,
- assessment of nutrient inputs from agricultural areas and sediment/salts/nutrients from residential and municipal areas,
- removal of invasive species.

Monitoring recommendations include:
- addition of sampling sites where non-point nutrient loading and urban run-off is anticipated (this assessment did not include those sites) to assess potential contamination levels,
- collection of water quality data (pH, DO, metal loading, discharge) in addition to river assessment habitat metrics,
- continued macroinvertebrate sampling to evaluate change over time.

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INTRODUCTION

Riparian Ecology and Functionality

Riparian zones are transitional areas between upland habitats and bodies of water including creeks, streams, rivers, wetlands, lakes and often times, irrigation ditches. Riparian zones are focal points for maintenance and restoration of biological diversity, wildlife habitat, and water quality throughout forest and rangeland landscapes of the western United States (US). Although riparian zones and wetlands only cover 1-2% of these landscapes, they are critical ecosystems from both a biological and economic perspective (Kauffman and Krueger 1984). They are complex systems characterized by high productivity, high plant and wildlife diversity, buffering potentials, zones of soil erosion and deposition, and temporally and spatially variable biogeochemical cycles (Kauffman and Krueger 1984, Gregory et al. 1991, Gilliam 1994, Clary and Leininger 2000, Blank et al. 2006).

Aboveground production, vegetation structural diversity, accumulation of organic material and proximity to water make riparian zones excellent wildlife habitats. They have been considered "keystone nodes" within landscapes as they are utilized by aquatic and terrestrial species: invertebrates, amphibians, reptiles, fish, migratory birds, and large mammals, especially ungulates (Naiman et al. 2005). Riparian areas and stream banks provide substrate for insects emerging from water (a food source for birds), microhabitats for frogs, toads, salamanders and reptiles that require aquatic-terrestrial interfaces to complete their life cycles (Benke and Wallace 1990, Graf et al. 2002, NRC 2002). Riparian vegetation is especially crucial for enhancing in-stream habitat for aquatic invertebrates and fish. It is also a source of organic inputs which sustain these food webs, for example, terrestrial invertebrates can provide as much as 50% of energy needs to fish such as trout (Wipflli 1997). The zones are also a source of large wood inputs which can create structural habitat: pools, eddies, and back channels for fish. Wood provides a stable substrate in streams dominated by fine grained bed sediment (Junk et al. 1989). Stream bank riparian vegetation provides canopy cover which shades and cools streams. Furthermore, riparian ecosystems function as corridors for wildlife movement (i.e. migratory birds, ungulates) between different habitats and across landscapes and consequently facilitate gene flow and biological diversity (Naiman et al. 1993, Fischer et al. 2000).

Riparian vegetation is often a preferential food source for ungulates, both wild species as well as domestic livestock. Cattle often congregate in riparian areas and utilize the vegetation much more intensively than in adjacent uplands (Roath and Krueger 1982, Schulz and Leininger 1990). Heavy livestock use of riparian areas may result in decreased plant vigor, productivity, changes in species composition, altered biogeochemical cycles and bank destabilization (Shultz and Leininger 1991, Belsky et al. 1999). Changes in cattle grazing practices in riparian zones since the late 1960s (reduced stocking rates, rotational practices, riparian exclosures) have facilitated recovery of previously livestock-degraded riparian areas. Continued adaptive management is critical to restore and enhance proper functioning of riparian zones where livestock are grazed.

Another unique attribute of riparian zones is their potential to buffer runoff into aquatic systems. Healthy riparian ecosystems are effective in removing sediments and nutrients from uplands (Mosley et al. 1997, Pearce et al. 1998, Corley et al. 1999, Hook 2003) and agricultural areas

(Cooper et al. 1987, Daniels and Gilham 1996) and, thus, decrease nonpoint-source pollution to the stream. Nonpoint upland sources have the greatest impact on water quality in rivers and streams in Wyoming and Colorado (Hogan 1988). Several pollutants, including nitrogen (N) and phosphorus (P) along with endocrine disruptors, may be associated with organics or soil particles and are transported in runoff water (Sharpley 1985, Hubbard et al. 1999, McEldowney et al. 2002). Although N and P are essential nutrients for plant growth, elevated concentrations in surface water can cause eutrophication of surface waters that is detrimental to many aquatic life forms (Monke et al. 1981).

The vegetation and root systems of riparian zones not only buffer nonpoint-source pollution to streams but they also stabilize stream banks and reduce erosion (Kauffman and Krueger 1984, Naiman et al. 2005). Dense root systems of rushes, sedges and willows trap sediment and reduce shear stresses of water flowing along stream banks (Florsheim et al 2008). In high gradient channels riparian vegetation can reduce incision and channelization and in low gradient systems it can help maintain channel sinuosity. Improved bank stability of vegetated riparian zones is also critical for dissipating energy of flowing water during high discharge or flood events (NRC 2002) and thus, is important for flood mitigation in developed or residential areas. Riparian vegetation near stream banks is exposed to different flood frequencies, duration and magnitudes (NRC 2002, Naiman et al. 2005) which results in a successional gradient of plant communities. Riparian communities closest to the channel are colonized by fast-growing herbaceous species that are adapted to water: sedges, rushes, grasses, herbs, and seedlings of trees and shrubs (Gregory et al. 1991, NRC 2002). Species of willow, alder, and cottowood establish further away from the channel edge, often at higher elevations or terraces. These species' roots are adapted to periodic floods (NRC 2002). The diverse riparian plant communities are a result of dynamic erosion-deposition processes and not all bank erosion is detrimental. Bank erosion is an integral component of river ecosystems because it promotes riparian vegetation succession and diversity and creates habitats for aquatic and riparian species (Florsheim et al 2008, Salo et al. 1986). Cottonwood seedlings, for example, require bare substrate created during floods to establish along river banks (Friedman and Auble 2000). Therefore, it is important to recognize that riverine ecosystems are complex systems that frequently change under dynamic hydrologic conditions.

Uncompahgre River Watershed

A detailed description of the Uncompahgre Watershed is available in the Uncompahgre Watershed Plan.

The Uncompahgre River is a 3rd order stream that drains 1,115 square miles of the upper Colorado River Basin. It is the largest tributary to the Gunnison River. The Uncompahgre River flows north for 77 miles from the Alaska Basin in San Juan Mountains to its confluence with the Gunnison River in Delta, Colorado (Fig. 1). The Uncompahgre is non-navigable except at high water. Starting at an elevation over 10,000 feet in glaciated valleys, the river descends through mixed coniferous and aspen forests, Gambles oak shrublands, pinon-juniper woodlands, shrub steppe, wet meadows and agricultural lands on its way to Delta at an elevation of less than 5,000 feet. Riparian vegetation changes along the elevation gradient: at high elevations it comprises of

Engleman spruce, Douglas fir, aspen and willow, at mid-elevations it consists of river birch, red-osier dogwood, silver buffalo berry, Rocky Mountain juniper and some aquatic herbaceous species, and at low elevations is dominated by cottonwoods, willows, skunkbrush, sedges, rushes, grasses and herbs adapted to aquatic environments (Blair 1996).

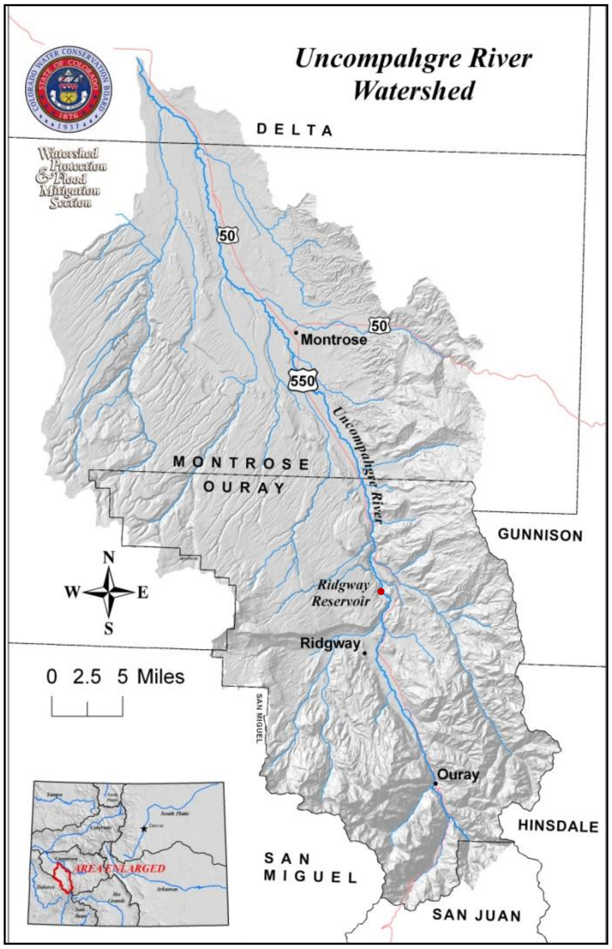

Figure 1. The Uncompahgre River Watershed.

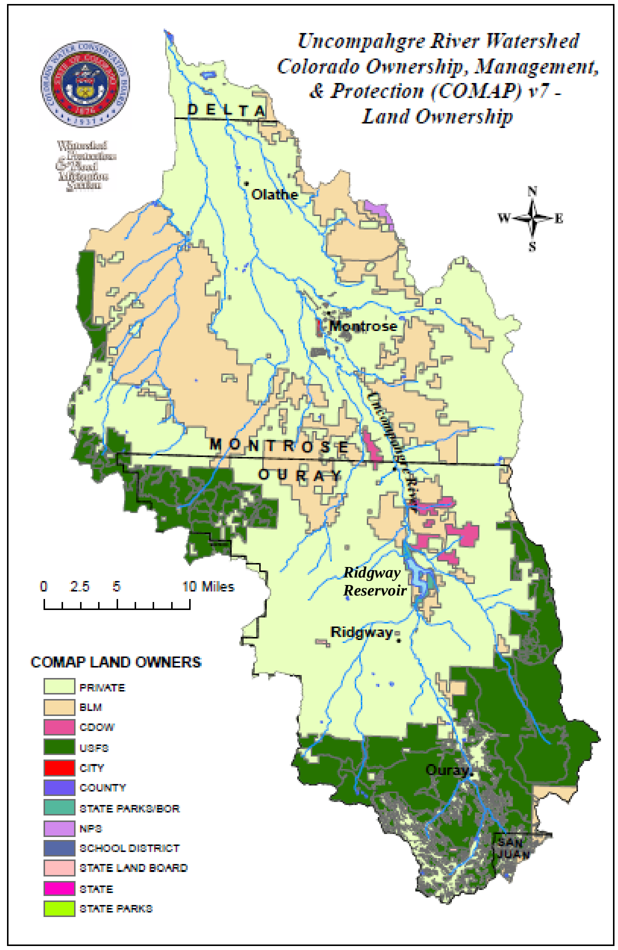

Figure 2. Land ownership in the Uncompahgre River Watershed.

The Uncompahgre Watershed includes Ouray and Montrose counties and a portion of Delta county. Approximately half of the land in the Uncompahgre River Watershed is managed for conservation and recreation by the federal government (Fig. 2). The US Forest Service (USFS) manages the Grand Mesa Uncompahgre National Forest (GMUG) and San Juan National Forest located mostly in the upper watershed. Additionally, there are 2 federally designated wilderness areas in the upper Uncompahgre: the Uncompahgre Wilderness and Mt. Sneffles Wilderness. The State of Colorado manages Billy Creek and Chipeta State Wildlife Areas as well as Ridgway and Sweitzer Lake State Parks while the Bureau of Land Management (BLM) manages a large portion of rangelands in the lower watershed. The rest of the lands are private: residential, commercial, and agricultural. Approximately 11% of the watershed is irrigated agriculture which is aggregated along the river valley in Montrose and Delta Counties.

Recreation and tourism activities are economically important to the Uncompahgre Valley and some have direct impacts on the riverine ecosystems. Popular activities include jeeping, hunting, skiing, backpacking, fishing and wildlife viewing. There are multiple public access points on the Uncompahgre River including the Ouray River Walk, Rollans Park in Ridgway, Ridgway State Park, the Uncompahgre Riverway and Baldridg Park in Montrose, and Confluence Park in Delta. Each park has a pedestrian trail system, fishing access, and wildlife viewing. Rollans Park currently has two constructed waves designed for boaters. Rollans Park is home to the annual Ridgway River Festival. Ridgway State Park is the gem of the Colorado State Park system (331,775 visitors in 2009-2010) providing boating, swimming, camping and fishing opportunities as well as a Gold Medal trout fishery in Pa-Co-Chu-Puk.

There are several tributaries that have significant effects on the health of the Uncompahgre River. Red Mountain Creek, originating near the top of Red Mountain Pass, meets the Uncompahgre River above the Uncompahgre Gorge. Natural mineralization in addition to an extensive network of historic mining infrastructure in the Red Mountain Creek basin contribute low pH and substantial amounts of heavy metals to the Uncompahgre River. Other tributaries such as Canyon Creek above Ouray and Cow Creek south of Ridgway contribute flows that have an overall dilution effect on the Uncompahgre River. Tributaries such as Cedar Creek, and Dry Cedar Creek, and Dry Creek below Ridgway Reservoir drain the selenium-rich Mancos Shale agricultural lands of the lower watershed.

While natural mineralization and acid mine drainage contributes heavy metals to the Uncompahgre River in the upper watershed, farms, ranches, and urban areas contribute sediment, nutrients, and bacteria via irrigation return flows or storm water discharges in the lower watershed. Deep groundwater percolation from irrigation, ponds and septic systems are also sources of salt and selenium. The communities of Ouray, Ridgway, Montrose, Olathe and Delta are located along the mainstream Uncompahgre River. They each operate domestic wastewater treatment plants that discharge directly to the Uncompahgre River. Trans-mountain diversion water also influences water quality and quantity in the Uncompahgre River. Approximately 850,000 AFY from the Gunnison River are diverted to the Uncompahgre valley via the Gunnison Tunnel and South Canal located east of Montrose. The trans-mountain diversion increases the amount of water flowing through the Uncompahgre River Basin for the majority of each year (March through November). There are two dams on the Uncompahgre River, a small diversion dam in the Uncompahgre Gorge (Ouray Hydrodam), and Ridgway Dam below the town of Ridgway which forms Ridgway Reservoir.

The Uncompahgre Watershed is characterized by high and low gradient streams, riparian zones that are structurally and biologically diverse, and multiple land uses and resource management practices. The riparian systems in this watershed provide many benefits to water quality and quantity, wildlife and biological diversity, and human quality of life. The riparian zones within the watershed are at various states of equilibrium and in need of assessment to identify impairments as well as priorities for restoration or protection.

METHODS

The Rapid River Assessment of the Uncompahgre Watershed was designed to provide baseline data on aquatic and riparian habitat quality, water quality, in-stream habitat, channel physical attributes, riparian vegetation structure and cover, and aquatic. The assessment was based on a modified EPA protocol (Barbour et al. 1999) and NRCS Visual Assessment (Newton et al. 1998). Seventeen sites between Uncompahgre's headwaters and confluence with the Gunnison River were chosen based on access, existing monitoring data, and representativeness (land use, channel gradient, water quality impairments). Five sites were in high gradient reaches upstream of the City of Ouray (Region 1), 12 sites (Region 2-4) were in low gradient reaches downstream from Ouray to the confluence in Delta (Fig. 3). The assessment was designed and completed by the Uncompahgre Watershed Partnership (UWP). All data were collected by a crew of 23 volunteers on 9 October 2010.

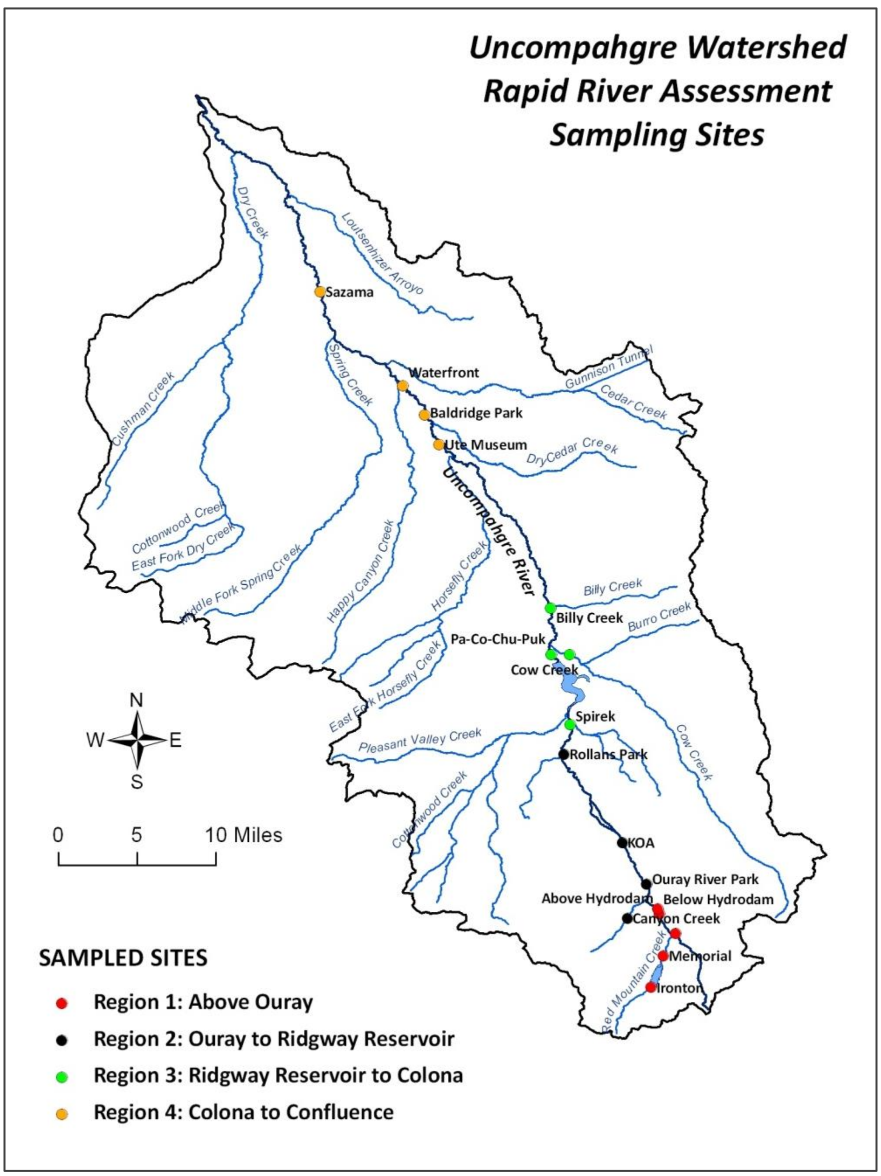

Figure 3. Sites sampled in the Rapid River Assessment of the Uncompahgre Watershed. These 17 sites were utilized in the habitat assessment, 4 of these sites were also sampled for macroinvertebrates: Rollans Park, Billy Creek, Baldridge Park and Waterfront.

Site Selection

Sampling sites were selected along the entire stretch of the Uncompahgre River (headwaters to confluence) to provide and overall characterization of the watershed and baseline data for key regions of the watershed. The sites were chosen along an elevation gradient and included sites under different management: private, municipal, state, and federal. The watershed was first divided into four distinct regions based on similar geology, land use, and water quality:

Region 1: Above Ouray (5 sites),
Region 2: Ouray to Ridgway Reservoir (4 sites),
Region 3: Ridgway Reservoir to Colona (4 sites),
Region 4: Colona to Confluence (4 sites).

Four to five sites were then selected within each region for a total of 17 sampling sites (Fig. 3). These sites were selected based on: access, existing monitoring stations, and representativeness (sites without potential impairments: mining, agriculture, recreation and those with little and with low impacts). All sites had to be easily accessible from roads or trails and permitted for access by private land owners. Several sites regularly sampled by the River Watch and the Selenium Task Force programs were selected to complement those monitoring efforts.

Volunteers

One of the assessment's objectives was to engage volunteers and stakeholders in the data collection process to increase local understanding of river dynamics and encourage inputs for future projects. The UWP recruited volunteers from local communities and hosted a short volunteer training at Baldridge Park in Montrose before the field sampling event. The training included an overview of project goals and design, review of sampling protocols and data sheets, and a question-and-answer session. The volunteers divided into four groups, one per sampling region. A team leader was identified for each team based on their relevant background or field experience.

Habitat Criteria and Scoring

Field methods, habitat criteria and scoring were guided by assessments from 2 other Gunnison Basin watershed groups: North Fork River Improvement Association and Coal Creek Watershed Coalition (USACE 2007, Alexander and Brown 2009) as well as the NRCS *Stream Visual Assessment Protocol* (Newton et al 1998) and EPA *Rapid Bioassessment Protocols for Use in Stream and Wadeable Rivers* (Barbour et al 1999). Some EPA definitions for scoring criteria were modified based on knowledge of existing conditions in the Uncompahgre Watershed.
A list of habitat criteria used in Uncompahgre River assessment are in Table 1, detailed definitions are included on datasheets in Appendix 1.

Table 1. Habitat criteria used to score aquatic, terrestrial and visual attributes for high gradient sites. Numbers correspond to attributes used to calculate habitat scores in Table 3.

High Gradient Sites		
Aquatic	**Terrestrial**	**Visual**
1. Aquatic barriers & diversion sinks	**11.** Riparian vegetation cover	**17.** Water appearance
2. In-stream fish cover	**12.** Riparian veg. structural diversity	
3. Insect/invertebrate habitat	**13.** Percent native woody vegetation	
4. Embeddedness	**14.** Palustrine wetland area & function	
5. Velocity/Depth regimes	**15.** Riparian vegetation zone width	
6. Sediment deposition	**16.** Coldwater fishery canopy cover	
7. Flow continuity		
8. Channel alteration		
9. Frequency of riffles		
10. Bank stability		

Table 2. Habitat criteria used to score aquatic, terrestrial and visual attributes for high gradient sites. Numbers correspond to attributes used to calculate habitat scores in Table 3.

Low Gradient Sites		
Aquatic	**Terrestrial**	**Visual**
1. Aquatic barriers & diversion sinks	**10.** Riparian vegetation cover	**16.** Riparian. zone width
2. In-stream fish cover	**11.** Riparian veg. structural diversity	**17.** Water appearance
3. Pool substrate characterization	**12.** Percent native woody vegetation	**18.** Nutrient enrichment
4. Pool variability	**13.** Channel sinuosity	**19.** Manure present
5. Insect/invertebrate habitat	**14.** Coldwater fishery canopy cover	
6. Sediment deposition	**15.** Warmwater fishery canopy cover	
7. Flow continuity		
8. Channel alteration		
9. Bank stability		

The characteristics of each site were evaluated by walking a 200-ft stream reach, taking notes and photographs, and then assigning a score for each habitat criterion listed in Table 1 or 2, depending on site's gradient. Scores were on a scale of 0 to 20 but in some instances they were divided into 2 ten-point categories, one for the each bank of the river (Appendix 1). Some criteria were corrected during follow-up site visits. Channel sinuosity was derived with a GIS procedure that measured channel length (total length of the low flow channel center visible in aerial photographs)and valley length (the straight-line distance from the low-flow channel center at the top and bottom of the reach. Sinuosity was calculated as stream length divided by valley length, and then scored.

Criteria scores for each sampling site were used to calculate aquatic, terrestrial, and total habitat scores (Table 3). Scores within each of the three habitat criteria (aquatic, terrestrial, visual) were summed, divided by total possible points within each respective habitat criteria and weighted so that aquatic and terrestrial score contributed 45% each and visual score 10% to the total habitat score. The three scores were summed to calculate the total habitat score. The scores were then assigned to qualitative indices (poor, fair, good, excellent) based on quartiles of maximum scores (Table 4).

Table 3. Formulas used to calculate aquatic, terrestrial and visual scores for low and high gradient sampling sites. Scores 1-19 correspond to attributes listed in Table 1 and 2 and described in Appendix 1.

Score	High Gradient	Low Gradient	Max Score
Aquatic	(∑ Scores 1 - 10) /200 x 45%	(∑ Scores 1, 2, 4 – 9, 19) /180 x 45%	45
Terrestrial	(∑ Scores 11 - 16) /120 x 45%	(∑ Scores 10 - 15) / 100 x 45%	45
Visual	(∑ Scores 17) /20*10%	(∑ Scores 16 - 18) /60 x 10%	10
Habitat Score	(∑Aquatic, Terrestrial, Visual)	(∑Aquatic, Terrestrial, Visual)	100

Table 4. Habitat score value ranges for qualitative habitat indices.

Score	Max Score	Poor	Fair	Good	Excellent
Aquatic	45	0 – 11.24	11.25 - 22.25	22.26 - 33.74	33.75 - 45
Terrestrial	45	0 – 11	11.25 - 22.25	22.5 - 33.5	33.75 - 45
Visual	10	0 – 2.4	2.5 – 4.9	5 – 7.4	7.5 - 10
Habitat Score	100	0 - 24	25 - 49	50 - 74	75- 100

The physical habitat of each site was also evaluated visually. The physical habitat datasheet (Appendix 2) included a site sketch, GPS coordinates, and a summary of watershed and habitat features, vegetation, signs of erosion, substrate and significant in-stream features. In wadeable reaches, volunteers were asked to create a depth profile of the stream channel.

Macroinvertebrates

Macroinvertebrate samples were collected at 4 sites: Rollans Park, Billy Creek, Baldridge Park, and Waterway (Fig. 3). Samples were collected and analyzed according to Colorado River Watch protocols. Volunteers used a D-net to collect samples in slow (0.5-1.5 ft/s) and fast (1.5-2.5 ft/s) moving riffles. Three kick-net samples were collected at each of the 4 sampling sites. The samples were preserved in alcohol and sent to Timberline Aquatic in Fort Collins for 300-count identification and analysis. The following physical habitat data was also recorded for each kick-net collection site: sampling time, sampling depth, riffle type, inorganic substrate components, and organic substrate components (see Appendix 3 for data sheet).

Water quality can be assessed by the presence or absence of macroinvertebrates, especially those sensitive to organic or sediment pollution. Pollution sensitive organisms generally decrease in number or disappear in polluted streams, while pollution tolerant organisms increase in number and taxa richness (cite). Several indices were calculated from macroinvertebrate counts to assess water quality at the sampled sites. Taxa richness (measure of the number of different kinds of organisms in a collection) and total number of organisms in each sample were calculated to assess biological diversity (Barbour et al. 1999). EPT index (pollution sensitive orders: **E**phemeroptera (mayflies), **P**lecoptera (stoneflies), and **T**richoptera) and HBI index (Hilsenhoff's Biotic Index: species intolerant to organic pollution) were calculated to assess pollution intolerant assemblages (Weber 1973, Hilsenhoff 1982). EPT was calculated by dividing the sum of organisms in the Ephemeroptera, Plecoptera, and Trichoptera orders and dividing by total number of organisms in sample. HBI was calculated by first assigning regional tolerance values (Barbour et al. 1999) to each species and then dividing the value by the relative abundance of each species. Lastly, all species were assigned into Feeding Functional Groups (Barbour et al. 1999) to assess trophic structure at each site. The FFGs guilds can reflect stable food dynamics or stressed conditions (Cummins and Klug 1979, Wallace et al. 1977, Barbour et al. 1999).

RESULTS

Habitat assessment data and habitat scores are presented in order of the 4 sampling regions; consecutively from Uncompahgre River's headwaters to its confluence in Delta (Fig. 4). Habitat scores are in Appendix 4. Macroinvertebrate data collected at 4 sampling sites are presented last. Data counts are in Appendix 5.

Among all 17 sites, the highest total habitat score was assessed for the Engineer Pass site on the Uncompahgre River above its tributary junction with Red Mountain Creek. Baldridge Park had the lowest habitat score. Two of the 17 sites were ranked as excellent for habitat quality, 10 as good, and 5 as fair. None of the sites were characterized as poor (Fig. 4).

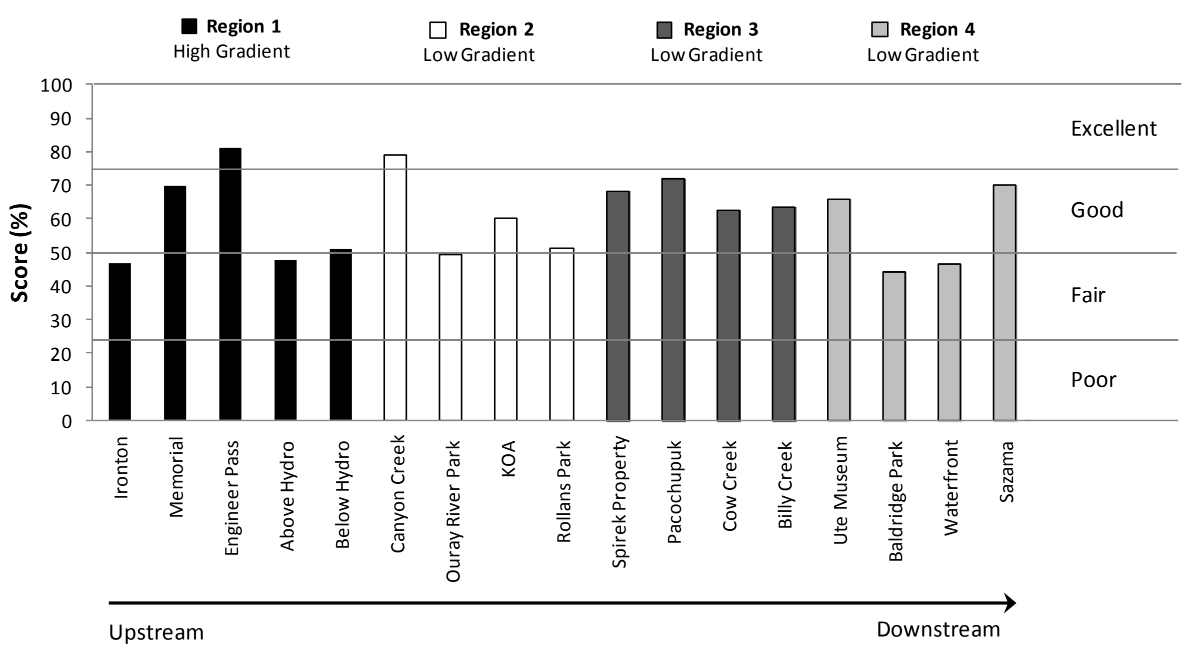

Figure 4. Total habitat scores for 17 sites in the Uncompahgre Watershed. The habitat scores (HB) are categorized into qualitative categories: poor (HB < 25), fair (HB 25-49), good (HB 50-74), excellent (HB ≥ 75).

Region 1: Above Ouray

These were 5 high gradient sites in Region 1 and all were located above the City of Ouray. The Ironton and Memorial sites were on Red Mountain Creek which is a major tributary to the Uncompahgre River. Engineer Pass, Above Hydrodam and Below Hydrodam sites were all on the mainstem of the Uncompahgre River. With the exception of Ironton which had a run morphology, the 4 downstream sites were characterized by step-pool channels. Boulders were prevalent at all sites with more cobble at Ironton than the other sites. Riparian zones ranged from 10 to 35 ft on each stream bank with the exception of the site Below Hydrodam where there was no riparian zone or vegetation. Riparian vegetation was low and on average provided about 20% of ground cover and very little stream shade except at the Engineer Pass site where stream cover was estimated at 90%. Erosion was low at the first 3 sites but became extensive above the hydrodam where a shallower gradient and lower flow velocity deposited large amounts of alluvium. Two sites on Red Mountain Creek (Ironton and Memorial) as well as the site above the hydrodam had visible iron oxide in stream water while Engineer Pass site before tributary junction with Red Mountain Creek and the site below the hydrodam did not exhibit discoloration.

Summary of habitat scores for these sites is in Figure 5, additional results follow for each site. Habitat scores in this region were lowest at Ironton and Above Hydrodam sites. The Engineer Pass site on the Uncompahgre River just above tributary junction with Red Mountain Creek had the highest habitat score (81) in Region 1 and among all sampled sites.

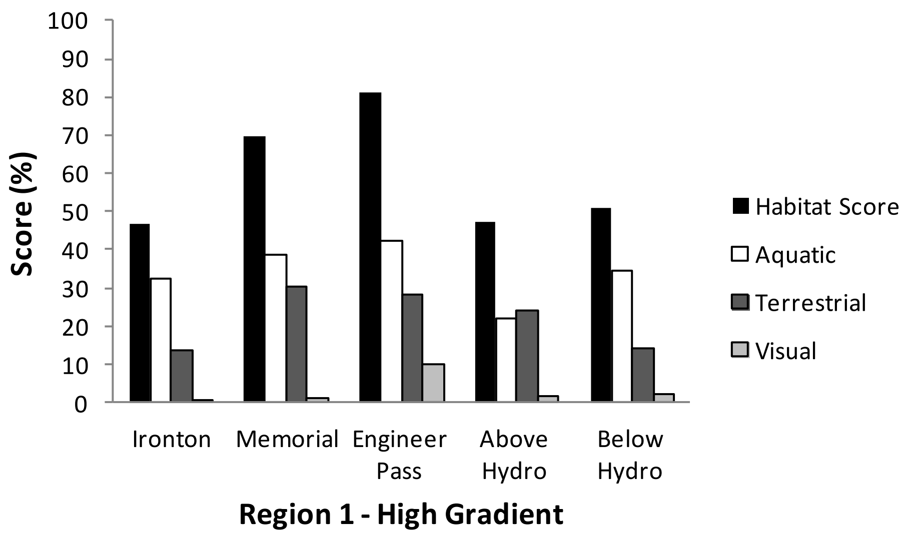

Figure 5. Scores from Habitat Assessment for Region 1, high gradient sites. Sites are listed upstream to downstream from left to right.

Site 1: Ironton

The sampling site at Ironton park was located on Red Mountain Creek, a tributary, where natural and land use processes directly affect aquatic, terrestrial and visual attributes. The Idarado mine and othe tailings piles are located just upstream of the site and in combination with the natural mineralization of the Red Mountain Massif affect the color and water quality of the stream (Photo 1). This study did not assess water quality but other studies have shown that pH is low (3.5 at low-flow) and dissolved concentrations of aluminum, cadmium, copper, lead, and zinc exceed chronic aquatic-life standards established by the State of Colorado just upstream of the Ironton habitat assessment site (Runkel et al. 2005).

The channel at Ironton has been channelized and straightened (sinuosity = 1.05) during mine reclamation effors and is bounded by a tailings pile to the east and Hwy-550 to the west. Stream banks are 80% bare with some trees, shrubs and grasses. Riparian width totaled 30 ft and there were signs of localized erosion. The morphology is a riffle-run with no shade and no in-stream habitat. The substrate is 90% cobble and 10% sand.

Habitat scores for Ironton ranged from poor to good with the total score assessing the habitat a fair (Table 5). This was the lowest score among the 5 high gradient sites in this region of the watershed.

Table 5. Habitat scores and qualitative indices for Ironton site.

Ironton	Score	Index
Aquatic	32.4	Good
Terrestrial	13.9	Fair
Visual	0.5	Poor
Habitat Score	46.8	Fair

Photo 1. Red Mountain Creek at Ironton.

Site 2: Memorial

The Memorial site is also on Red Mountain Creek, just a few miles downstream from Ironton. There was an abandoned mine on river left and localized and road-caused erosion (Hwy-550) on the right bank. The riparian zone was 20 ft on each bank and was moderately vegetated with 40-80% being bare banks and trees providing partial shade. The channel was straight with sinuosity of 1.12. The morphology was step-pool and substrate was a mix of cobbles and boulders. The water appearance was red from iron oxidation (Photo 2),

The site had the second lowest score in Region 1 after Ironton (Fig. 5). Habitat scores ranged from poor to excellent and the overall habitat score was good (Table 6).

Table 6. Habitat scores and qualitative indices for Memorial site.

Memorial	Score	Index
Aquatic	38.5	Excellent
Terrestrial	30.4	Good
Visual	1.0	Poor
Habitat Score	69.9	Good

Photo 2. Red Mountain Creek at Memorial.

Site 3: Engineer Pass

The Engineer Pass site is at the pull-off from Hwy-550 to Engineer Pass and is on the upper Uncompahgre River right before it joins Red Mountian Creek to form the mainstem of the Uncompahgre River. Land uses upstream of this site include recreation and mining although most of the mines are now inactive. The riparian zone ranged from 10-15 ft. The conifers and shrubs on the steep hillslopes adjacent to the channel provided 90% canopy cover over the channel but the stream banks had 80-100% bare soil. The river at the sampling site was incised (sinuosity = 1.14) and adjacent to un-paved County Rd. 18 which could be a source of sediment inputs into the river (Photo 3). The channel had a step-pool morphology and substrate comprised of 50% boulders and 35% cobble.   There was no discoloration of the water and macroinvertebrates were observed in the stream.

The Engineer Pass site received the highest scores in Region 1 and the highest habitat score of 81 among all study sites.

Table 7. Habitat scores and qualitative indices for Engineer Pass site.

Engineer Pass	Score	Index
Aquatic	42.5	Excellent
Terrestrial	28.5	Good
Visual	10.0	Excellent
Habitat Score	81.0	Excellent

Photo 3. Engineer Pass site, Uncompahgre River before junction with Red Mountain Creek.

Site 4: Above Hydrodam

As Red Mountain Creek joins the Uncompahgre River scores decline compared with those at the Engineer Pass site above the tributary junction. Below the junction, the river becomes highly incised into a bedrock canyon (sinuosity = 1.10). Above the Ouray Hydrodam there was channelization from sediment buildup caused by the grade change of the river bed and the subsequent change of water velocity (Photo 4). The substrate comprised of 75% cobble and 25% sand. There was extensive erosion from undercutting in the alluvium and bank failures were noted.   The stream banks at bankfull flow line were 80% bare but hardwoods were predominant on the edges of the floodplain. Riparian zone width was 25 ft on left bank (LB) and 35 on right bank (RB). Iron oxide was present in the water.

Overall habitat quality was assessed as fair at the site Above Hydrodam, primarily as a result of low aquatic and terrestrial scores (Table 8). This site was one of 5 sites which ranked fair in the watershed.

Table 8. Habitat scores and qualitative indices for site Above Hydrodam.

Above Hydrodam	**Score**	**Index**
Aquatic	22.1	Fair
Terrestrial	24.0	Good
Visual	1.5	Poor
Habitat Score	47.6	Fair

Photo 4. Above Hydrodam, Uncompahgre River.

Site 5: Below Hydrodam

The channel below the Ouray Hydrodam becomes highly incised into bedrock and channelized; sinuosity = 1.17 (Photo 5). There was no vegetation on the canyon bottom and bed surface comprised 75% of cobble. Terrestrial habitat scores decreased below the dam while aquatic scores improved (Table 9). There was a slight increase in the aquatic score below the dam and no visual impairment to water from iron oxide. Visual comparisons of water quality above and below the dam indicate that the dam traps sediment and iron precipitate which results in improved water quality belwo the dam. The overall habitat score belwo the Ouray Hydrodam was good.

Table 9. Habitat scores and qualitative indices for site Below Hydrodam.

Below Hydrodam	Score	Index
Aquatic	34.7	Excellent
Terrestrial	14.3	Fair
Visual	2.0	Poor
Habitat Score	50.9	Good

Photo 5. Uncompahgre River below the Ouray Hydrodam (Below Hydrodam site).

Region 2: Ouray to Ridgway Reservoir

This region comprised of 4 sites between the City of Ouray and Town of Ridgway. All sites had a lower channel gradient than those in Region 1, however valley width at the 2 upstream sites, Canyon Creek and Ouray River Park, was lower than at the downstream KOA and Rollans Park site. Channel morphology also changed from step-pool/pool-riffles at the Canyon Creek site to riffle-dominated morphologies at the 3 lower sites. Land use practices in Region 2 were also quite different than in Region 1. Region 2 is comprised of 2 municipalities (Ouray and Ridgway) and agricultural lands between the 2 towns. Ouray was a mining boom town in the late 1800s and there are several inactive mines in the vicinity. Currently, Ouray is a historic mountain town which is frequented by tourists. However, most river recreation is limited to the Ouray Ice Park which is located on the Uncompahgre River in the vicinity of Canyon Creek. South of the KOA site valley bottoms are primarily private and utilized for ranching, farming, and housing.

Riparian zones comprise of mixed conifer and aspen forests in the upper half of the sampling region and cottonwood galleries in the lower half. The cottonwood stands and willow communities in the lower half of this region (below the KOA site), however, are constrained to the river banks and some ditches. The remainder of the valley floor are wet meadows and hay fields. River water in this portion of the watershed is utilized primarily for field irrigation. The towns rely on alternative sources for drinking water.

Average Total Habitat Score in Region 2 were similar to Region 1, 60 and 59 respectively. However, aquatic and terrestrial scores were lower in Region 2 compared with upstream Region 1 sites (Fig. 5 vs. 6). Habitat scores in this region were highest at the upstream-most Canyon Creek site and lowest in Ouray River Park. Habitat scores at the 2 town river parks (Ouray River Park and Rollans Park in Ridgway) were very similar.

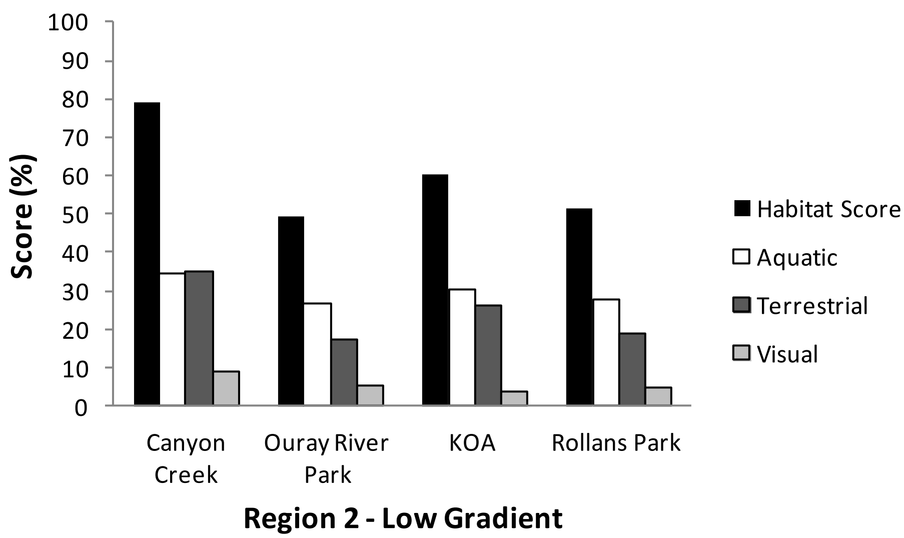

Figure 6. Scores from Habitat Assessment for Region 2, low gradient sites. Sites are listed upstream to downstream from left to right.

Site 6: Canyon Creek

Canyon Creek is a tributary to the Uncompahgre River on the south end of Ouray a short distance up Camp Bird Road. Thus, impacts from the City of Ouray are minimal. Furthermore, this creek drains a portion of the Sneffels Wilderness area which has not been drastically impacted by land use practices.

The riparian zone was well developed here, 30 ft width on LR and 15 ft on RB, and bare ground was 10%. Vegetation cover was mixed cottonwoods and conifers which provided partial shade over the active channel (Photo 6). There was some evidence of localized erosion with slight bank movements (Photo 6), sinuosity was 1.13. The channel was 25% riffle, 50% run, and 25% pools. The substrate was 75% boulders, 10% cobble and 15% sand. The morphology combined with substrate diversity and inputs of in-stream wood contributed to excellent habitat quality.

This site ranks excellent for all habitat criteria including the overall habitat (Table 10). The habitat scores are actually slightly higher, except for total habitat score, than the Engineer Pass sight (see Table 7 vs. Table 10).

Table 10. Habitat scores and qualitative indices for Canyon Creek site.

Canyon Creek	Score	Index
Aquatic	34.8	Excellent
Terrestrial	34.9	Excellent
Visual	9.2	Excellent
Habitat Score	78.8	Excellent

Photo 6. Canyon Creek site.

Site 7: Ouray River Park

The Ouray River Park is located on the north end of the City of Ouray and it is an area of high sediment loading and lateral channel migration. As a result the potential for erosion is high and the city has stabilized large portions of the reach with boulders and rip-rap (Photo 7). Residential and commercial properties were on both sides of the river and the riparian zone was limited to 20 ft on LB and 15 ft on RB. Vegetation was dominated by willows and box elder (these appear to have been planted) which comprised 90% ground cover but did not provide stream shade. Visual assessment of water indicated iron loading as evidenced by iron oxide precipitate. The entire reach was a riffle morphology (sinuosity = 1.10) with 60% gravel and some boulders as bed substrate. This, coupled with low canopy cover, indicated poor in-stream habitat.

This was the lowest habitat scoring site in Region 2 (Table 11, Fig. 6). Assessment of this site suggests that even though a great deal of channel engineering and restoration has been done at this site, the efforts have not improved in-stream structures for habitat.

Table 11. Habitat scores and qualitative indices for Ouray River Park.

Ouray River Park	Score	Index
Aquatic	26.8	Good
Terrestrial	17.3	Fair
Visual	5.2	Good
Habitat Score	49.2	Fair

Photo 7. Ouray River Park, Uncompahgre River.

Site 8: KOA

There were no residential, commercial or agricultural land uses near the KOA site on the Uncomahgre River south of Ouray. This area was forested and the riparian zone was 80 ft on LB and 163 ft on RB. The vegetation on LB of the river was dominated by conifers and there were few riparian hardwoods and herbaceous vegetation on the bank to stabilize it (Photo 8). The reach exhibited extensive erosion and bank failures. The right river bank did not appear unstable and had high young cottonwood recruitment. Although the conifers provided about 10% stream shade, the young riparian hardwoods were set back from the active channel and likely contributed little to in-stream habitat. This reach was 95% riffle morphology (sinuosity = 1.05) and little in-stream stream structure to provide habitat. The bed surface was 70% boulders, 20% cobble and 10% sand. The water appeared discolored from sediment and iron oxide.

The habitat scores suggested good aquatic and riparian habitat (Table 12).

Table 12. Habitat scores and qualitative indices at KOA site.

KOA	Score	Index
Aquatic	30.3	Good
Terrestrial	26.2	Good
Visual	3.8	Fair
Habitat Score	60.3	Good

Photo 8. KOA site, Uncompahgre River.

Site 9: Rollans Park

Rollans Park is located near the center of the Town of Ridgway. Similarly to Ouray River Park, it has undergone several river engineering and restoration efforts. Parts of the reach have been stabilized with rip-rap to minimize lateral channel migration and flood risk to nearby private and commercial properties. Two wave features have also been installed for recreational use.

Mature cottonwoods were established in the riparian zone. However, they were on a 100-yr flood terrace and did not interact directly with the active channel. Willows were abundant in parts of the reach: intermittently along the right bank and along stretches of the left bank below the terrace. Although the willows stabilized banks where present, they did not provide shade over the active channel. Where willows and herbaceous cover were absent, banks were destabilized and there were signs of moderate bank collapse (Photo 8). Spotted knapweed was present. Sediment deposition, 75% cobble and 25% gravel was high. The reach was 65% riffle and 35% run (sinuosity = 1.21) which resulted in very little in-stream habitat. Stream water was discolored with sediment.

This site is very similar to Ouray River Park in terms of land-use impacts, stream morphology, legacy of restoration, and riparian vegetation. As a result, habitat scores are very similar between the 2 sites with Rollans Park 2.2 total habitat scores higher than Ouray River Park (Table 11 and 13). The total habitat score at Rollans Park was good , just barely higher than fair.

Table 13. Habitat scores and qualitative indices at Rollans Park in Ridgway.

Rollans Park	**Score**	**Index**
Aquatic	27.5	Good
Terrestrial	18.9	Fair
Visual	5.0	Good
Habitat Score	51.4	Good

Photo 9. Rollans Park, Uncompahgre River.

Region 3: Ridgway Reservoir to Colona

This region had 4 sites downstream of the Town of Ridgway: Spirek, Pa-co-shu-puk, Cow Creek, and Billy Creek. The land use at the first site was residential/agricultural while the 3 downstream sites were state park or wildlife areas. All sites were in a low gradient section of the watershed characterized by riffle-run morphologies, no channelization, and cobble as dominant substrate. Total riparian zone width increased from 53 ft to 200 ft from the upstream to downstream site in this sampling region and on average more than 10% of the river banks were vegetated but the active channels had no canopy cover or partial cover. There was some evidence of localized erosion at all sites.

Habitat scores in Region 3 averaged at 66.6 resulting in good habitat quality and better habitat quality than upstream Region 1 and 2 and downstream Region 4 (Fig. 4). Habitat scores among the 4 sites were very similar, especially between Cow Creek and Billy Creek (Fig. 7). Pa-co-chu-puk had the highest total habitat score which was attributed to more in-stream structures built as part of a fish habitat improvement project.

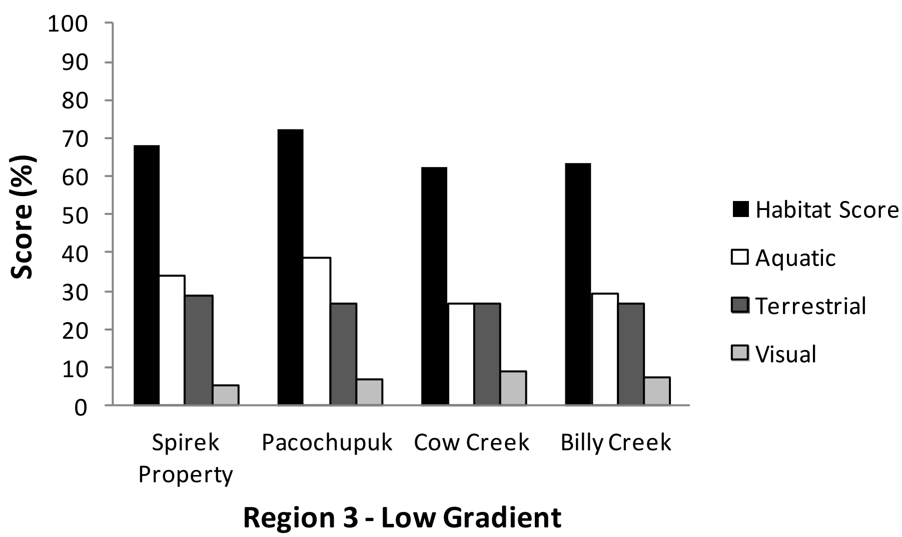

Figure 7. Scores from Habitat Assessment for Region 3, low gradient sites.

Site 10: Spirek

The Spirek Property is located on the Uncompahgre River above Ridgway Reservoir, less than one mile south of County Road 24 in Ouray County. The dominant land use at the Spirek Property site is residential on the left and residential and agricultural on the right bank (RB). The width of the riparian zone ranged from 13 ft (LB) to 20 ft (RB) (Photo 10). The riparian vegetation consisted of trees (LB) and shrubs (LB, RB), but provided little in-stream cover. The riparian zone showed no signs of invasive or non-native species or disruption from grazing or development.

The Uncompahgre River at the Spirek Property was a riffle-run reach with no pool development and sinuosity of 1.10. However, vegetated and undercut banks, snags and root wads provided ample in-stream fish cover and insect habitat. There was some evidence of aquatic vegetation (20%) and little evidence of erosion including slight bank movement. The substrate was 45% cobble and there was little evidenced of sediment deposition.

Aquatic habitat score was excellent while all other scores were good (Table 14).

Table 14. Habitat scores and qualitative indices at Spirek.

Spirek Property	Score	Index
Aquatic	33.8	Excellent
Terrestrial	29.0	Good
Visual	5.5	Good
Habitat Score	68.3	Good

Photo 10. Spirek Property, Uncompahgre River.

Site 11: Pa-co-chu-puk

The Pa-co-chu-puk site is located on the mainstem Uncompahgre River, immediately below Ridgway Reservoir, in Ridgway State Park. Pa-co-chu-puk is the site of an extensive restoration project that was designed to improve fish habitat. This site is a popular destination for fishermen and is stocked with trout. The vegetation surrounding Pa-co-chu-puk consists of shrubs, grasses and a few large trees. There is an extensive riparian zone on the left bank, but the right bank is limited to approximately 20 feet due landscaped grasses and paved trails as part of the park infrastructure (Photo 11). River banks were 30% vegetated. The riparian vegetation provided little in-stream canopy cover. Russian olive was noted at this site.

The structural additions from the restoration projected provided this site with ample pool and riffle development, but limited in-stream cover for fish and macroinvertebrates. The substrate was 70% cobble with no signs of sediment deposition (sinuosity = 1.10). Our survey found few indications of localized erosion and some undercut banks. Approximately 30% of the stream substrate was covered in attached algae.

Pa-co-chu-puk site received the highest scores among Region 3 sites and had a total habitat score of 72 = good index (Table 15).

Table 15. Habitat scores and qualitative indices at Pa-co-chu-puk.

Pa-co-chu-puk	Score	Index
Aquatic	38.8	Excellent
Terrestrial	26.6	Good
Visual	6.7	Good
Habitat Score	72.0	Good

Photo 11. Pa-co-chu-puk site, Uncompahgre River.

Site 12: Cow Creek

The Cow Creek site is located in the Billy Creek State Wildlife Area (SWA), across Hwy-55- from the Pa-co-ch-puk entrance of Ridgway State Park. Cow Creek is a tributary that joins the Uncompahgre River below Ridgway Reservoir.

The riparian vegetation at the Cow Creek site was similar to the Billy Creek SWA site, mostly willow with some interspersed cottonwood trees (Photo 12). The riparian zone ranged from 127 ft to 80 ft in width and showed no signs of human or livestock disturbance. Russian olive was present. River banks were 40% vegetated, but the riparian vegetation provided little in-stream canopy cover.

The Cow Creek site was 90% run with few riffles (sinuosity = 1.15) and no obvious signs of pools and little water in the active channel. There was marginal in-stream cover and habitat diversity for fish and insects. The substrate was 55% cobble. This site exhibited extensive signs of erosion, bare bank soil, and sediment deposition. Thirty percent of the reach was covered with attached algae.

The Cow Creek site had a total habitat score of 62.6 and ranked as good for habitat quality (Table 16).

Table 16. Habitat scores and qualitative indices at Cow Creek.

Cow Creek	**Score**	**Index**
Aquatic	26.5	Good
Terrestrial	26.9	Good
Visual	9.2	Excellent
Habitat Score	62.6	Good

Photo 12. Cow Creek, tributary to Uncompahgre River.

Site 13: Billy Creek

The Billy Creek State Wildlife Area (SWA) is located three miles south of Colona in Ouray County. Billy Creek is a tributary to the Uncompahgre River.

The vegetation at the Billy Creek SWA site consists primarily of sagebrush, oakbrush and pinon-juniper. Some cottonwood habitat exists on the Uncompahgre and Billy Creek riparian zones. The riparian zone was approximately 100 ft wide on both banks, had optimal structural diversity and was dominated by willows (Photo 13). River banks were 40% vegetated and the canopy provided partial canopy cover. Russian olive and Canadian thistle were present at this site. The riparian zone showed signs of disruption, and may have been impacted by foot traffic from the adjacent parking lot or maintenance of an irrigation canal. The Billy Creek SWA site was characterized as half riffle and half run (sinuosity = 1.14), with no signs of pool development. There was marginal in-stream fish cover and over 50% cobble. Stream substrate was 50% cobble and exhibited few signs of sediment deposition. River banks at this site were stable with slight evidence of localized bank movement. Over 40% of the reach was covered with attached algae, indicating possible nutrient enrichment.

The Billy Creek site had a total habitat score of 63.7 and ranked as good for habitat quality. The scores at this site were very similar to those at Cow Creek (Table 16 vs. 17).

Table 17. Habitat scores and qualitative indices at Billy Creek.

Billy Creek	Score	Index
Aquatic	29.5	Good
Terrestrial	26.9	Good
Visual	7.3	Excellent
Habitat Score	63.7	Good

Photo 13. Billy Creek, tributary to Uncompahgre River.

Region 4: Colona to Confluence

Region 4 included 4 sites: Ute Museum, Baldridge Park, Waterfront and Sazama.

Land use at all sampled sites had agricultural use and sites were designated as fields/pastures. Part of Baldridge Park also had a recreational park designation. Riparian zone widths ranged from 100 – 600 ft total width and 90% of the stream banks were vegetated. All sites had diverse riparian vegetation structure which comprised of herbaceous (exception was Sazama), shrub, and tree components. Cottonwoods were present at all sites and 3 of the 4 sites had non-native species, tamarisk and Russian olive. Baldridge Park also had canary reed grass. These sites had low gradient channels with higher sinuosity than all other upstream sites. Channel morphologies were riffle-runs with very few pools, no channelization, and gravel-sand bed substrate compared with cobble substrate at upstream sites. There was some evidence of erosion at 2 of the sites and extensive erosion at one of the sites. Overall, there was little in-stream structure for fish.

Total habitat scores averaged 56 in Region 4 which was the lowest estimate among the 3 other sampling regions; lower by only 3 in comparison with Region 1 and 2 and lower by 13 compared with Region 3. Overall habitat quality was good at Ute Museum and Sazama sites and fair at Baldridge Park and Waterfront sites (Fig. 8).

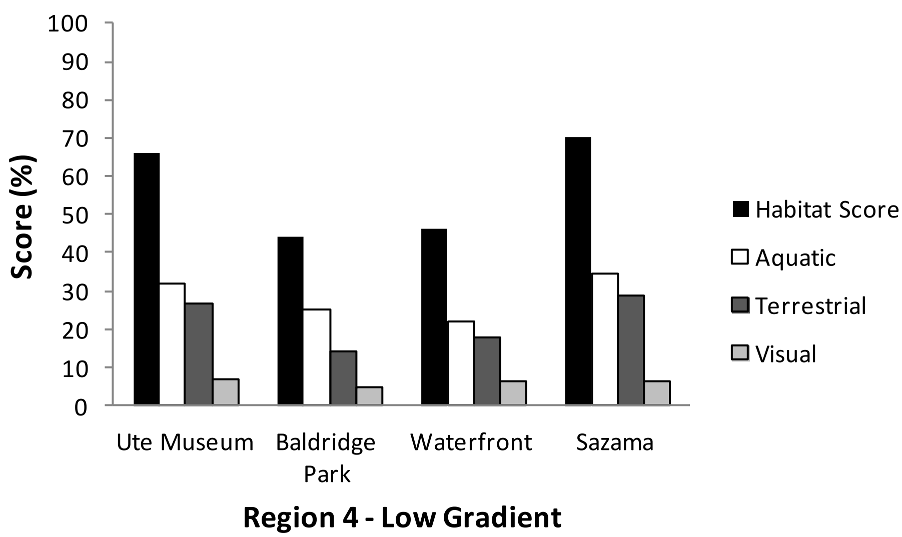

Figure 8. Scores from Habitat Assessment for Region 4, low gradient sites.

Site 14: Ute Museum

The Ute Museum site was located in on the southern edge of Montrose, where Hwy-550 crosses the Uncompahgre River.

The dominant land use surrounding the Ute Museum site is commercial/park (LB) and field/pasture (RB). The riparian zone on the right bank was 60 ft wide and consisted of shrubs, grasses and herbaceous plants (Photo 14). The left bank had a thick and structurally diverse riparian zone (200 ft) with trees, shrubs, grasses and herbaceous plants. Russian olive was observed. River banks were 50% vegetated and the riparian zone provided marginal canopy cover.

The Uncompahgre River at the Ute Museum had a low sinuosity (1.27) and marginal pool (5%) and riffle (25%) development. There were no pools, but overhanging vegetation and undercut banks provided for moderate in-stream fish cover. River banks were stable with no evidence of bank movement. Stream substrate consisted of 50% cobble and few signs of sediment deposition.

All habitat scores indicated good habitat quality at this site (Table 18).

Table 18. Habitat scores and qualitative indices at Ute Museum site.

Ute Museum	Score	Index
Aquatic	32.0	Good
Terrestrial	26.7	Good
Visual	7.2	Good
Habitat Score	65.9	Good

Photo 14. Ute Museum site, Uncompahgre River.

Site 15: Baldridge Park

The Baldridge Park site is a community park located adjacent to the Uncompahgre River on the west side of downtown Montrose.

The landscape at Baldridge Park was comprised of a grassy community park (RB) and steep cliff (LB) (Photo 15). There was limited development of the riparian zone at this site. The sparsely vegetated riparian zone was less than 20 feet wide on the cliff side. There was increased structural diversity in the 75 foot wide riparian zone on the park side, with trees, shrubs, non-native grasses and herbaceous plants present. There was an abundance of Russian olive, tamarisk and canary reed grass at this site. There was evidence of trash and disturbance of the riparian zone, most likely from park visitors. The Uncompahgre River at Baldridge Park is the site of a former restoration project designed to improve fish habitat and bank stability. Our survey found few indications of bank erosion. Habitat diversity at this site consisted of 60% riffle, 40% run, no pools (sinuosity = 1.20) and limited in-stream fish cover and insect habitat. There were signs of sediment formation including sand bars. The limited riparian vegetation did not provide stream canopy cover.

Baldridge Park had the lowest habitat scores in Region 4 and second lowest scores, to Ironton, among all the other sampled sites (Table 19, Fig. 8). The total habitat score of 44.4 indicated fair habitat quality.

Table 19. Habitat scores and qualitative indices at Baldridge Park.

Baldridge Park	Score	Index
Aquatic	25.0	Good
Terrestrial	14.4	Fair
Visual	5.0	Good
Habitat Score	44.4	Fair

Photo 15. Baldridge Park site, Uncompahgre River.

Site 16: Waterfront

The Waterfront site is located in the Waterway View subdivision on the mainstem Uncompahgre River near the northwest side of Montrose.

The dominant land use was residential (LB) and field/pasture (RB) (Photo 16). On the right bank, there was a riverine wetland with a structurally diverse riparian zone that included trees, shrubs, grasses, and herbaceous plants. Left bank consisted of a residential yard with a minimal riparian zone (15 feet) dominated by non-native grasses and a few trees. River banks were 50% vegetated. Russian olive and Tamarisk were present at this site. The riparian zone provided little canopy cover.

The Uncompahgre River at the Waterway View site had a sinuosity of 1.36 and the dominant in-stream feature was run (75%). There was minimal pool development and the existing pools were small and shallow. There was limited in-stream fish cover and the site showed signs of sediment deposition in the form of bar formation and accumulation of fine sediments in pools and riffles. The site also exhibited extensive signs of heavy erosion including bank failure on the left bank. The owner of the Waterway View property experienced excessive loss of land after the 2010 flood season.

Habitat scores at the waterway property were low and habitat quality was fair (Table 20).

Table 20. Habitat scores and qualitative indices at the Waterway site.

Waterfront	Score	Index
Aquatic	22.3	Fair
Terrestrial	17.9	Fair
Visual	6.3	Good
Habitat Score	46.5	Fair

Photo 16. Waterway site, Uncompahgre River.

Site 17: Sazama

The Sazama property is located on the mainstem Uncompahgre River two miles south of Olathe.

The dominant land use was field/pasture on the left bank (LB) and field/pasture and cottonwood gallery on the right bank (RB). The width of the riparian zone ranged from 200 ft (LB) to 400 ft (RB). The heavily vegetated riparian zones consisted of grasses (LB) and grasses and trees (RB), but no shrubs (Photo 17). There were no obvious signs of invasive or non-native species or disruption from grazing or development. The healthy riparian zone is likely a result of restoration activities that the landowner engaged in over the last several years.

The Uncompahgre River at the Sazama Property was straight (sinuosity = 1.30), 90% run, and had no obvious signs of pools. There was little evidence of aquatic vegetation (less than 1%) and some evidence of erosion including slight bank movement. Undercut banks and vegetative root wads provided ample in-stream fish cover. The water appearance was cloudy and greenish. Although no irrigation diversions were directly present, this condition of the Uncompahgre River at the Sazama Property exhibited many signs of stress from local irrigation water management.

The aquatic score was excellent while all other scores ranked as good. Thus, the overall assessment of this site was good habitat quality.

Table 21. Habitat scores and qualitative indices at the Sazama site.

Sazama	Score	Index
Aquatic	34.5	Excellent
Terrestrial	29.0	Good
Visual	6.5	Good
Habitat Score	70.0	Good

Photo 17. Sazama site, Uncompahgre River.

Macroinvertebrate Assessment

All macroinverebrate samples were collected in riffles where cobble was the dominant bed surface substrate (Baldridge Park sample #3 was the only exception where gravel was the dominant inorganic substrate). There was hardly any coarse particulate organic matter (CPOM) and no fine particulate organic matter (FPOM) at the Rollans Park site. The other sites had 5-20% CPOM and 0-10% FPOM (Table 22).

Table 22. Site characterization of collected macroinvertebrate samples.

			Inorganic Substrate					Organic Substrate	
Site	**Kick Sample**	**Habitat**	**% Cobble**	**% Gravel**	**% Sand**	**% Silt**	**% Clay**	**% CPOM[2]**	**% FPOM[3]**
Rollans Park	1	Slow riffle (0.2-1.5 ft/s)	70	0	25	5	0	5	0
	2	Slow riffle (0.2-1.5 ft/s)	50	0	40	10	0	0	0
	3	Fast riffle (1.5-2.5 ft/s)	50	0	40	10	0	0	0
	4	Fast riffle (1.5-2.5 ft/s)	50	0	40	10	0	0	0
Billy Creek[1]	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waterfront	1	Slow riffle (0.2-1.5 ft/s)	95	5	0	0	0	5	1
	2	Slow riffle (0.2-1.5 ft/s)	95	5	0	0	0	5	5
	3	Slow riffle (0.2-1.5 ft/s)	95	5	0	0	0	20	10
	4	Slow riffle (0.2-1.5 ft/s)	85	10	3	2	0	10	10
Baldridge Park	1	Slow riffle (0.2-1.5 ft/s)	50	40	5	3	2	5	0
	2	Fast riffle (1.5-2.5 ft/s)	70	25	3	2	0	5	0
	3	Fast riffle (1.5-2.5 ft/s)	5	70	15	5	5	5	0
	4	Fast riffle (1.5-2.5 ft/s)	60	30	5	5	0	5	0

[1] *Data sheet was missing upon report completion.*

[2] *CPOM = coarse particulate organic matter (sticks, wood, coarse plant material)*

[3] *FPOM = fine particulate organic matter (black, very fine organic material)*

Taxa richness as well as total number of organisms was lowest at Rollans Park and highest at the Waterfront site which suggests macroinvertebrate diversity was higher south of Ridgway Reservoir (Table 23). Although diversity was low at Rollans Park, the species were comprised of pollution insensitive orders: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) and EPT was 72%. EPT% was also high at the 3 downstream sites (72, 75, 54% respectively) indicating that water quality at all sites was high for the 3 pollution sensitive orders (Weber 1973). Good water quality was also supported by HBI. All HBI values were less than 5.5 indicating presence of species intolerant to organic and sediment pollution and therefore indicative of good water quality (low organic pollution and sedimentation, Hilsenhoff 1982). The HBI increased consistently from 1.93 at the upstream Rollans Park site to 3.73 at the most downstream Baldbridge Park site (Table 23) which suggests that there is a relative decline in water quality downstream.

Low levels of organic pollution and sedimentation were also supported by patterns in the abundance of scrapers across the sampling sites. Scrapers increased from 0% at the upstream Rollans Park site to 13% at the downstream Baldridge. These low abundances of scrapers indicate that periphyton was relatively low and therefore particulate pollution was low as well (Barbour et al. 1999). Filterers have variable responses to FPOM or sediment (Barbour et al. 1999) but they are also thought to be sensitive in low-gradient streams (Wallace et al. 1977). Filterer abundance was variable with % FPOM: at Rollans Park filterers composed 41% of the Feeding Functional Groups (FFG) but no signs of FPOM or sedimentation were observed at the site, while the Baldridge site filterers comprised 21% of FFG where similarly no FPOM was observed (Table 22 and 23). Nevertheless, filterers decreased downstrem suggesting a likely deterioration of water quality downstream.

Relative abundances of key FFGs in the Uncompahgre Watershed differed between sites which indicates that there were some differences in water quality, CPOM, FPOM, sediment dynamics as well as authoctonous and allocthonous nutrient inputs (Fig. 9). The trophic structure characterized by FFGs can reflect stable food dynamics or stressed conditions (Barbour et al. 1999). Specialized feeders (scrapers and shredders) are sensitive organisms present in healthy streams. Generalists (gatherers and filterers) have a broader range of tolerance to pollution and food availability as a result their responses are variable (Cummins and Klug 1979).
The shredder composition at the sites was indicative of allocthanous inputs into the streams. Higher abundances of shredders (21% at Rollans Park and 38% at Baldridge Park) suggest that there were more terrestrial inputs of litter into the channel than at Billy Creek (5% shredders) and Waterfront (8% shredders). As discussed above, filterers (generalists) decreased downstream while gatherers (also generalists) increased then decreased downstream (Fig. 9) supporting that they have a broad range of responses to food dynamics.

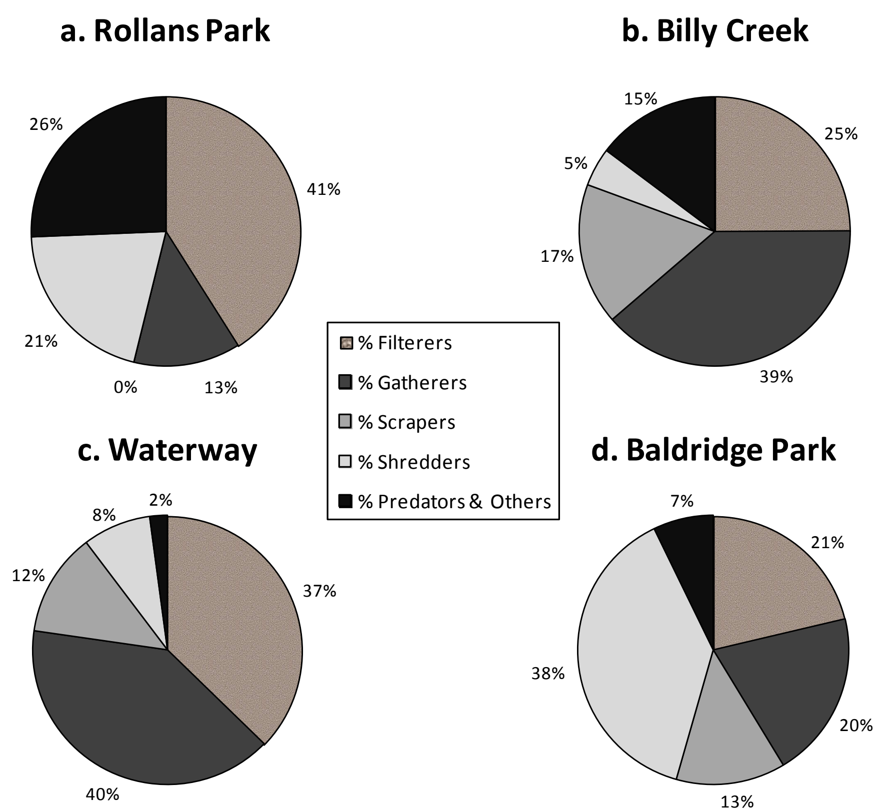

Figure 9. Feeding Functional Groups (FFG) of macroinvertebrates at 4 sampling site.

Table 23. Metrics for macroinvertebrate taxa richness, pollution indices, and trophic structure at 4 sampling sites.

	Rollans Park	Billy Creek	Waterfront	Baldridge Park	Interpretation	Predicted Response to Increasing Perturbation
Richness Metrics						
# of Organisms	39	325	330	305	Organism density is variable and affected by loss of habitat, low pH and toxic substances.	Decrease (Barbour et al. 1999)
Taxa richness	8	22	23	31	Measure of overall diversity of the biological community sampled.	Decrease (Weber 1973)
Pollution Tollerance						
% EPT	72%	72%	75%	54%	Summarizes taxa richness within the "pollution sensitive" orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies).	Decrease (Weber 1973)
HBI	1.93	2.17	2.94	3.73	The (Hilsenhoff Biotic Index) HBI reflects an organism's relative sensitivity to organic pollution; values range from 0 (least tolerant organisms) to 10 (most tolerant organisms). HBI > 5.5 indicates poor water quality.	Increase (Barbour et al. 1992, Hayslip 1993, Hilsenhoff 1982)
Trophic Structure						
% Filterers	41%	25%	37%	21%	Filter feeders increase in response to fine particulate organic matter (FPOM) from water column or sediment. Filter feeders can be sensitive to toxicants bound to FPOM.	Variable (Barbour et al. 1999)
% Scrapers	0%	17%	12%	13%	Reflects riffle community food base, indicates availability of periphyton. Will decrease following sediment and organic pollution.	Decrease (Barbour et al. 1999)
% Shredders	21%	5%	8%	38%	Percent of the macrobenthos that "shreds" leaf litter	Decrease (Barbour et al. 1992, Hayslip 1993)

DISCUSSION AND RECOMMENDATIONS

The Total Habitat Scores indicate that aquatic and riparian habitat quality is highest in the lower portion of the Uncompahgre Watershed, Region 3 of the assessment between the Town of Ridgway and Colona. Average regional habitat scores between all regions ranked as follows:

Region 4 Colona to Confluence	<	Region 1 Above Ouray	<	Region 2 Ouray to Ridgway	<	Region 3 Ridgway to Colona

Low Habitat Score → **High Habitat Score**

Aquatic macroinvertebrates were collected at 4 sites between Rollans Park in Region and Baldridge Park in Region 4. Pollution tolerance indices (%EPT = pollution sensitive orders: Ephemeroptera, Plecoptera, and Trichoptera and HBI = species intolerant to organic pollution) met good water quality criteria but EPT decreased downstream from 72% to 54% and Hilsenhoff Biotic Index (HBI) which reflects organisms sensitivity to organic pollutants increased from 1.92 to 3.73 (increasing values indicate impairment). Taxa richness, however, indicated the opposite trend: richness increased downstream suggesting increased water quality. These conflicting trends were not elucidated by composition of Feeding Functional Groups (FFG). The relative abundance of each FFG (filterer, gatherer, scraper, shredder, and predator assemblages) varied between sites which indicates that there were some differences in water quality, coarse particulate organic matter (CPOM), fine particulate organic matter (FPOM), sediment dynamics as well as authoctonous and allocthonous nutrient inputs between sites. Thus, additional macroinvertebrate sampling is recommended for all sites.

Despite limitations of macroinvertebrate data, recommendations for future watershed mitigation, restoration and monitoring projects can be inferred from the 4 regions used in the aquatic, terrestrial and visual assessments. Conclusions and recommendations are summarized here into 3 areas of the Uncompahgre Watershed: Upper, Middle, and Lower.

Upper Watershed

Approaches for the Upper Watershed (above Ouray) should be guided by rapid river assessment data from Region 1: Above Ouray. Impairments to habitat and water quality in this region resulted from channelization of Red Mountain Creek at Ironton which decreased pools and riparian vegetation, alteration of sediment dynamics with the Ouray Hydrodam which also reduced in-stream habitat and pools, and heavy metal loading as evidenced by iron oxide precipitate (from natural mineralization of Red Mountain Massif and acid mine drainage) in Red Mountain Creek and mainstem Uncompahgre River downstream of the Red Mountain Creek-Uncompahgre River tributary junction. Heavy metals indicative of low pH and poor aquatic habitat. Much of the iron oxide appeared to be trapped by the Ouray hydrodam because the precipitate was less abundant below the dam. The Engineer Pass site above the Red Mountain Creek tributary junction had highest habitat scores and best water quality in this region as it had not been impacted by channel alteration, heavy sedimentation or high metal loading. Its step-pool morphology, riparian vegetation cover and clean water (based on visual assessment only) resulted in high habitat scores.

Based on the assessment data, recommendations for improvements in the Upper Watershed should include: 1) mitigation of acid mine drainage and mine reclamation to reduce anthropogenic heavy metal loading into streams, 2) channel restoration/engineering efforts that include pools and in-stream structures, 3) restoration of sediment transport dynamic above the hydrodam or removal of sediment trapped by the dam to improve natural geomorphic processes above the dam, 4) better understanding of downstream impacts from flushing potentially heavy metal-laden sediment from the dam.

Monitoring recommendations include: 1) addition of sampling sites in the headwaters of the Uncompahgre River upstream of Red Mountain Creek-Uncompahgre River to identify potential impairments from abandoned mines, 2) addition of a sampling site just below the tributary junction of Red Mountain Creek-Uncompahgre River to collect baseline data before remediation of Red Mountain Creek, 3) continued sampling of sites included in Region 1 of this assessment, 4) collection of water quality data (pH, DO, metal loading, discharge) in addition to habitat metrics, 5) addition of macroinvertebrate assessment (especially above the Red Mountain Creek-Uncompahgre River tributary junction) to establish a baseline data set.

Middle Watershed

Approaches for the Middle Watershed (Ouray to Ridgway Reservoir) should be guided by rapid river assessment data from Region 2. This region had the second highest average habitat score. Habitat scores were highest in Canyon Creek (similar to those of Engineer Pass) which drains part of the Sneffels Wilderness area and is a tributary to the Uncompahgre just upstream of Ouray. The channel had complex morphology (riffles, pools and runs) and good stream shade from a mixed conifer forest which enhanced in-stream habitat. There were also no signs of pollution from metals, nutrients or sediment. Impairments to habitat quality at the other sampling sites included some iron oxide in the mainstem sites (these appeared lower than in Region 1), erosion and bank destabilization (especially at the KOA site), limited stream canopy at Ouray River Park and Rollans Park, limited pools and in-stream habitat structures in Ouray River Park and Rollans Park. Even though extensive restoration projects have been carried out in the 2 parks, restoration primarily included bank stabilization and some re-vegetation but did not include improvements to in-stream habitats through pool formation or large wood additions.

The following recommendations are suggested for the Middle Watershed: 1) reduction of iron and other metals in the river (this might be mitigated by reductions of metal loading in the Upper Watershed), 2) planting of riparian hardwoods to stabilize river banks, provide stream canopy cover, terrestrial nutrient inputs, and large wood recruitment into streams, 3) improvements to in-stream habitat structure through creation of pools, backwaters or wetlands; this should be especially considered as part of other riparian active restoration projects, 4) engineering and stabilization of river banks to mitigate flooding where necessary to protect infrastructure and private property (these efforts should include in-stream structures for aquatic habitats). Monitoring efforts should include: 1) addition of at least one more sampling site between the

KOA and Ridgway because land use is different along this stretch of the watershed and additional sources of point or non-point source pollution might exist, 2) continued sampling of sites included in Region 2 of this assessment, 3) collection of water quality data (pH, DO, metal loading, discharge) in addition to river assessment habitat metrics, 4) macroinvertebrate sampling to generate a baseline data set and to monitor change over time.

Lower Watershed

Approaches for the Lower Watershed (Ridgway Reservoir to Confluence) should be guided by rapid river assessment data from Region 3 and 4. All sites in Region 3 had excellent or good habitat indices. The sites included two locations on Uncompahgre River's tributaries (Cow Creek and Billy Creek) which were in a State Wildlife Area. These areas have been managed for wildlife habitat thus having positive impacts on riparian vegetation and in-stream habitats. Furthermore, since the sites were on tributaries and not on the mainstem they were not impacted by heavy metals (i.e. no evidence of iron oxide) from Uncompahgre's headwaters. The Pa-co-chu-puk site also ranked high because it was a former restoration site where efforts were focused on implementing in-stream structures to facilitate pool and riffle formation; these structures are functioning properly. The Spirek Property in this region had low impacts from residential and agricultural uses. Undercut banks, roots and in-stream wood provided in-stream habitat in place of pools which were low in this reach. Russian olive was present at 3 sites and Canda thistle at 1 of the 4 sites.

Region 3 was contrasted by Region 4 which had the lowest average habitat score. Land use at all Region 4 sites had agricultural uses or lands were designated as fields/pastures. These uses however, did not appear to have direct impacts on habitat quality at the 4 sampled sites. Similarly to Pa-co-chu-puk in Region 3, site restoration in Baldridge Park was aimed at improving fish habitat and bank stability, however, few pools, limited in-stream fish cover and macroinvertebrate habitat resulted. Riparian vegetation was also low and did not provide much stream canopy cover. Habitat scores at the Ute Museum were higher because there was abundant riparian vegetation, some stream shade and overhanging vegetation and undercut banks provided moderate in-stream fish cover. The last downstream site, Sazama, had good habitat scores but physical habitat descriptions did not correspond well with the assessed aquatic, terrestrial and visual habitat metrics. Thus, results for this site should be interpreted with caution. It was noted that undercut banks and root wads provided ample in-stream fish cover but water appearance was cloudy and greenish. Lastly, 7 of the 8 sites in Region 3 and 4 (Sazama being the exception) had at least one of these invasive species: tamarisk, Russian olive, canary reed grass.

Based on river assessment data from Region 3 and 4, recommendations for the Lower Watershed include: 1) efforts to increase in-stream structure (planting of riparian willows and cottonwoods could be a surrogate for pools and in-stream structure because over-hanging vegetation and undercut banks and root crowns in these regions have been shown to provide fish habitat), 2) creation of pools and aquatic habitats (i.e. rock veins, backwater channels, wetlands) should be part of active restoration and stream engineering projects especially in public use areas, 3) bank stabilization in high use areas, 4) assessment of nutrient inputs from agricultural areas and sediment/salts/nutrients from residential and municipal areas, 5) removal of invasive species. Monitoring efforts should include: 1) addition of sampling sites where non-point nutrient loading and urban run-off is anticipated (this assessment did not include those sites) to assess potential contamination levels, 2) collection of water quality data (pH, DO, metal loading, discharge) in addition to river assessment habitat metrics, 3) continued macroinvertebrate sampling to evaluate change over time.

LIMITATIONS

This assessment was designed to characterize several riparian and aquatic attributes: water quality, in-stream habitat, channel physical attributes, vegetation structure and cover of the Uncompahgre River and some of its key tributaries. The goal was to provide a baseline dataset for comparisons in the future. These data provided a snapshot of conditions at the time of the collection but because this was a one time-effort it is difficult to assess if the results are representative of average/baseline conditions or how conditions vary seasonally.

An additional objective of the assessment was to engage volunteers and stakeholders in the data collection process to increase local understanding of river dynamics and encourage inputs for future projects. Thus, data collection was cost-effective and fast. However, methods were streamlined and most metrics were defined by categorical indices rather than field measurements. This resulted in a rapid assessment approach but the lack of continuous data likely decreased the sensitivity of calculated habitat scores. Furthermore, even though the metrics were well defined, the selection of appropriate values by volunteers with varying expertise levels was highly subjective. As a result, habitat assessment data did not always support data recorded on the physical characterization data sheets. The volunteer training period was brief and neither accuracy nor repeatability was evaluated. Future assessments should refine methods to be repeatable, increase accuracy and precision among data collectors, and require more field measurements.

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APPENDIX

Appendix 1. Data sheets for habitat assessment of high gradient and low gradient sites.

Habitat Assessment Field Data Sheet - High Gradient

1. Aquatic Habitat Barriers and Diversion Sinks	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Physical barriers do not exist, or minimally inhibit movement of fish or other aquatic organisms through the reach; diversion structures are absent or mostly prevent aquatic animal movement into ditches.	Physical barriers exist but prevention of aquatic animal movement is limited to brief seasons or to only large fish. Diversion structures partially prevent movement of aquatic animals into ditches.	Physical barriers exist that inhibit movement of aquatic animals during substantial time periods, or inhibit movement of a range of fish size classes.	Substantial physical barriers exist that mostly or entirely prevent movement of aquatic animals. Diversion structures allow and encourage movement of aquatic animals into ditches.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

2. Instream Fish Cover	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	>7 cover types available	5 to 7 cover types available	2 to 4 cover types available	0 to 1 cover types available
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Cover Types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophyte beds, isolated/backwater pools, other: ____________________________________.				
Notes:				

3. Insect/ invertebrate habitat	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen).	3 to 4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream.	1 to 2 types of habitat. The substrate is often disturbed, covered, or removed by high stream velocities and scour or by sediment deposition.	0 to 1 type of habitat.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Cover types: Fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel, other: ____.				
NOTES:				

Habitat Assessment Field Data Sheet - High Gradient

4. Embeddedness	Optimal	Suboptimal	Marginal	Poor
	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

5. Velocity/Depth Regimes	Optimal	Suboptimal	Marginal	Poor
	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <0.3 m/s, deep is >0.5 m).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

6. Sediment Deposition	Optimal	Suboptimal	Marginal	Poor
	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, obstructions, and bends. Moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - High Gradient

7. Flow Continuity	Optimal	Suboptimal	Marginal	Poor
	Water reaches base of both lower banks and minimal amount of channel substrate exposed	Water fills > 75% of the available channel or <25% of channel substrate is exposed	Water fills 25%-75% of the available channel, and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

8. Channel Alteration	Optimal	Suboptimal	Marginal	Poor
	Channelization absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

9. Frequency of Riffles (or bends)	Optimal	Suboptimal	Marginal	Poor
	Occurrence of riffles relatively infrequent; ratio of distance between riffles divided by width of the stream <7:1, variety of habitat is key, In-stream where riffles are continuous, placement of boulders or other large, natural obstructions is important	Occurrences of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15	Occasional riffle or bend, bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25	Generally all flat water or shallow riffles; poor habitat distance between riffles divided by the width of the stream is a ratio of >25
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - High Gradient

10. Bank Stability (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Banks stable; evidence of erosion or bank failure absent or minimal; banks are low (at elevation of floodplain); 33% or more of eroding surface area is protected by roots that extend into base-flow elevation	Moderately stable; banks are low (at elevation of floodplain); less than 33% or more of eroding surface area is protected by roots that extend into base-flow elevation	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently) outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

11. Riparian Vegetation Cover (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Less than 20% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities minimal or absent; almost all plants able to grow naturally	20-35% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be evident but not seriously affecting riparian structure	36-50% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be evident and seriously affecting riparian structure	More than 50% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be present and seriously affecting riparian structure
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - High Gradient

12. Riparian Vegetation Structural Diversity (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Riparian vegetation from streambank to project area boundary has even mix of mature trees (seedlings to 10 m tall), shrubs, and herbaceous vegetation or wetland emergents	Riparian vegetation from streambank to project area is mostly lacking one of the 4 structural classes; rank higher if the other 3 classes are well represented, lower if only one or more is partially lacking	Riparian vegetation from Streambank to project area boundary is mostly lacking 2 of the 4 structural classes; rank higher if the other 2 classes are well represented, lower if only one is partially lacking	Riparian vegetation from Streambank to project area boundary is mostly or entirely one of the 4 structural classes
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

13. Percent Native Woody Vegetation (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Riparian woody vegetation (trees and shrubs) from streambank to project area boundary is >90% native species; exotic species are absent or scattered, rarely or never dominant.	Riparian woody vegetation from streambank to project area boundary is 60-90% native species; exotic species are scattered, infrequently dominant.	Riparian woody vegetation from streambank to project area boundary is 30-60% native species; exotic species are distributed throughout and sometimes dominant.	Riparian woody vegetation from streambank to project area boundary is <30% native species; exotic species are widely distributed throughout and frequently or entirely dominant.
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

14. Palustrine Wetland Area and Function	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	10% or more of riparian area contains backwaters, sloughs, or beaver ponds; most of these support dense, tall (>1 m) emergent wetland vegetation; 1 or more wetlands are at least 3 acres in size.	5-10% of riparian area contains backwaters, sloughs, or beaver ponds; some but not most support dense, tall emergent wetland vegetation; 1 or more wetlands are at least 2 acres in size.	< 5% of riparian area contains backwaters, sloughs, or beaver ponds; some support dense, tall emergent wetland vegetation; 1 or more wetlands are at least 1 acre in size.	< 5% of riparian area contains backwaters, sloughs, or beaver ponds; few support dense, tall emergent wetland vegetation; wetlands are <1 acre in size.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Assessment Field Data Sheet - High Gradient

15. Riparian Vegetation Zone Width (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns) have no impacts	Width of riparian zone 12-18 meters, human activities have minimal impacts	Width of riparian zone 6-12 meters, human activities have a great deal of impacts	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

16. Coldwater Fishery Canopy Cover ***Do not assess this element if woody vegetation is naturally absent (e.g., wet meadows)).***	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	> 75% of water surface shaded and upstream 2 to 3 miles generally well shaded.	>50% shaded in reach or >75% in reach, but upstream 2 to 3 miles poorly shaded.	20 to 50% shaded.	< 20% of water surface in reach shaded.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

17. Water appearance	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Very clear, or clear but tea-colored; objects visible at depth 3-6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slightly green color; no oil sheen on water surface	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film or moderate odor of ammonia or rotten eggs	Very turbid or muddy appearance most of the time; objects visible to depth <0.5 ft; slow moving water may be bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface. Or strong odor of chemicals, oil, sewage, or other pollutants
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Assessment Field Data Sheet - Low Gradient Streams

1. Aquatic Habitat Barriers and Diversion Sinks	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Physical barriers do not exist, or minimally inhibit movement of fish or other aquatic organisms through the reach; diversion structures are absent or mostly prevent aquatic animal movement into ditches.	Physical barriers exist but prevention of aquatic animal movement is limited to brief seasons or to only large fish. Diversion structures partially prevent movement of aquatic animals into ditches.	Physical barriers exist that inhibit movement of aquatic animals during substantial time periods, or inhibit movement of a range of fish size classes.	Substantial physical barriers exist that mostly or entirely prevent movement of aquatic animals. Diversion structures allow and encourage movement of aquatic animals into ditches.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

2. Instream Fish Cover	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	>7 cover types available	5 to 7 cover types available	2 to 4 cover types available	0 to 1 cover types available
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Cover Types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophyte beds, isolated/backwater pools, other: ____________________________________.				
Notes:				

3. Pool Substrate Characterization	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Mixture of substrate materials with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud or clay, mud may be dominant, some root mats and submerged vegetation present	All mud or clay or sand bottom, little or no root mat; no submerged vegetation	Hard-pan clay or bed-rock; no root mat or vegetation
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

4. Pool Variability	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Even mix of large-shallow, large-deep, small-shallow and submerged vegetation	Majority of pools large-deep, very few shallow	Shallow pools much more prevalent than deep pools	Majority of pools small-shallow or pools absent
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - Low Gradient Streams

5. Insect/ invertebrate habitat	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen).	3 to 4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream.	1 to 2 types of habitat. The substrate is often disturbed, covered, or removed by high stream velocities and scour or by sediment deposition.	0 to 1 type of habitat.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Cover types: Fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel, other: ____.				
NOTES:				

6. Sediment Deposition	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 20-50% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, obstructions, and bends. Moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

7. Flow Continuity	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Water reaches base of both lower banks and minimal amount of channel substrate exposed	Water fills > 75% of the available channel or <25% of channel substrate is exposed	Water fills 25%-75% of the available channel, and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - Low Gradient Streams

	Optimal	Suboptimal	Marginal	Poor
8. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				
9. Bank Stability (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Banks stable; evidence of erosion or bank failure absent or minimal; banks are low (at elevation of floodplain); 33% or more of eroding surface area is protected by roots that extend into base-flow elevation	Moderately stable; banks are low (at elevation of floodplain); less than 33% or more of eroding surface area is protected by roots that extend into base-flow elevation	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently) outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Notes:				
10. Riparian Vegetation Cover (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Less than 20% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities minimal or absent; almost all plants able to grow naturally	20-35% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be evident but not seriously affecting riparian structure	36-50% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be evident and seriously affecting riparian structure	More than 50% of the reach (excluding upland areas) is comprised of unconsolidated shore or gravel bars; disruption by grazing, cutting, or human activities may be present and seriously affecting riparian structure
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0

Habitat Assessment Field Data Sheet - Low Gradient Streams

11. Riparian Vegetation Structural Diversity **(score each bank, determine left or right side by facing downstream)**	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Riparian vegetation from streambank to project area boundary has even mix of mature trees (seedlings to 10 m tall), shrubs, and herbaceous vegetation or wetland emergents	Riparian vegetation from streambank to project area is mostly lacking one of the 4 structural classes; rank higher if the other 3 classes are well represented, lower if only one or more is partially lacking	Riparian vegetation from Streambank to project area boundary is mostly lacking 2 of the 4 structural classes; rank higher if the other 2 classes are well represented, lower if only one is partially lacking	Riparian vegetation from Streambank to project area boundary is mostly or entirely one of the 4 structural classes
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

12. Percent Native Woody Vegetation **(score each bank, determine left or right side by facing downstream)**	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Riparian woody vegetation (trees and shrubs) from streambank to project area boundary is >90% native species; exotic species are absent or scattered, rarely or never dominant.	Riparian woody vegetation from streambank to project area boundary is 60-90% native species; exotic species are scattered, infrequently dominant.	Riparian woody vegetation from streambank to project area boundary is 30-60% native species; exotic species are distributed throughout and sometimes dominant.	Riparian woody vegetation from streambank to project area boundary is <30% native species; exotic species are widely distributed throughout and frequently or entirely dominant.
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

	Condition Category			
13. Channel Sinuosity	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	The bends in the stream increase the stream 3 to 4 times longer than if it was in a straight line	The bends in the stream increase the stream length 2 to 3 times longer than if was in a straight line	The bends in the stream increases the stream length 1 to 2 times longer than if it was in a straight line	Channel straight; waterway has been straightened for a long distance.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - Low Gradient Streams

Canopy Cover ***(Only address if applicable, Do not assess this element if active channel width is greater than 50 feet. Do not assess this element if woody vegetation is naturally absent (e.g., wet meadows)).***

14. Coldwater Fishery Canopy Cover	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	> 75% of water surface shaded and upstream 2 to 3 miles generally well shaded.	>50% shaded in reach or >75% in reach, but upstream 2 to 3 miles poorly shaded.	20 to 50% shaded.	< 20% of water surface in reach shaded.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

15. Warmwater Fishery Canopy Cover	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	25 to 90% of water surface shaded; mixture of conditions.	> 90% shaded; full canopy; same shading condition throughout the reach.	(intentionally blank)	< 25% water surface shaded in reach.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

16. Riparian Vegetation Zone Width (score each bank, determine left or right side by facing downstream)	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns) have not impacted	Width of riparian zone 12-18 meters, human activities have minimal impacts	Width of riparian zone 6-12 meters, human activities have a great deal of impacts	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities
Left Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
Right Bank SCORE:	10 9	8 7 6	5 4 3	2 1 0
NOTES:				

Habitat Assessment Field Data Sheet - Low Gradient Streams

17. Water Appearance	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Very clear, or clear but tea-colored; objects visible at depth 3-6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slightly green color; no oil sheen on water surface	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film or moderate odor of ammonia or rotten eggs	Very turbid or muddy appearance most of the time; objects visible to depth <0.5 ft; slow moving water may be bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface. Or strong odor of chemicals, oil, sewage, or other pollutants
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

18. Nutrient Enrichment	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
	Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.	Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrates.	Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.	Pea green, gray, or brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				
19. Manure Present	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
Do not score this element unless livestock operations or human waste discharges are present.	(intentionally blank)	Evidence of livestock access to riparian zone.	Occasional manure in stream or waste storage structure located on the flood plain.	Extensive amount of manure on banks or in stream or untreated human waste discharge pipes present.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
NOTES:				

Appendix 2. Data sheet for characterization of physical attributes.

Physical Characterization Field Data Sheet - (FRONT)

Site Name: ____

River Name: __________________________ **Date:** ____________**Time:** ______________

Region: Delta – Colona, Colona – Ridgway, Ridgway to Ouray, Above Ouray (Circle one)

Upstream GPS: Latitude: ______________ Longitude: ______________ Datum: _______

Downstream GPS: Latitude: ______________ Longitude: ______________ Datum: _______

Weather Conditions: Today: _________________ Past 2-5 days: _____________________

***Ecoregion:** ____

***Sampling Reach Area** __________________ mi^2 ***Gradient** ______________________

Team Members: ____

Site Diagram *(Include flow direction and north arrow)*

** To be completed in the office*

AVERAGE DEPTH PROFILE

Select a spot that is typical of the sample area. Measure depth at 1 ft intervals from bank to bank. UNIT = Ft

1 ________	6 ________	11 ________	16 ________
2 ________	7 ________	12 ________	17 ________
3 ________	8 ________	13 ________	18 ________
4 ________	9 ________	14 ________	19 ________
5 ________	10 ________	15 ________	20 ________

Physical Characterization Field Data Sheet - (BACK)

Watershed Features	**Predominant Surrounding Landuse** □ Forest □ Residential □ Field/Pasture □ Commercial □ Agriculture □ Industrial □ Other: ______________	**Local Watershed NPS Pollution** □ No Evidence □ Some potential sources □ Obvious Sources **Local Watershed Erosion** □ None □ Moderate □ Heavy
Riparian Vegetation (18 meter/60 ft buffer)	**Indicate the dominant type and record dominant species present** □ Trees □ Shrubs □ Grasses □ Herbaceous **Dominant Species present**: ________________________________	
Instream Features	**Estimated Reach Length ______ m** **Estimated Stream Width ______ m** **Sampling Reach Area _________ m^2** **Area in km^2 (m^2x1000) _______ km^2** **Channelized:** Yes □ No □ **Diversion Present:** Yes □ No □ **Proportion of reach represented by stream morphology types:** □ Riffle _____ % □ Run _____ % □ Pool _____ %	**Canopy Cover** □ Partly Open □ Partly Shaded □ Shaded **High Water Mark ______ m** **Estimated Stream Depth ______ m** **Dam Present:** Yes □ No □ Name of Diversion: __________________
Large Woody Debris	**LWD ___________** m^2 **Density of LWD**: _________ m^2/km^2 (LWD/reach area)	
Aquatic Vegetation	**Indicate the dominant type and record the dominant species present** □ Rooted emergent □ Rooted submergent □ Rooted floating □ Free Floating □ Floating Algae □ Attached Algae **Dominant Species Present**: ____________________________ **Portion of the reach with aquatic vegetation: ________** %	
Sediment/ Substrate	**Odors** □ Normal □ Sewage □ Petroleum □ Chemical □ Anaerobic □ None □ Other: _______________________ **Oils** □ Absent □ Slight □ Moderate □ Profuse	**Deposits** □ Sludge □ Sawdust □ Gravel □ Sand □ Other: ____________________ **Looking at stones which are not deeply embedded, are the undersides black in color?** Yes □ No □

INORGANIC SUBSTRATE COMPONENTS (Should add up to 100%)			**ORGANIC SUBSTRATE COMPONENTS** (Does not need to add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	>256 mm (10”)				
Cobble	64 - 256 mm (2.5 “ - 10”)		Mud-Muck	black, very fine organic (FPOM)	
Gravel	2 - 64 mm (0.1 “ - 2.5”)				
Sand	0.06 - 2 mm (gritty)		Marl	grey, shell fragments	
Silt	0.004 - 0.06 mm				
Clay	<0.004 mm (slick)				

Appendix 3. Data sheet for characterizing macroinvertebrate sampling sites.

MACROINVERTEBRATE COLLECTION FORM
ROCKY SUBSTRATE (page 1)

Kick #1

A. Total Time Sampled: ______________________ sec
B. Average Depth of Rectangle Sampled: ____________________ ft
C. Circle: FAST Riffle OR SLOW Riffle
(1.5 – 2.5 ft/sec) (0.5 – 1.5 ft/sec)

INORGANIC SUBSTRATE COMPONENTS (Should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (Does not need to add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	>256 mm (10”)				
Cobble	64 - 256 mm (2.5 “ - 10”)		Mud-Muck	black, very fine organic materials (FPOM)	
Gravel	2 - 64 mm (0.1 “ - 2.5”)				
Sand	0.06 - 2 mm (gritty)		Marl	grey, shell fragments	
Silt	0.004 - 0.06 mm				
Clay	<0.004 mm (slick)				
	TOTAL %				

Kick #2

A. Total Time Sampled: ______________________ sec
B. Average Depth of Rectangle Sampled: ____________________ ft
C. Circle: FAST Riffle OR SLOW Riffle
(1.5 – 2.5 ft/sec) (0.5 – 1.5 ft/sec)

INORGANIC SUBSTRATE COMPONENTS (Should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (Does not need to add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	>256 mm (10”)				
Cobble	64 - 256 mm (2.5 “ - 10”)		Mud-Muck	black, very fine organic materials (FPOM)	
Gravel	2 - 64 mm (0.1 “ - 2.5”)				
Sand	0.06 - 2 mm (gritty)		Marl	grey, shell fragments	
Silt	0.004 - 0.06 mm				
Clay	<0.004 mm (slick)				
	TOTAL %				

Appendix 4. Summary of data collected for habitat assessment at 17 sites.

Metric #	Metric	Region 1: Above Ouray (High Gradient)				
		Ironton	Memorial	Engineer Pass	Above Hydrodam	Below Hydrodam
1	Aquatic habitat barrier and diversion sinks	20	20	20	0	20
2	Instream fish cover	6	18	20	7	10
3	Insect/invertebrate habitat	11	20	20	7	18
4	Embeddedness	17	5	20	16	20
5	Velocity /depth regimes	15	12	20	8	8
6	Sediment deposition	18	19	20	13	18
7	Flow continuity	19	20	20	11	20
8	Channel alteration	10	20	11	16	20
9	Frequency of riffles or bends	16	17	20	4	2
10 L	Bank stability left	5	10	10	8	9
10 R	Bank stability right	7	10	8	8	9
11 L	Riparian vegetation cover left	1	9	10	5	0
11 R	Riparian vegetation cover right	7	9	8	3	0
12 L	Riprarian vegetation structural diversity left	0	8	7	4	1
12 R	Riparian vegetation structural diversity right	3	8	7	5	1
13 L	Percent native woody vegetation left	10	10	10	10	10
13 R	Percent native woody vegetation right	10	10	10	10	10
14	Palustrine Wetland Area and Function	0	0	0	4	0
15 L	Riparian vegetation zone width left	1	5	3	5	0
15 R	Riparian vegetation zone width right	4	3	1	10	0
16	Coldwater Fishery Canopy Cover	1	19	20	8	16
17	Water Appearance	1	2	20	3	4

Metric #	Metric	Region 2: Ouray to Ridgway Reservoir (Low Gradient)			
		Canyon Creek	Ouray River Park	KOA	Rollans Park
1	Aqu habitat barriers and diversion sinks	20	20	20	20
2	Instream fish cover	9	5	10	12
3	Pool substrate characterization	16	10	16	16
4	Pool variability	11	5	5	6
5	Insect/ invert habitat	11	11	11	10
6	Sediment deposition	14	15	15	12
7	Flow continuity	16	11	12	10
8	Channel alteration	20	1	20	10
9 L	Bank stability left	9	10	1	5
9 R	Bank stability right	9	10	8	5
10 L	Riparian vegetation cover left	8	3	8	8
10 R	Riparian vegetation cover right	7	3	8	8
11 L	Riparian vegetation structural diversity left	9	4	10	5
11 R	Riparian vegetation structural diversity right	9	4	8	5
12 L	% native woody veg left	10	8	8	5
12 R	% native woody veg right	10	6	8	5
13	Channel sinuosity	5.63	5.49	5.24	6.05
14	Coldwater fish canopy cover	19	5	3	NA
15	Warmwater fish canopy cover	NA	NA	NA	NA
16 L	Riparian zone width left	8	3	9	3
16 R	Riparian zone width right	7	3	9	5
17	Water appearance	20	5	3	9
18	Nutrient enrichment	20	20	2	13
19	Manure present	20	19	19	20

Metric #	Metric	Region 3: Ridgway Reservoir to Colona (Low Gradient)			
		Spirek	Pacochupuk	Cow Creek	Billy Creek
1	Aqu habitat barriers and diversion sinks	20	20	20	13
2	Instream fish cover	17	11	7	8
3	Pool substrate characterization	17	16	11	0
4	Pool variability	0	19	0	0
5	Insect/ invert habitat	17	14	8	15
6	Sediment deposition	15	20	8	18
7	Flow continuity	13	15	6	8
8	Channel alteration	20	18	20	18
9 L	Bank stability left	9	9	10	9
9 R	Bank stability right	4	9	7	9
10 L	Riparian vegetation cover left	10	7	9	6
10 R	Riparian vegetation cover right	9	7	7	9
11 L	Riparian vegetation structural diversity left	9	9	9	9
11 R	Riparian vegetation structural diversity right	8	9	9	9
12 L	% native woody veg left	9	7	9	8
12 R	% native woody veg right	9	9	9	8
13	Channel sinuosity	5.52	6.17	5.76	5.68
14	Coldwater fish canopy cover	5	5	2	5
15	Warmwater fish canopy cover	NA chan>50ft	NA chan>50ft	NA chan>50ft	NA chan>50ft
16 L	Riparian zone width left	2	9	10	9
16 R	Riparian zone width right	2	5	10	4
17	Water appearance	15	15	19	18
18	Nutrient enrichment	14	11	16	13
19	Manure present	20	20	20	20

Metric #	Metric	Region 4: Colona to Confluence (Low Gradient)			
		Ute Museum	Baldridge Park	Waterfront	Sazama
1	Aqu habitat barriers and diversion sinks	20	20	10	20
2	Instream fish cover	15	8	1	14
3	Pool substrate characterization	0	13	16	0
4	Pool variability	0	3	5	0
5	Insect/ invert habitat	12	8	9	10
6	Sediment deposition	14	11	11	20
7	Flow continuity	15	13	13	20
8	Channel alteration	13	8	7	20
9 L	Bank stability left	9	9	4	7
9 R	Bank stability right	10	9	9	7
10 L	Riparian vegetation cover left	10	1	1	10
10 R	Riparian vegetation cover right	6	8	9	10
11 L	Riparian vegetation structural diversity left	8	1	2	8
11 R	Riparian vegetation structural diversity right	10	8	9	8
12 L	% native woody veg left	9	1	1	10
12 R	% native woody veg right	5	6	8	10
13	Channel sinuosity	6.33	5.98	6.79	6.51
14	Coldwater fish canopy cover	NA-meadow	NA-meadow	NA-meadow	NA-meadow
15	Warmwater fish canopy cover	5	1	3	2
16 L	Riparian zone width left	10	1	3	10
16 R	Riparian zone width right	2	7	10	10
17	Water appearance	15	11	10	9
18	Nutrient enrichment	16	11	15	10
19	Manure present	20	11	20	20

Appendix 5. Macroinvertebrate data for 4 sites. These are also Colorado River Watch sites.

Rollans Park

Taxon	300-count	100%
OLIGOCHAETA		
Lumbricidae	1	
EPHEMEROPTERA		
Baetis tricaudatus	4	
PLECOPTERA		
Pteronarcella badia	8	
TRICHOPTERA		
Arctopsyche grandis	7	
Brachycentrus americanus	4	
Hydropsyche sp.	5	
DIPTERA		
Atherix pachypus	7	
Hexatoma sp.	3	
TOTAL ORGANISMS	39	
Number of Grids Picked	1 of 15	
Number of Organisms per Grid		
Grid 1	39	

Billy Creek

Taxon	300-count	100%
ACARI		
Atractides sp.	1	
Sperchon sp.	2	
EPHEMEROPTERA		
Baetis tricaudatus	96	
Drunella grandis	2	
Ephemerella sp.	20	
Paraleptophlebia sp.	2	
Rhithrogena sp.	46	
PLECOPTERA		
Capniidae	3	
Chloroperlidae	16	
Pteronarcella badia	7	
Skwala americana	2	
TRICHOPTERA		
Arctopsyche grandis	11	
Brachycentrus americanus	16	
Brachycentrus occidentalis	4	
Hydropsyche sp.	8	
COLEOPTERA		
Optioservus sp.	9	
DIPTERA		
Atherix sp.	25	
Cricotopus/Orthocladius sp.	5	
Eukiefferiella sp.	2	
Hexatoma sp.	2	
Simulium sp.	42	
Tvetenia sp.	4	
TOTAL ORGANISMS	325	
Number of Grids Picked	2 of 15	
Number of Organisms per Grid		
Grid 14	181	
Grid 2	144	

Waterfront

Taxon	300-count	100%
ACARI		
Sperchon sp.	1	
EPHEMEROPTERA		
Baetis tricaudatus	18	
Drunella grandis	2	
Ephemerella sp.	100	
Paraleptophlebia sp	1	
Rhithrogena sp.	10	
PLECOPTERA		
Pteronarcella badia	1	
Perlodidae	1	
Skwala americana	2	
TRICHOPTERA		
Brachycentrus americanus	4	
Brachycentrus occidentalis	4	
Hydropsyche sp.	104	
Lepidostoma sp.	2	
Rhyacophila coloradensis		1
COLEOPTERA		
Optioservus sp.	30	
Zaitzevia sp.	1	
DIPTERA		
Atherix pachypus		1
Cricotopus/Orthocladius sp.	24	
Eukiefferiella sp.	8	
Hexatoma sp.	2	
Microtendipes sp.	1	
Neoplasta sp.	1	
Simulium sp.	10	
Tvetenia sp.	2	
GASTROPODA		
Physa sp.	1	
TOTAL ORGANISMS	330	
Number of Grids Picked	3 of 15	
Number of Organisms per Grid		
Grid 7	91	
Grid 10	115	
Grid 1	124	

Baldridge Park

Taxon	300-count	100%
NEMATODA	2	
OLIGOCHAETA		
Tubificidae with hair chaetae	7	
ACARI		
Sperchon sp.	1	
EPHEMEROPTERA		
Acentrella sp.	2	
Baetis tricaudatus	2	
Ephemerella sp.	44	
Rhithrogena sp.	24	
PLECOPTERA		
Capniidae	2	
Chloroperlidae	1	
Claassenia sabulosa	2	
Perlodidae	1	
Pteronarcella badia	4	
Skwala americana	3	
TRICHOPTERA		
Arctopsyche grandis	1	
Brachycentrus occidentalis	51	
Glossosoma sp.	5	
Hydropsyche sp.	8	
Lepidostoma sp.	13	
COLEOPTERA		
Optioservus sp.	9	
DIPTERA		
Atherix pachypus	1	
Cricotopus/Orthocladius sp.	95	
Eukiefferiella sp.	1	
Hexatoma sp.	2	
Micropsectra sp.	1	
Monodiamesa sp.	1	
Neoplasta sp.	2	
Odontomesa sp.	1	
Phaenopsectra sp.	2	
Polypedilum sp.	3	
Simulium sp.	5	
Stictochironomus sp.	7	
Tvetenia sp.	2	
GASTROPODA		
Physa sp.		1
TOTAL ORGANISMS	305	
Number of Grids Picked	8 of 15	
Number of Organisms per Grid		
Grid 4	53	
Grid 9	16	
Grid 3	35	
Grid 11	62	
Grid 6	36	
Grid 15	37	
Grid 2	37	
Grid 1	29	