Summary Report

Benthic Macroinvertebrate Biomonitoring and Pebble Count Study, Upper Colorado River

2018

Prepared for:

Upper Colorado River
Wild and Scenic Stakeholder Group

Prepared by:

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Introduction

The Upper Colorado River provides a valuable natural resource which supports a variety of terrestrial and aquatic life while also sustaining an assortment of human needs including: municipal, agricultural, and recreational opportunities. The river and adjacent riparian corridor support terrestrial and aquatic ecosystem function, while providing important habitat for a variety of species, including endangered species and species of concern (Beeby et al. 2014). The bald eagle (*Haliaeetus leucocephalus*), American river otter (*Lontra canadensis*), brown trout (*Salmo trutta*), and the salmonfly (*Pteronarcys californica*) are among the vast group of wildlife that rely on the health of the Colorado River for survival (CPW 2015). These species all play a critical role in ecosystem function as well as providing recreational and economic value to humans. In order to preserve these valuable natural resources, it is important to monitor the health of the aquatic ecosystem through the assessment of biotic and abiotic components that are the foundation of this river system.

Benthic macroinvertebrates in rivers and streams are dependent on the physical, chemical, and biological components of the associated ecosystem. Most macroinvertebrate taxa also have a relatively long aquatic life stage and limited mobility. These unique features provide an opportunity to monitor past and present influences of potential stressors to the aquatic environment at specific locations. Several recent studies have emphasized the need for biological monitoring (biomonitoring) to further evaluate aquatic ecosystems (Barbour et al. 1999, Paul et al. 2005, Bonada et al. 2006).

Biomonitoring programs that utilize benthic macroinvertebrate assemblages have advantages that are not realized through physical or chemical water quality monitoring alone (Ward et al. 2002). The sensitivity of benthic macroinvertebrates to disturbances can exist at a structural (species/taxon) and functional (trophic) level, where each taxon in the community potentially exhibits different levels of sensitivity to any given disturbance. The wide range of stressors and potential interaction among disturbances can make identification of the predominant sources of stress difficult (Johnson et al. 2013). However, some insight into the source and spatial distribution of stressors can be obtained as a result of changes in the structure and function of benthic macroinvertebrate communities.

Long-term biomonitoring studies are essential for the evaluation of aquatic life in systems with increasing water demands or changes in land-use practices (Likens and Lambert 1998, Voelz et al. 2005). The results obtained from consistent sampling practices and accurate identifications can provide valuable insight regarding short-term and long-term changes in aquatic conditions.

The biomonitoring portion of this study was designed to monitor and evaluate the health of aquatic life in the Upper Colorado River. This study area included a stream section where recreational use (rafting, fishing, etc.) has been historically high and upstream diversions may be altering the natural flow regime. In this section of the Upper Colorado

River there is limited residential development (although there are several small municipalities that exist upstream). Results from the biomonitoring portion of this study should provide a reliable measurement of the health of benthic macroinvertebrate communities at specific locations within the study area.

Sedimentation, or the deposition of fine sediment in the stream bed, is considered to be one of the most common and widespread forms of pollution affecting aquatic ecosystems in the western United States (Waters 1995). An increase in fine sediment bedload typically results in a reduction in habitat complexity (filling spaces that exist between cobbles and gravel), which can ultimately reduce macroinvertebrate density and diversity (Wohl 2000). Sediment in transit reduces light transmission and can have abrasive properties, while the deposition of fine sediment reduces benthic habitat and can smother benthic organisms and fish eggs (Culp et al. 1986; Wood and Armitage 1997). The Water Quality Control Commission's Guidance for Implementation of Colorado's Narrative Sediment Standard Regulation #31 (Colorado Water Quality Control Commission 2014) provides an extensive review on the negative impacts that sedimentation can have on fish and macroinvertebrate populations, and also suggests that the deposition of fine sediment can alter stream morphology (velocity, hydraulic roughness, habitat type), and water chemistry (Colorado Water Quality Control Commission 2014). These types of impacts to habitat and aquatic life can disrupt ecological processes by altering the structure and balance of aquatic communities.

Although some sediment deposition and transport is expected to naturally occur based on surrounding geological conditions, certain anthropogenic activities (such as changes in land-use, road construction, etc.) may trigger or speed up the rate of sedimentation. Pebble count studies are a common tool used to evaluate and monitor stream bed material and assess potential impacts from this common source of stress. The results from benthic macroinvertebrate sampling and pebble count studies in the fall (28th-29th) of October 2018 are provided in this report.

Study Area

The Upper Colorado River study area included approximately 83 km of the Colorado River within Grand and Eagle Counties (Table 1, Figure 1). The five (5) sampling locations were previously established for the purpose of evaluating physical habitat and the health of aquatic life in assessments conducted by Colorado State University and the Eagle River Watershed Council (Beeby et al. 2014). The two most upstream study sites (CR-PH and CR-Rad) were located within Grand County, and the three downstream sites (CR-SB, CR-aC, and CR-bRD) were located in Eagle County. The benthic macroinvertebrate monitoring and pebble count studies conducted during October of 2018 took place at the same coordinates used by Beeby et al. (2014). The most upstream site (CR-PH) was sampled below the Pumphouse Boat Ramp at Pumphouse Recreation Area, while site CR-Rad was located approximately 6.7 km downstream in riffle habitat below Radium Hot Springs. Farther downstream, site CR-SB was specifically located in riffle habitat upstream from State Bridge near the intersection of New Trough Rd and Highway 131 in Eagle County. The two remaining study sites included CR-aC (above Elk Creek in Catamount), and the farthest downstream site (CR-bRD), which was located upstream from the confluence with the Eagle River (Figure 1). A comparison of metric values and pebble count results was used to assess substrate/habitat conditions and macroinvertebrate community health at each sampling location.

Table 1. GPS coordinates and elevations of sample sites on the Colorado River.

	Location	Latitude	Longitude	Elevation (m)
CR-PH	Colorado River at Pumphouse	39.98497	-106.51365	2122
CR-Rad	Colorado River at Radium	39.94984	-106.55788	2100
CR-SB	Colorado River at State Bridge	39.85765	-106.6469	2058
CR-aC	Colorado River above Catamount	39.91232	-106.78523	2008
CR-bRD	Colorado River below Red Dirt	39.70961	-107.04671	1898

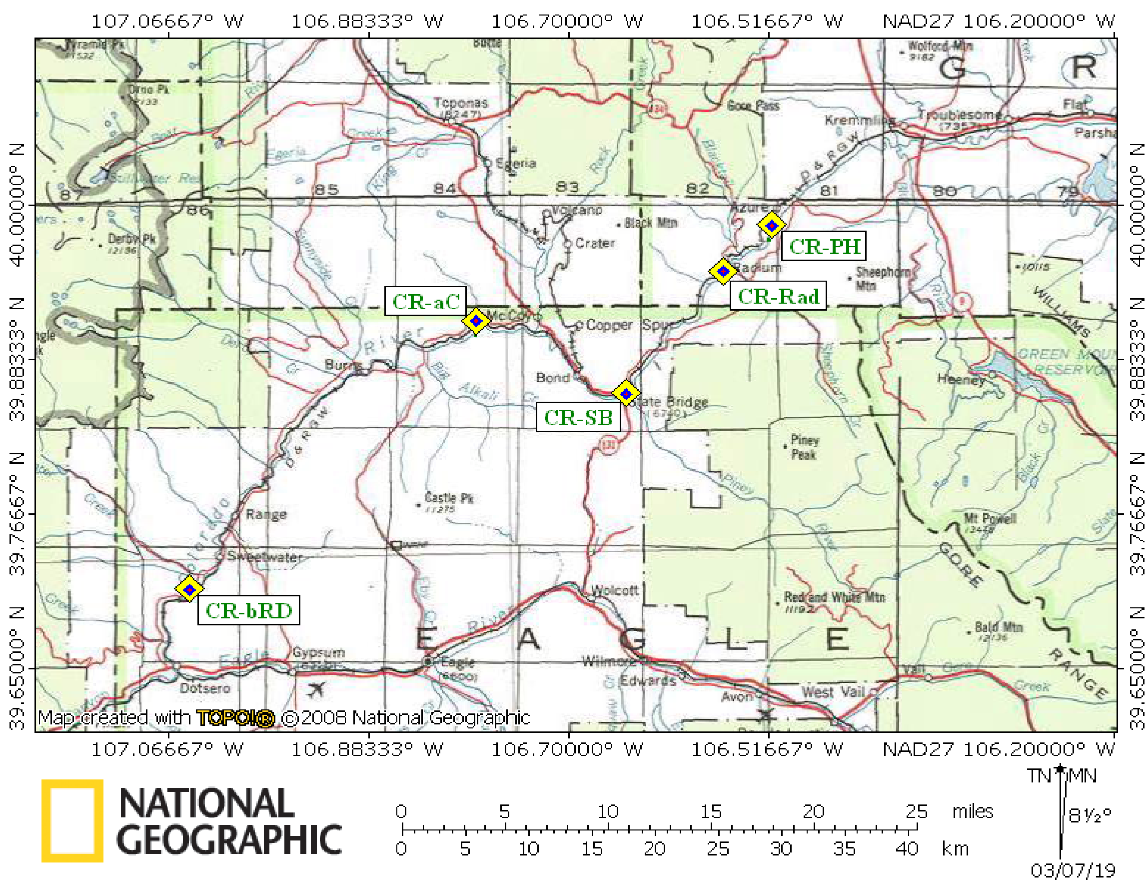

Figure 1. Map of study sites used for Macroinvertebrate and Pebble Count studies on the Upper Colorado River in 2018. This map was created with TOPO! © National Geographic Maps.

Objectives

The overall objective for the Benthic Macroinvertebrate Sampling and Analysis portion of this study was to provide an assessment of the health of macroinvertebrate communities in the Upper Colorado River and identify areas with potential anthropogenic impacts. The goal of the pebble count portion of this study was to collect representative substrate data in riffle habitat that would provide insight into the physical characteristics of the stream bed within the Upper Colorado River study area. Additional information was also collected to determine the relative abundance of fine sediment, percent algae cover, and percent embeddedness.

Methods

Biomonitoring Study

The effort that is used during benthic macroinvertebrate sampling (and processing of samples) is often proportional to the quality and quantity of information obtained in the investigation. The objective of this particular study required that three (3) replicate quantitative Hess samples were taken from similar habitat at each study site. The Multi-Metric Index (MMI v4) and several individual biotic indices (metrics) were included in the data analysis to evaluate different aspects of macroinvertebrate community health, and account for different responses to various types of disturbances. The biomonitoring and analysis approach used for this project was intended to provide information describing local aquatic conditions, level of potential disturbances, and densities of various taxa.

Three quantitative, replicate samples were collected from each of the five sites in the study area during late October (28^{th}-29^{th}), 2017. All samples were taken in similar habitat at each sampling location using a Hess Sampler to provide quantitative benthic macroinvertebrate data. Substrate within each sample was thoroughly agitated and individual rocks were scrubbed by hand to dislodge benthic organisms. All macroinvertebrates were rinsed into sample jars and preserved in 80% ethanol solution. Each sample jar was labeled (with date, location, and sample ID number) on the outside and inside of each container. Samples were transported to the lab at Timberline Aquatics, Inc. where they were sorted, identified, and enumerated. The sorting and identification process was conducted for each entire sample to avoid potential problems or controversy associated with subsampling.

The sorting and identification process used in this study required that all macroinvertebrates be removed from each sample and placed into vials containing major taxonomic groups. As part of the quality control protocols at Timberline Aquatics, Inc., all sorted macroinvertebrate samples were checked by a qualified taxonomist, and approximately 10% of the identifications were checked by Dr. Boris Kondratieff (Professor of Entomology at Colorado State University). As an additional means of QA/QC, Dr. Kondratieff confirmed identifications in all cases where the classification of a species was difficult or questionable. Macroinvertebrates were identified using variety of taxonomic keys including Ward et al. (2002) and Merritt et al. (2008).

Multi-Metric Index (MMI)

In the fall of 2010, the Water Quality Control Division (WQCD) for the Colorado Department of Public Health and Environment (CDPHE) developed a Multi-Metric Index (MMI) to assist in the evaluation of benthic macroinvertebrate data from across the State of Colorado (Colorado Department of Public Health and Environment 2010). In 2017, the MMI was recalibrated and updated to produce a new analysis tool - the MMI (v4) - that relies on specific methods and protocols for sample processing and analysis (Colorado Department of Public Health and Environment 2017).

The MMI (v4) was applied to quantitative macroinvertebrate data collected from the Colorado River using the guidelines established in the WQCD Listing Methodology, 2018 Listing Cycle. Macroinvertebrates collected from the Upper Colorado River were identified to a taxonomic level consistent with the Operational Taxonomic Unit (OTU) established by the CDPHE. This level of identification is typically genus or species for mayflies, stoneflies, caddisflies, and many dipterans. Members of the family Chironomidae were also identified to the genus level. The MMI tool uses a rarefication process in the calculation of scores; however, any taxa that were both large and rare were included in the data used to generate final scores. The inclusion of rare taxa may provide important biological information because many rare taxa are also considered sensitive to disturbances (Fore et al. 1996).

The group of metrics used in MMI (v4) calculations depends on the sampling location and corresponding Biotype (Mountains, Transitional, or Plains). All sampling locations for the Upper Colorado River Study were located within Biotype 1 (the Transition Zone) which includes lower mountain areas in the State of Colorado. Each of the individual metrics used in the analysis produces a score that is adjusted to a scale from 1 to 100 based on the range of metric scores found at "reference sites". In Biotype 1, these metrics include: EPT Taxa, Percent Non-Insect Individuals, Percent EPT Individuals (excluding Baetidae), Percent Coleoptera Individuals, Percent Intolerant Taxa, Percent Increaser Individuals (Mid-Elevation), Clinger Taxa, and Predator/Shredder Taxa. A detailed description of individual metrics and the development of the MMI (v4) can be found in the "Aquatic Life Use Attainment: Methodology to Determine Use Attainment for Rivers and Streams, Policy 10-1" (Colorado Department of Public Health and Environment 2017). Thresholds for the MMI (v4) in Biotype 1 are as follows:

Biotype	Attainment Threshold	Impairment Threshold
Transitional (Biotype 1)	45.2	33.7

MMI (v4) scores that fall between the thresholds for ‘attainment’ and ‘impairment’ are in the ‘grey zone’ and require further evaluation using two auxiliary metrics (Diversity and HBI). The following thresholds for the Diversity and HBI metrics have been adjusted specifically for the MMI (v4) by the WQCD:

Biotype	HBI	Diversity
Transitional (Biotype 1)	5.8	2.1

Additional metrics used in the study:

Population densities and species lists were developed for each sampling location in the study area and data were used in a variety of individual metrics to provide additional information regarding aquatic conditions. The following section provides a description of each individual metric used in this study:

Shannon Diversity (Diversity): Diversity was used as an auxiliary metric for the MMI and as an independent metric in this study to evaluate changes in macroinvertebrate community structure. In unpolluted waters, Diversity values typically range from near 3.0 to 4.0. In polluted waters, this value is generally less than 1.0. The Diversity metric provides a measure of macroinvertebrate community balance.

Hilsenhoff Biotic Index (HBI): The HBI is another auxiliary metric used for the MMI; however, it is also valuable as an independent metric and has been widely used and/or recommended in numerous regional biomonitoring studies (Paul et al. 2005). Most of its value lies in the detection of organic pollution, but it is also used to evaluate aquatic conditions in a variety of other circumstances. The HBI was originally developed using macroinvertebrate taxa from streams in Wisconsin; therefore, it may require regional modifications (Hilsenhoff 1988). Tolerance values for taxa occurring in this study area were taken from a list provided by the CDPHE which was derived from a variety of regional sources. Although HBI values may naturally vary among regions, a comparison of the values produced within the same river system should provide information regarding locations impacted by nutrients and/or other aquatic disturbances. Values for the HBI range from 0.0 to 10.0, and increase as water quality decreases.

Ephemeroptera Plecoptera Trichoptera (EPT Taxa): The design of this metric is based on the assumption that the orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are generally more sensitive to pollution than other benthic macroinvertebrate orders (Lenat 1988). The EPT Taxa metric is currently an important and widely used metric in many regions of the United States (Barbour et al. 1999). The EPT Taxa value is simply given as the total number of distinguishable taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera found at each station. This number will naturally vary among river systems, but it can be an excellent indicator of disturbance within a specific drainage. The EPT Taxa value is expected to decrease in response to a variety of stressors including nutrients (Wang et al. 2007).

Percent EPT (excluding Baetidae): This metric value is expressed as the percent composition of mayflies, stoneflies, and caddisflies in the sample, excluding the mayfly family Baetidae. The family Baetidae is considered one of the more tolerant families that that is included among EPT taxa. A higher percentage from this metric is expected to indicate lower levels of stress in the aquatic environment. This metric is also included as a component of the MMI (v4), where the metric value is transformed into a score (based on a scale from 0 to 100).

Percent Chironomidae: Chironomidae taxa are generally considered to be fairly tolerant of environmental stress when compared to other aquatic insect families (Plafkin et al. 1989). The Percent Chironomidae metric relies on the assumption that Chironomidae density will increase with decreasing water quality. Streams that are undisturbed often have a relatively even distribution of Ephemeroptera, Plecoptera, Trichoptera, and Chironomidae (Mandaville 2002); while the Chironomidae family often dominates (75% or more of the macroinvertebrate density) at sites degraded by metals or other pollutants (Barton and Metcalf-Smith 1992). Most species of Chironomidae tend to have a relatively short life cycle which enables them to continually re-colonize unstable or polluted habitats, making their abundance a relatively reliable indicator of environmental stress (Lenat 1983).

Density of *Pteronarcys californica*: *Pteronarcys californica* (aka the salmonfly or giant stonefly) is one of the largest stoneflies occurring in the western U.S. Since this species provides a major food source for fish and other aquatic and terrestrial species in the Upper Colorado River, the mean densities (number/m^2) of *Pteronarcys californica* were provided (based on quantitative replicate samples) for each study site.

Taxa Richness: Taxa Richness is another metric that is often used to provide an indication of habitat adequacy and general water quality. Taxa Richness, or the total spectrum of taxa groups present at a given site, will generally decrease in response to decreasing water quality or habitat degradation (Weber 1973). The Taxa Richness measurement is reported as the total number of identifiable taxa collected from each sampling location. It is similar to the EPT Taxa metric, except that it includes all aquatic macroinvertebrate taxa (including those thought to be tolerant to disturbance).

Density: Macroinvertebrate abundance (Density) was reported as the mean number of macroinvertebrates per m^2 found at each study site. Density provides a means of measuring and comparing standing crop at each site and this metric provides an indication of productivity for the macroinvertebrate portion of the food web at each sampling location.

Functional Feeding Groups: Most of the previously described metrics use macroinvertebrate information that relies on community structure; however, macroinvertebrate taxa were also separated into functional guilds based on food acquisition to provide a measurement of ecological function. Some representation of each group usually indicates good aquatic conditions; however, it is normal for certain groups (such as collector-gatherers) to be more abundant than others (Ward et al. 2002). Scrapers and shredders are often considered sensitive to disturbance because they are specialized feeders (Barbour et al. 1999). Consequently, these sensitive groups are expected to be well represented in healthy streams. Much of the value from this type of analysis comes from comparison of sites within a specific study area. Changes in the proportion of functional feeding groups can provide insight into various types of stress in river systems (Ward et al. 2002).

Pebble Count Study Methods

The methodology used for the Pebble Count Study followed the guidelines developed by Colorado State University and The Eagle River Watershed Council for the Colorado River in Eagle County Inventory and Assessment (CRIA) of 2014 (Beeby et al. 2014). Measurements from each transect included pebble counts (size classifications), percent fine and coarse sediment, percent algae, and percent embeddedness. Results from data analysis included a compilation of substrate (pebble) size categories and a graph depicting the distribution of sediment size classes at each location.

This study utilized a 300-count methodology which employed a point grid frame system coupled with a gravelometer to measure the proportional size classes of sediment at established transects. The point grid frame consisted of 25 (5x5) intersections of elastic bands stretched over a rigid frame. The gravelometer is an aluminum template with several measured square holes that correspond with size classes based on the intermediate axis (width) of selected pebbles. To complete the 300-count study, the grid was placed on twelve (12), equally distanced plots along each transect. The distance between each plot depended on the total length of each transect (which was determined using a rangefinder). The point grid frame was placed under the surface of the water and on top of the stream bed. The size of the pebble directly below each of the intersections of elastic bands was recorded using a gravelometer. The selected pebble was measured based on the smallest opening that the pebble could fit through, which then designated it into a respective size class. Data were recorded as the total number of pebbles counted that were 'less than' the designated particle size criterion on the gravelometer. For example, a pebble that measured 43mm in diameter would be placed within the '<45mm size class.' If the flow was too deep or too fast to visually hand-pick the pebbles, the operator used a bucket viewer to determine the particle size at each intersection. Pebble size classes were recorded before pebbles were placed back in their original position in the stream bed.

The point grid frame was also used along with the bucket viewer to record the presence or absence of algae at each cross-section. Any substrate covered in filamentous algae greater than or equal to 2mm in length would be recorded as supporting algal growth. Embeddedness data were also collected at each site (using at least 15 random rocks) to measure the depth of finer substrate surrounding the rock.

Results/Discussion

Benthic Macroinvertebrate Sampling - Fall 2018

Five study sites on the Upper Colorado River were sampled for benthic macroinvertebrates in the fall (28-29 October) of 2018 in order to evaluate the health of aquatic life. Following the collection of macroinvertebrates in the field, all samples were transported to the lab at Timberline Aquatics, Inc. where specimens were sorted, identified, and enumerated (Appendix A: Tables A1-A5). The previously described metrics were applied to the macroinvertebrate data, and results were compared among sites to evaluate potential changes in the structure and function of benthic communities.

Results from the MMI (v4)

The MMI (v4) scores from the Upper Colorado River ranged from 62.7 (site CR-PH) to 78.3 (site CR-SB), indicating that all sampling locations were able to support relatively healthy macroinvertebrate communities (Table 2, Figure 2). These MMI scores were derived from several individual metrics that appeared to be somewhat inconsistent in their evaluation of aquatic conditions at each site (Table 2). The EPT Taxa and Clinger Taxa metrics showed some general improvements in a downstream direction, while the Percent Non-Insect Individuals and Percent Increasers scores remained relatively stable among study sites. The Percent Coleoptera metric performed poorly throughout the study area, while the Percent Increasers metric generated nearly perfect scores at all study sites (Table 2). The combination of results from these individual metrics suggested that high proportions of sensitive taxa were present throughout the study area, and the richness of these sensitive taxa increased (slightly) in a downstream direction. Taxa requiring healthy riffle habitat (Clinger Taxa) also increased in a downstream direction, while the Percent Coleoptera (aquatic beetles) scores remained low. The distribution and relative abundance of aquatic beetles is often seasonally and spatially variable, which may have contributed to the unusually low scores from this metric. Much of the variability in MMI (v4) scores observed in this study area could probably be attributed to minor changes in individual component metrics that were responding to changes in habitat.

The MMI (v4) scores from this assessment were compared with threshold values to determine attainment or impairment within the study area (Figure 2). MMI scores greater than 45.2 (the green line in Figure 2) are considered in attainment for aquatic life use, while MMI scores below 33.7 (the red line in Figure 2) would indicate impaired aquatic conditions. Although MMI scores exhibited some variability among sites, all sampling locations produced scores that were in attainment for aquatic life use during the fall of 2018 (Figure 2, Table 3). It is likely that some of the variability among sites could be attributed to natural changes in community composition that occurred from upstream to downstream.

Table 2. MMI (v4) scores from composited replicate (Hess) samples collected from the Upper Colorado River in October 2018.

Metric	CR-PH	CR-Rad	CR-SB	CR-aC	CR-bRD
EPT Taxa	54.5	73.7	95.3	97.2	95.3
% Non-Insect Individuals	93.9	85.5	95.1	88.9	92.1
% EPT Individuals, no Baetidae	51.6	43.7	79.2	68.6	55.9
% Coleoptera Individuals	6.7	14.1	30.1	14.7	21.6
% Intolerant Taxa	86.0	70.9	74.1	65.0	70.0
% Increasers, Mid-Elevation	98.5	98.7	98.3	97.4	98.7
Clinger Taxa	53.2	87.7	97.0	100.0	100.0
Predator/Shredder Taxa	57.1	50.0	57.1	57.1	64.3
MMI Score	**62.7**	**65.5**	**78.3**	**73.6**	**74.7**
Auxiliary Metrics					
Shannon Diversity	2.83	3.45	3.62	3.33	3.46
HBI	3.45	3.92	2.86	3.59	3.88
TIV (Sediment Region 3)	4.02	4.73	4.52	4.69	4.60

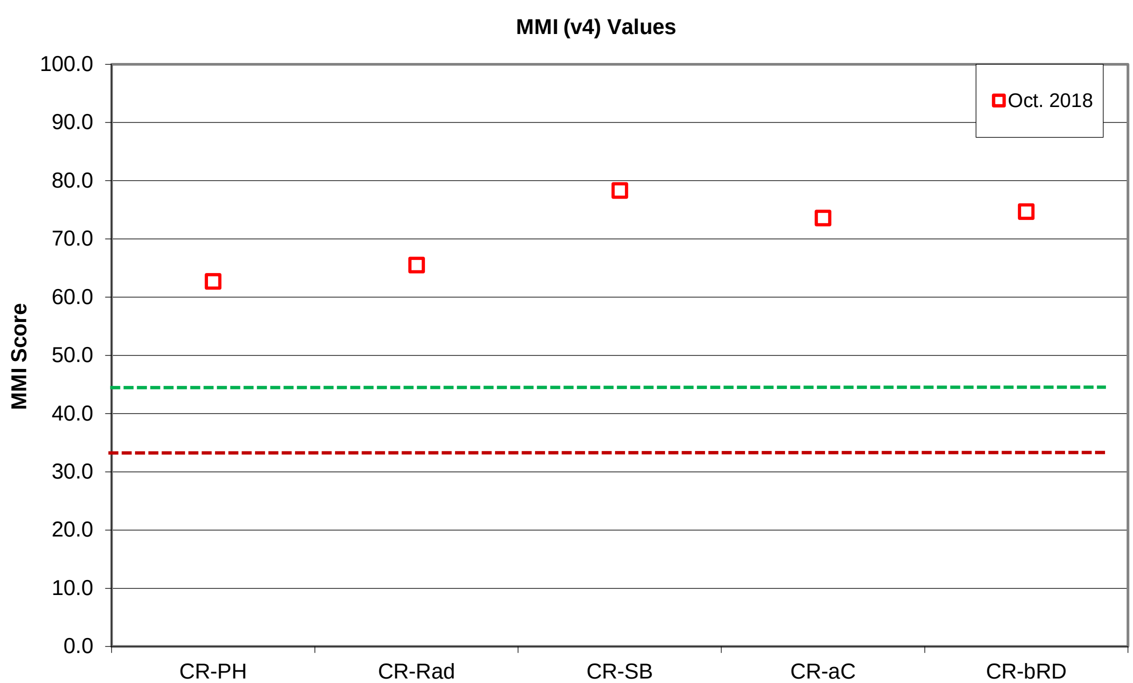

Figure 2. MMI (v4) scores from composited quantitative (Hess) samples during fall 2018 sampling at sites on the Upper Colorado River.

Table 3. Aquatic life designations based on MMI (v4) scores for five sample sites on the Upper Colorado River, October 2018.

Aquatic Life Designations	
Site	Quantitative (Hess) Samples
CR-PH	Attainment
CR-Rad	Attainment
CR-SB	Attainment
CR-aC	Attainment
CR-bRD	Attainment

Results from Additional Metrics

In addition to the MMI (v4), eight individual metrics were applied to the macroinvertebrate data from the Upper Colorado River to provide a more comprehensive evaluation of aquatic life during the fall of 2018 (Table 4). Although the individual metrics were able to detect subtle changes in macroinvertebrate community structure among sites, each of the metrics generally indicated that aquatic communities remained healthy throughout the study area (Table 4). Overall, the study sites could be characterized as supporting a variety of sensitive taxa in well-balanced communities. The relative abundance of sensitive taxa was high (compared to tolerant taxa), and the density of benthic macroinvertebrates was typical (or slightly elevated) compared to other Colorado mountain streams. The following comparison of individual metric values among study sites provides a more detailed description of changes in aquatic communities occurring throughout the study area.

While the combination of individual metrics suggested that the aquatic community at site CR-PH was healthy, several metrics detected more stress at this upstream sampling location than at other sites in the study area. The Diversity, EPT Taxa, Percent Chironomidae, and Taxa Richness metrics detected greater stress at site CR-PH; however, this pattern was not supported by the Percent EPT (excluding Baetidae) and HBI metrics (Table 4). The combination of these results suggested that there may be slight impacts to community balance and taxa richness (including sensitive taxa) at this location, although the proportion of sensitive taxa in the community remained relatively high. Detectable differences between site CR-PH and other sampling locations were relatively minor and not sufficient to suggest that the macroinvertebrate community was unhealthy or impaired. However, recreational use (fishing, rafting, etc.) at site CR-PH is fairly high, and it is likely that wadable habitat is frequently disturbed. This could account for some minor stress to aquatic macroinvertebrates and variability in *Pteronarcys californica* densities found at site CR-PH.

Table 4. Metrics and comparative values for macroinvertebrate samples collected from the Upper Colorado River in October 2018.

Metric	CR-PH	CR-Rad	CR-SB	CR-aC	CR-bRD
Diversity	2.83	3.45	3.62	3.33	3.46
HBI	3.45	3.92	2.86	3.59	3.88
EPT Taxa	18	20	26	23	23
Percent EPT (excluding Baetidae)	39.22%	31.89%	58.56%	52.31%	40.54%
Percent Chironomidae	3.66%	3.32%	2.22%	0.83%	1.89%
Density of *Pteronarcys californica* (mean #/m^2)	113	361	206	39	4
Taxa Richness	35	45	47	47	41
Density (mean #/m^2)	4,667	7,258	6,313	9,822	10,466

Site CR-Rad was located approximately 6.7 km downstream from site CR-PH, and the results from this location demonstrated minor changes in community structure, while still showing evidence of a healthy macroinvertebrate community (Table 4). Improvements in community balance (based on the Diversity metric), Taxa Richness, and the richness of sensitive taxa (based on the EPT Taxa metric), were observed at site CR-Rad; although, there was also some decline in the proportion of sensitive taxa, demonstrated by the Percent EPT (excluding Baetidae) metric (Table 4). Several of the individual metrics may have been positively influenced by the high densities of *Pteronarcys californica* at this location (Figure 3). *Pteronarcys californica* (the giant stonefly or salmonfly) is considered highly sensitive to stress, and likely provides a substantial contribution to the aquatic and terrestrial ecosystem at this location.

Most of the individual metrics (and the MMI v4) generated their most optimal values at site CR-SB, suggesting that this location was able to support the healthiest benthic macroinvertebrate community in the study area (Tables 2 and 4). The Diversity value (3.62) indicated that site CR-SB maintained optimal community balance, while the EPT and Taxa Richness metrics showed that this site was able to support a variety of aquatic taxa (including a large number of sensitive species). The Percent EPT (excluding Baetidae) metric provided additional evidence of healthy aquatic conditions by showing that more than half (58.56%) of the aquatic community was relatively sensitive to perturbations (Table 4). Additionally, the two metrics that measure the percent composition of tolerant macroinvertebrates (HBI and Percent Chironomidae) produced relatively low values at this location. High densities of *Pteronarcys californica* along with other sensitive taxa provided supporting evidence of healthy aquatic conditions at site CR-SB, while also suggesting that this location was able to sustain a healthy fish population (Table 4).

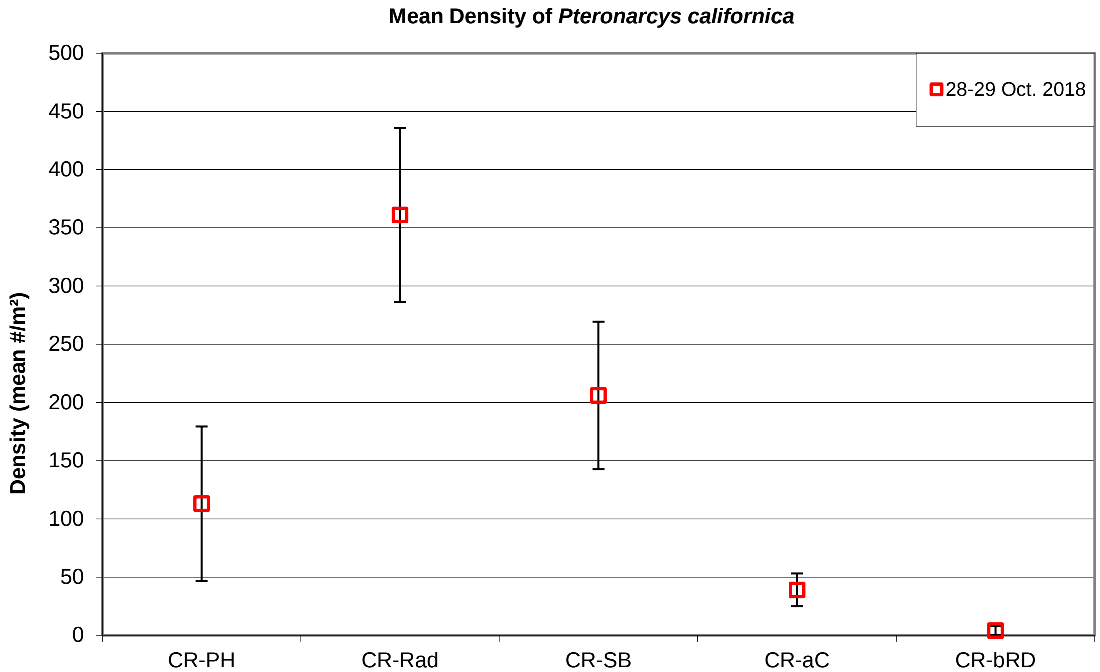

Figure 3. Mean densities (± 1 standard error) of *Pteronarcys californica* collected during the fall of 2018 at sampling sites on the Upper Colorado River.

Farther downstream, the Colorado River above Catamount (site CR-aC) generated metric values that continued to describe healthy aquatic conditions, although some metrics showed minor changes in macroinvertebrate community structure. Results from individual metrics suggested that macroinvertebrates at site CR-aC were well-balanced and aquatic conditions were able to support a high proportion of sensitive taxa (Table 4). However, the EPT Taxa value (23) showed some decline compared to the adjacent upstream site (CR-SB), while the Taxa Richness value (47) remained unchanged. This suggested that a few of the sensitive taxa from site CR-SB may have been replaced by tolerant taxa at site CR-aC. Also, the HBI demonstrated a slight increase in the proportion of macroinvertebrates that would be expected to tolerate higher levels of nutrients or sedimentation. Overall, these fluctuations in metric values were relatively minor and could be related to natural changes in habitat. The Percent Chironomidae metric produced its lowest (most optimal) value in the study area at site CR-aC, and although the density of *Pteronarcys californica* declined, the overall density of benthic macroinvertebrates more than doubled compared to site CR-PH (Table 4).

At the most downstream sampling location (site CR-bRD), the applied metrics continued to detect healthy macroinvertebrate community parameters along with minor changes in community structure. The Diversity and Density metrics showed a slight improvement in macroinvertebrate community balance and abundance (respectively), while the Total Taxa and Percent EPT (excluding Baetidae) declined slightly compared to upstream study sites (Table 4). The EPT value (23) showed no change in the richness of sensitive taxa compared to site CR-aC, but the HBI metric detected a slight increase in the proportion of nutrient-tolerant (or sedimentation-tolerant) taxa. Collectively, these results suggested that macroinvertebrate communities were likely influenced by changes in habitat, temperature, etc., that were occurring in a downstream direction. Gradual changes in habitat (including reduced riparian habitat and increases in the proportion of fine sediment) may have also been responsible for the observed reduction in the density of *Pteronarcys californica* at site CR-bRD (Figure 3).

The reorganization of benthic macroinvertebrate specimens according to their method of food acquisition provided an opportunity to evaluate aquatic communities based on ecological function rather than taxonomic structure (Table 5, Figure 4). Healthy ecosystems typically support adequate representation from several feeding groups; however, it is common for certain groups (such as collector-gatherers) to be proportionally dominant. During the fall of 2018, all five sites in the study area were dominated by the collector-gatherer group (>57.0%), although other feeding groups that are considered sensitive and/or specialized (collector-filterers, shredders, and scrapers) were also well-represented (Figure 4). The downstream portion of the study area exhibited a slight decline in shredders and scrapers, while collector-filterers increased proportionally (Table 5, Figure 4). These minor shifts in the relative abundance of various feeding groups may have been partially caused by an increase in fine particulate organic material (FPOM) and a decrease in coarse particulate organic material (CPOM) in a downstream direction. As stream size increases, it is common for the proportion of CPOM (particularly leaf material from the riparian corridor) to decline compared to other food resources. A decline in leaf material entering the river at site CR-bRD may have also been a factor contributing to the lower densities of *Pteronarcys californica* at that location. Overall, results from the functional feeding group analysis supported the results from other metrics used in this study by detecting healthy aquatic communities at all sites despite minor changes in community composition.

Table 5. Relative abundance of functional feeding groups during fall 2018 sampling on the Upper Colorado River.

Site	Functional Feeding Group					
	Collector-Gatherer	Collector-Filterer	Shredder	Scraper	Predator	Omnivore
CR-PH	67.44%	8.41%	2.66%	18.98%	2.25%	0.25%
CR-Rad	57.41%	15.36%	5.03%	14.18%	7.54%	0.48%
CR-SB	60.65%	9.54%	3.51%	22.29%	4.00%	0.00%
CR-aC	67.73%	19.85%	0.51%	9.61%	2.25%	0.04%
CR-bRD	64.54%	24.41%	0.11%	7.08%	3.86%	0.00%

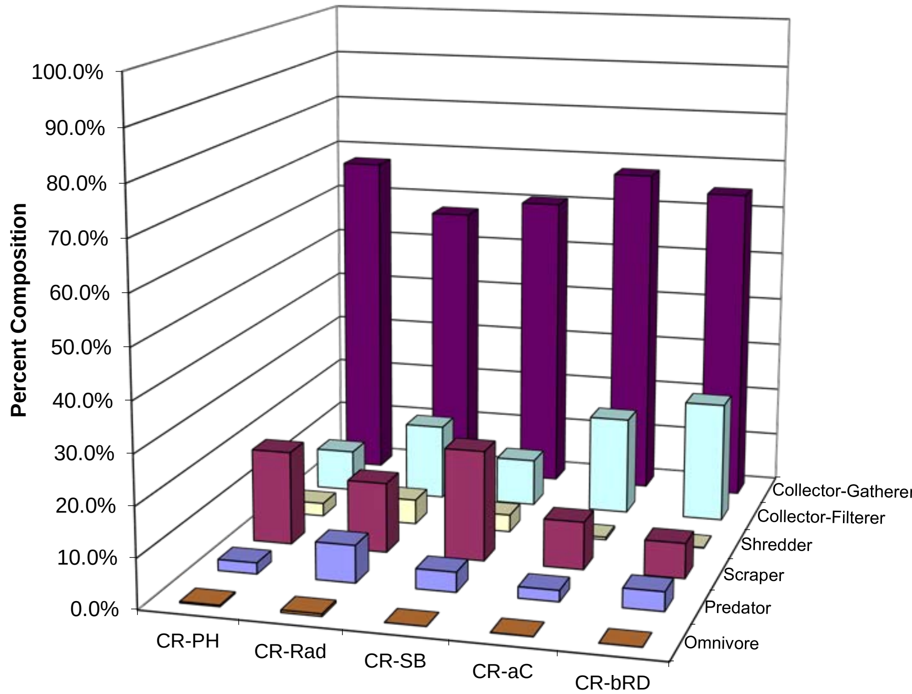

Figure 4. Functional feeding group composition for study sites on the Upper Colorado River in fall of 2018.

Pebble Count Results

During the Fall of 2018, substrate data were collected from a single transect in riffle habitat that was adjacent to the five macroinvertebrate study sites in the Upper Colorado River. Results from the pebble count study were compared among sites in order to observe any spatial changes in percent fine sediment, course sediment, percent algae, and/or embeddedness. Overall, the four upstream study sites maintained relatively even distributions of sediment size classes with low levels of algae and little embeddedness (Table 6, Figures 5-8). However, results from this study also showed slightly higher proportions of fine sediment and algae, and greater levels of embeddedness at the most downstream study site (Table 6, Figure 9).

The pebble count data that was collected between site CR-PH (the most upstream study site) and site CR-aC (above Catamount) indicated that the distribution of substrate size classes remained relatively consistent in this portion of the Upper Colorado River. The evaluation of substrate characteristics in riffle habitat at sites CR-PH, CR-Rad, CR-SB, and CR-aC exhibited similar results for percent fine sediment, course sediment, percent algae, and percent embeddedness. The percent of fine sediment (<2mm in diameter) present at these locations ranged from 3.10% at site CR-SB to 8.97% at site CR-aC

(Table 6). Although these measurements were all collected from a single transect in riffle habitat, the percent of fine sediment values were all well-below the threshold for fine sediment (41.00%) designated by the Colorado Water Quality Control Commission for this region of Colorado (Colorado Water Quality Control Commission 2014). Larger sized substrate was most common at these locations and the percent of course substrate (>8mm in diameter) constituted >84.00% of the bed material at the four most upstream study sites (Table 6, Appendix B: Tables B1-B4). The percent algae ranged from 12.07% at sites CR-Rad and CR-aC to 20.00% at site CR-PH, and the percent embeddedness was consistently less than 21.0% (Table 6). Results from this pebble count study suggested that sediment size classes and most other parameters of the streambed in riffle habitat remained similar from site CR-PH downstream to site CR-aC.

Detectable changes in the proportions of various sediment size classes and other streambed characteristics were observed at the most downstream study site (CR-bRD) during the fall of 2018 (Table 6). An increase in the proportion of fine sediment, percent algae, and percent embeddedness was recorded at this location, compared to upstream study sites. The percent of fine sediment (<2mm and <8mm) nearly doubled compared to the adjacent upstream study site, and percent of coarse bed material declined accordingly (Table 6). In addition, the percent algae cover and embeddedness increased to 46.55% and 25.50%, respectively (Table 6). Despite these notable changes in sediment size classes, the percent of fine sediment at this location was still well-below the State's threshold (41.00%) for impairment from sedimentation.

Sediment Tolerance Indicator Values (TIV's) were also reported for all sites in the study area (Table 6). This value provides a measurement (adjusted to a scale from 1 to 10) of the proportion of benthic macroinvertebrates that are tolerant to sedimentation. The TIV threshold selected by the State of Colorado for streams in Region 3 is 6.3 (Colorado Water Quality Control Commission 2014). All sites in the study area generated values well-below this threshold, suggesting that macroinvertebrate communities supported high proportions of taxa that are relatively sensitive to sedimentation.

Table 6. Pebble Count metrics for sample sites on the Upper Colorado River, October 2018.

Metric	CR-PH	CR-Rad	CR-SB	CR-aC	CR-bRD
Total Percent Algae	20.00%	12.07%	19.66%	12.07%	46.55%
Percent Fine (<2mm)	6.90%	5.52%	3.10%	8.97%	16.55%
Percent Fine (<8mm)	15.52%	11.03%	11.03%	14.48%	35.17%
Percent Coarse (>8mm)	84.48%	88.97%	88.97%	85.52%	64.83%
Percent Embeddedness	14.97%	20.52%	20.46%	19.41%	25.50%
TIV (Sediment Region 3)	4.02	4.73	4.52	4.69	4.60

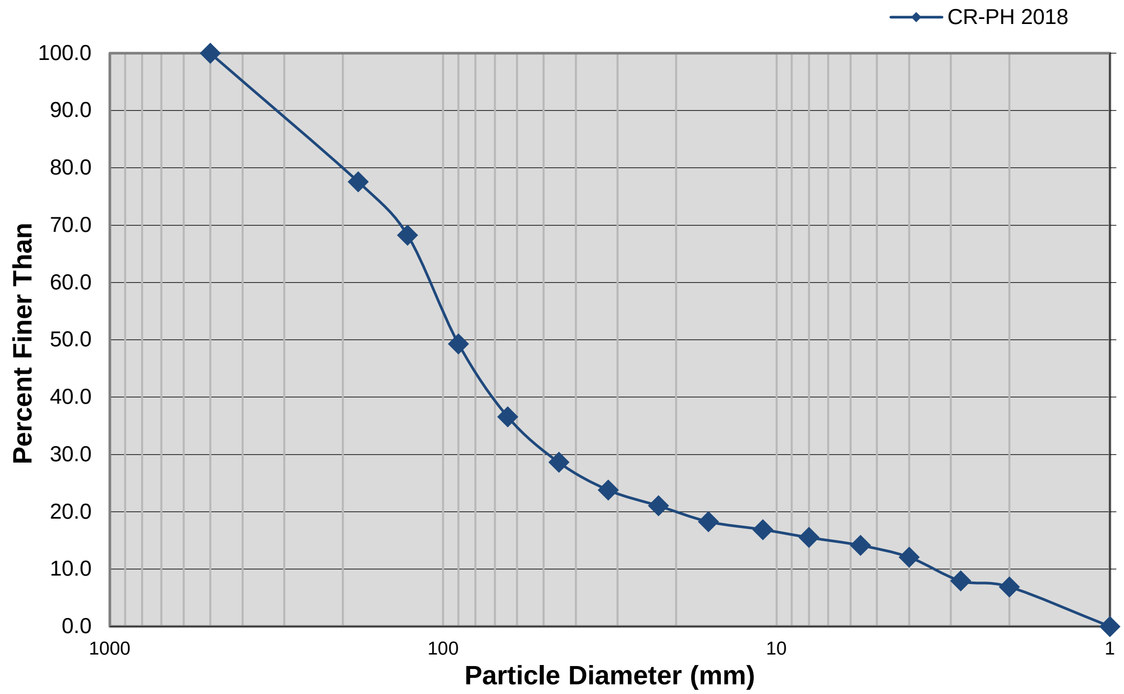

Figure 5. Pebble size distribution at site CR-PH on the Upper Colorado River in October 2018.

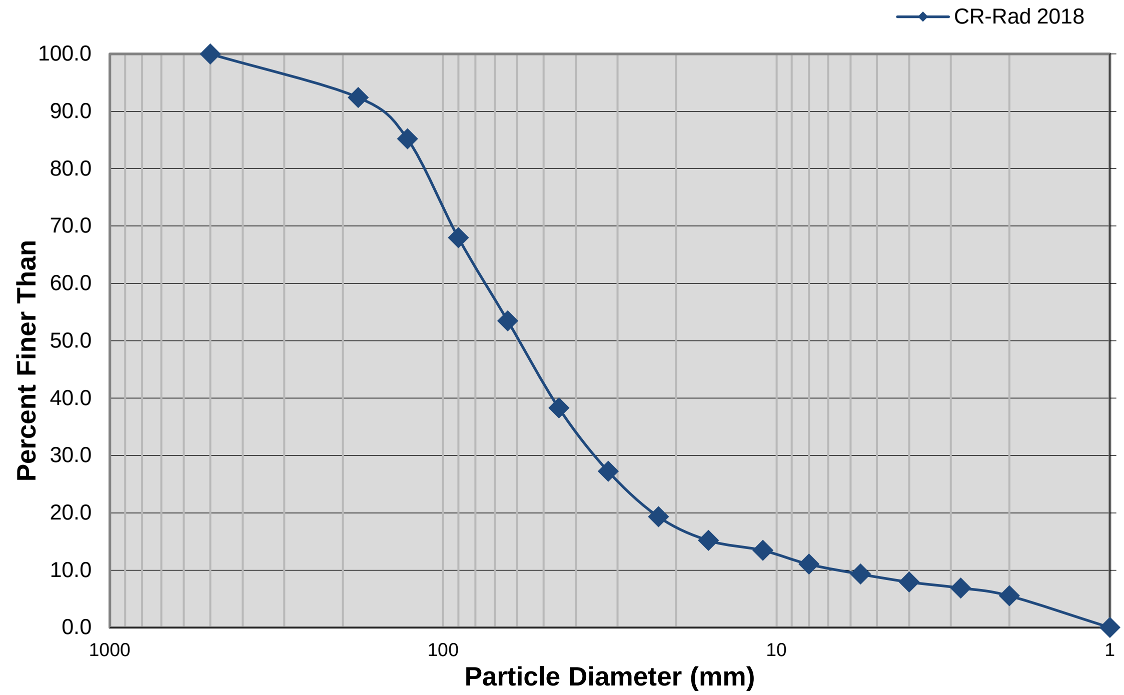

Figure 6. Pebble size distribution at site CR-Rad on the Upper Colorado River in October 2018.

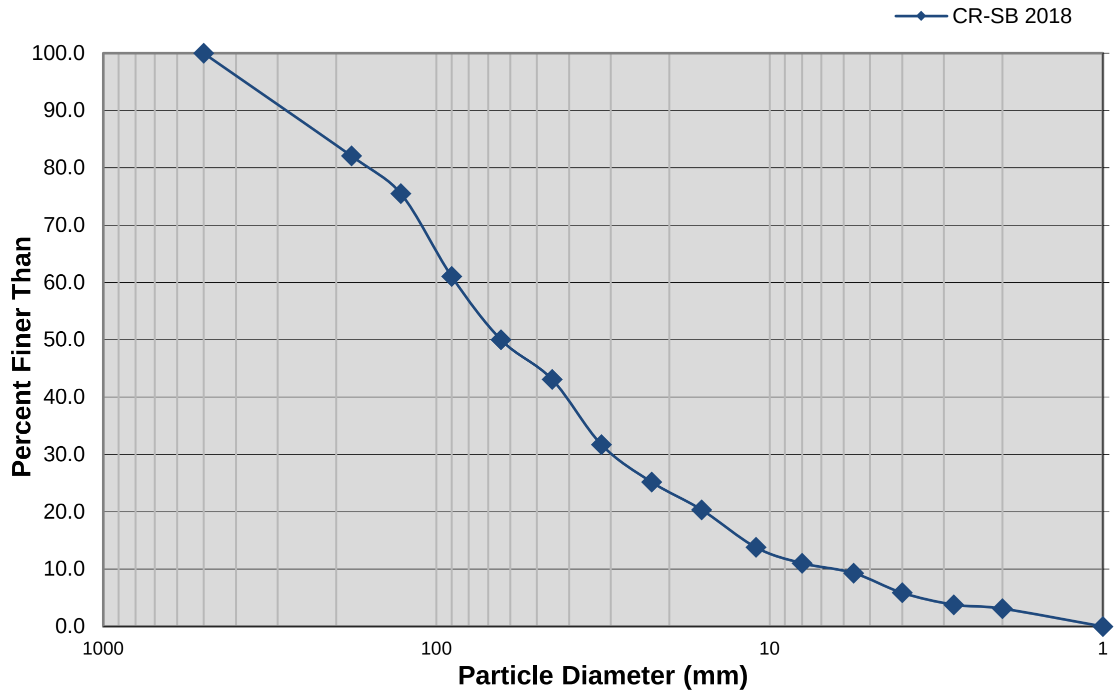

Figure 7. Pebble size distribution at site CR-SB on the Upper Colorado River in October 2018.

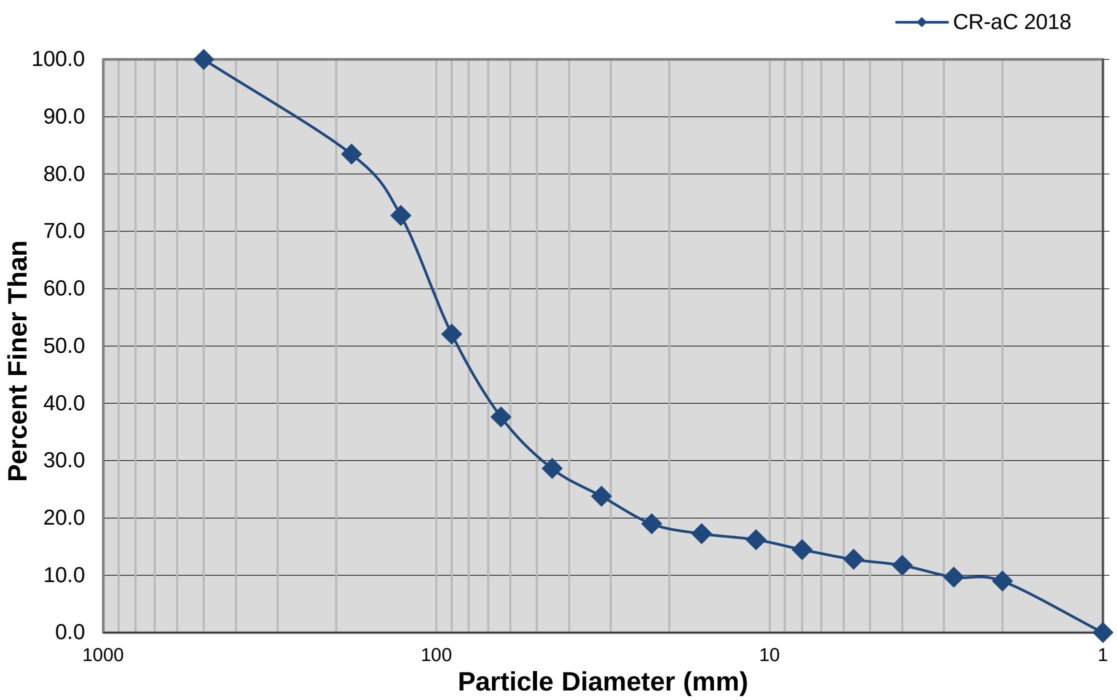

Figure 8. Pebble size distribution at site CR-aC on the Upper Colorado River in October 2018.

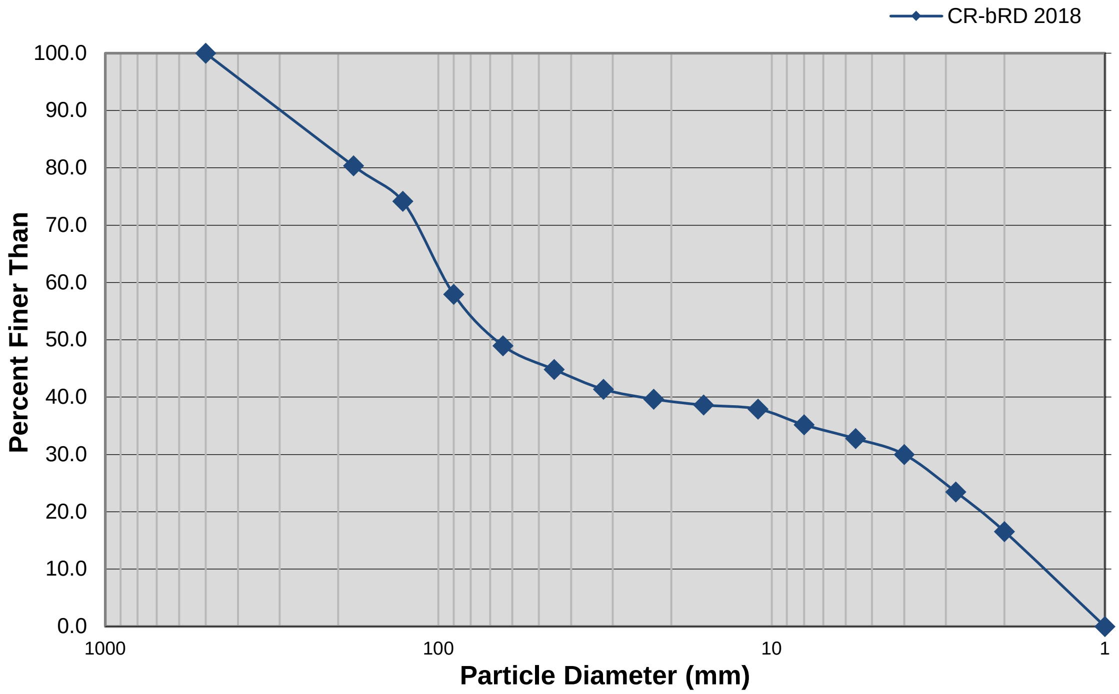

Figure 9. Pebble size distribution at site CR-bRD on the Upper Colorado River in October 2018.

Conclusions

Overall, benthic macroinvertebrate communities demonstrated minor changes in structure and function while remaining relatively healthy throughout the Upper Colorado River study area. Collectively, the MMI (v4) and most individual metrics used in this study indicated that sampling locations were able to support relatively well-balanced communities with high proportions of sensitive taxa. The densities of individual species (including *Pteronarcys californica*) likely fluctuated throughout the study area due to changes in the availability of preferred habitat, food resources, competition, predation, etc. It is also possible that high recreational use at certain locations may have had minor impacts on macroinvertebrate communities.

In general, the pebble count study identified similar distributions of sediment size classes at the four most upstream study sites, and an increase in the proportion of fine sediment and algal cover at site CR-bRD. Although higher proportions of fine sediment and algae in the downstream portion of the study area did not appear to have negative impacts on the macroinvertebrates, this slight change in habitat may have had some influence on observed changes in species composition and abundance. The increase in fine sediment in the downstream portion of the study area could probably be attributed to erosion from the surrounding watershed and the lower stream gradient that was common in this segment of the Upper Colorado River.

Literature Cited

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: Periphyton, benthic macroinvertebrates and fish, second edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Barton, D.R. and J.L. Metcalfe-Smith. 1992. A comparison of sampling techniques and summary indices for assessment of water quality in Yamaska River, Quebec, based on benthic macroinvertebrates. Environmental Monitoring and Assessment 21:225-244.

Beeby, J.C., B.P. Bledsoe, and K.W. Hardie. 2014. Colorado River in Eagle County Inventory and Assessment. Report prepared for the Eagle River Watershed Council.

Bonada, N., N. Prat, V. H. Resh, and B. Statzner. 2006. Developments in aquatic insect biomonitoring: A comparative analysis of recent approaches. Annual Review of Entomology 51: 495-523.

Colorado Department of Public Health and Environment. 2010. Aquatic life use attainment: Methodology to determine use attainment for rivers and streams. Policy Statement 2010-1.

Colorado Department of Public Health and Environment. 2017. Aquatic life use attainment: Methodology to determine use attainment for rivers and streams. Policy Statement 10-1.

Colorado Parks and Wildlife. 2015. State Wildlife Action Plan. 458pp

Colorado Water Quality Control Commission. 2014. Guidance for Implementation of Colorado's Narrative Sediment Standard. Policy 98-1. Regulation # 31, Section 31.11(1)(a)(i).

Culp, J. M., F. J. Wrona, and R. W. Davies. 1986. Response of stream benthos and drift to fine sediment deposition versus transport. Canadian Journal of Zoology 64:1345-1351.

Fore, L.S., J.R. Karr, and R.W. Wisseman. 1996. Assessing Invertebrate Responses to Human Activities: Evaluating Alternative Approaches. Journal of the North American Benthological Society 15: 212-231.

Hilsenhoff, W. L. 1988. Rapid field assessment of organic pollution with a family level biotic index. Journal of the North American Benthological Society 7(1): 65-68.

Johnson, R.C., H. Jin, M.M. Carreriro, and J.D. Jack. 2013. Macroinvertebrate community structure, secondary production and trophic-level dynamics in urban streams affected by non-point-source pollution. Freshwater Biology 58: 843-857.

Lenat, D.R. 1983. Chironomid Taxa Richness: Natural Variation and Use in Pollution Assessment. Freshwater Invertebrate Biology 2:192-198.

Lenat, D.R. 1988. Water quality assessment of streams using a qualitative collection method for benthic macroinvertebrates. Journal of the North American Benthological Society 7:222-33.

Likens, G. E., and K. F. Lambert. 1998. The importance of long-term data in addressing regional environmental issues. Northeastern Naturalist 5: 127-136.

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters-Taxa Tolerance Values, Metrics, and Protocols. Project H-1. Soil and Water Conservation Society of Metro Halifax,.xviii. 48. Pp., Appendices A-B 120pp.

Merritt, R. W., K. W. Cummins and M. B. Berg. 2008. An Introduction to the Aquatic Insects of North America. Fourth Edition, Kendall/Hunt. Dubuque, Iowa.

Paul, M. J., J. Gerritsen, C. Hawkins, and E. Leppo. 2005. Draft. Development of biological assessment tools for Colorado. Colorado Department of Public Health and Environment, Water Quality Control Division – Monitoring Unit. Denver, Colorado.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. EPA/444/4-89/001.

Voelz, N. J., R. E. Zuellig, S. Shieh, and J. V. Ward. 2005. The effects of urban areas on benthic macroinvertebrates in two Colorado plains rivers. Environmental Monitoring and Assessment 101: 175-202.

Wang, L., D. M. Robertson, and P. J. Garrison. 2007. Linkages between nutrients and assemblages of macroinvertebrates and fish in wadeable streams: implication to nutrient criteria development. Environmental Management 39: 194-212.

Ward, J. V., B. C. Kondratieff, and R. E. Zuellig. 2002. An Illustrated Guide to the Mountain Stream Insects of Colorado. Second Edition. University Press of Colorado. Boulder, Colorado.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7.

Weber, C.I. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. EPA-670/4-73-001. U.S. Environmental Protection Agency, Cincinnati, OH.

Wohl, E. E. 2000. Virtual rivers: Lessons from the mountain rivers of the Colorado Front Range. Yale University Press, New Haven, Connecticut.

Wood P. J., and P. D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. Environmental Management 21:203-217.

Appendix A

Benthic Macroinvertebrate Data – Fall 2018

Table A1. Macroinvertebrate data collected from site CR-PH on 28 Oct 2018.

Colorado River						
CR-PH		Sample				
28 October 2018	1	2	3		Totals	Mean #/m²
Ephemeroptera (mayflies)						
Acentrella sp.	1	1			2	8
Baetis (*tricaudatus*)	100	230	264		594	2303
Diphetor hageni						
Drunella grandis						
Ephemerella dorothea infrequens	30	55	73		158	613
Epeorus sp.	5	8	10		23	90
Heptagenia sp.						
Rhithrogena sp.	61	78	37		176	683
Tricorythodes explicatus			1		1	4
Paraleptophlebia sp.	2	10			12	47
Plecoptera (stoneflies)						
Claassenia sabulosa						
Perlodidae (*Cultus* sp.)	1		2		3	12
Isoperla sp.		1			1	4
Pteronarcys californica	3	5	21		29	113
Trichoptera (caddisflies)						
Brachycentrus americanus		3	1		4	16
Brachycentrus occidentalis						
Culoptila sp.			1		1	4
Glossosoma sp.	1	3			4	16
Protoptila sp.		1	1		2	8
Helicopsyche borealis						
Arctopsyche grandis						
Cheumatopsyche sp.						
Hydropsyche cockerelli						
Hydropsyche occidentalis	3	21	19		43	167
Hydropsyche oslari	2	4	3		9	35
Hydroptila sp.		1	1		2	8
Leucotrichia pictipes						
Lepidostoma sp.			3		3	12
Oecetis sp.						
Rhyacophila coloradensis						
Diptera (true flies)						
Chironomidae (chironomids)						
Cardiocladius sp.			3		3	12
Cricotopus/Orthocladius sp.	3	9	15		27	105
Eukiefferiella sp.			8		8	31
Lopescladius sp.						
Microtendipes sp.		1			1	4
Pagastia sp.		1	1		2	8
Parametriocnemus sp.						
Polypedilum sp.						
Potthastia sp.						
Thienemannimyia group		1			1	4
Tvetenia sp.		1	1		2	8
Other Diptera (true flies)						
Atherix pachypus	1	1	1		3	12
Chelifera/Neoplasta sp.						
Hemerodromia sp.						
Simulium sp.	1	9	34		44	171
Antocha sp.	1				1	4

Table A1. cont. Macroinvertebrate data collected from site CR-PH on 28 Oct 2018.

Coleoptera (beetles)						
Dubiraphia sp.						
Microcylloepus sp.						
Optioservus sp.	2	7	9		18	70
Zaitzevia parvula		1	2		3	12
Lepidoptera (butterflies & moths)						
Petrophila sp.						
Odonata (dragonflies & damselflies)						
Ophiogomphus sp.						
Miscellaneous						
Hygrobates sp.		3	2		5	20
Lebertia sp.						
Sperchon sp.		7	4		11	43
Ferrissia sp.		1			1	4
Lymnaeidae						
Physa sp.	1				1	4
Gyraulus sp.						
Pisidium sp.						
Dugesia sp.						
Polycelis coronata	2		1		3	12
Crangonyx sp.						
Lumbricidae						
Tubificidae w/out hair chaetae						
Nematoda						
Totals	**220**	**463**	**518**		**1201**	**4667**

Table A2. Macroinvertebrate data collected from site CR-Rad on 28 Oct 2018.

Colorado River						
CR-Rad		Sample				
28 October 2018	1	2	3		Totals	Mean #/m²
Ephemeroptera (mayflies)						
Acentrella sp.			1		1	4
Baetis (*tricaudatus*)	286	324	198		808	3132
Diphetor hageni						
Drunella grandis			1		1	4
Ephemerella dorothea infrequens	49	52	71		172	667
Epeorus sp.	7	1	1		9	35
Heptagenia sp.						
Rhithrogena sp.	53	7	1		61	237
Tricorythodes explicatus	1		2		3	12
Paraleptophlebia sp.	12				12	47
Plecoptera (stoneflies)						
Claassenia sabulosa						
Perlodidae (*Cultus* sp.)	6	5	3		14	55
Isoperla sp.	3	1	3		7	28
Pteronarcys californica	33	41	19		93	361
Trichoptera (caddisflies)						
Brachycentrus americanus	1		2		3	12
Brachycentrus occidentalis			1		1	4
Culoptila sp.	10	17	1		28	109
Glossosoma sp.	15		12		27	105
Protoptila sp.						
Helicopsyche borealis						
Arctopsyche grandis						
Cheumatopsyche sp.		1	1		2	8
Hydropsyche cockerelli	2	5	4		11	43
Hydropsyche occidentalis	9	14	19		42	163
Hydropsyche oslari	15	31	36		82	318
Hydroptila sp.	2	14	12		28	109
Leucotrichia pictipes						
Lepidostoma sp.						
Oecetis sp.						
Rhyacophila coloradensis						
Diptera (true flies)						
Chironomidae (chironomids)						
Cardiocladius sp.			1		1	4
Cricotopus/Orthocladius sp.	3	15	16		34	132
Eukiefferiella sp.	3	2	8		13	51
Lopescladius sp.						
Microtendipes sp.		1			1	4
Pagastia sp.	1				1	4
Parametriocnemus sp.						
Polypedilum sp.		1			1	4
Potthastia sp.			1		1	4
Thienemannimyia group	1		1		2	8
Tvetenia sp.	3	3	2		8	31
Other Diptera (true flies)						
Atherix pachypus	4	7	8		19	74
Chelifera/Neoplasta sp.		1			1	4
Hemerodromia sp.						
Simulium sp.	8	54	82		144	559
Antocha sp.		1	1		2	8

Table A2. cont. Macroinvertebrate data collected from site CR-Rad on 28 Oct 2018.

Coleoptera (beetles)						
Dubiraphia sp.						
Microcylloepus sp.						
Optioservus sp.	25	42	41		108	419
Zaitzevia parvula	4	6	7		17	66
Lepidoptera (butterflies & moths)						
Petrophila sp.						
Odonata (dragonflies & damselflies)						
Ophiogomphus sp.						
Miscellaneous						
Hygrobates sp.		13	2		15	59
Lebertia sp.		1	1		2	8
Sperchon sp.	19	35	14		68	264
Ferrissia sp.		1			1	4
Lymnaeidae			1		1	4
Physa sp.						
Gyraulus sp.	1				1	4
Pisidium sp.			1		1	4
Dugesia sp.						
Polycelis coronata	2	3	4		9	35
Crangonyx sp.						
Lumbricidae						
Tubificidae w/out hair chaetae		1			1	4
Nematoda	1	5	6		12	47
Totals	**579**	**705**	**585**		**1869**	**7258**

Table A3. Macroinvertebrate data collected from site CR-SB on 28 Oct 2018.

Colorado River						
CR-SB		Sample				
28 October 2018	1	2	3		Totals	Mean #/m^2
Ephemeroptera (mayflies)						
Acentrella sp.						
Baetis (*tricaudatus*)	69	116	225		410	1590
Diphetor hageni	1				1	4
Drunella grandis	1	2	2		5	20
Ephemerella dorothea infrequens	116	149	127		392	1520
Epeorus sp.	12	2	6		20	78
Heptagenia sp.	5	5	5		15	59
Rhithrogena sp.	21	23	43		87	338
Tricorythodes explicatus	4	11	2		17	66
Paraleptophlebia sp.	26	35	51		112	435
Plecoptera (stoneflies)						
Claassenia sabulosa						
Perlodidae (*Cultus* sp.)	3	5	5		13	51
Isoperla sp.	3	7	11		21	82
Pteronarcys californica	7	21	25		53	206
Trichoptera (caddisflies)						
Brachycentrus americanus	1		2		3	12
Brachycentrus occidentalis	19	4	6		29	113
Culoptila sp.	18	3	11		32	124
Glossosoma sp.	1	2	1		4	16
Protoptila sp.	1	1	1		3	12
Helicopsyche borealis	1				1	4
Arctopsyche grandis		1	2		3	12
Cheumatopsyche sp.	2		1		3	12
Hydropsyche cockerelli	8	11	7		26	101
Hydropsyche occidentalis	19	21	17		57	221
Hydropsyche oslari	8	17	6		31	121
Hydroptila sp.	6	6	5		17	66
Leucotrichia pictipes						
Lepidostoma sp.	2	1	1		4	16
Oecetis sp.	3				3	12
Rhyacophila coloradensis						
Diptera (true flies)						
Chironomidae (chironomids)						
Cardiocladius sp.						
Cricotopus/Orthocladius sp.	4	6	3		13	51
Eukiefferiella sp.	3	1			4	16
Lopescladius sp.						
Microtendipes sp.			1		1	4
Pagastia sp.	1	2	1		4	16
Parametriocnemus sp.		1			1	4
Polypedilum sp.						
Potthastia sp.	1				1	4
Thienemannimyia group	1		1		2	8
Tvetenia sp.	2	5	3		10	39
Other Diptera (true flies)						
Atherix pachypus	2	2	2		6	24
Chelifera/Neoplasta sp.						
Hemerodromia sp.						
Simulium sp.			2		2	8
Antocha sp.		1			1	4

Table A3. cont. Macroinvertebrate data collected from site CR-SB on 28 Oct 2018.

Coleoptera (beetles)						
Dubiraphia sp.						
Microcylloepus sp.		1			1	4
Optioservus sp.	57	56	45		158	613
Zaitzevia parvula	2	2	14		18	70
Lepidoptera (butterflies & moths)						
Petrophila sp.						
Odonata (dragonflies & damselflies)						
Ophiogomphus sp.			1		1	4
Miscellaneous						
Hygrobates sp.						
Lebertia sp.						
Sperchon sp.	4	2	12		18	70
Ferrissia sp.	2	1	2		5	20
Lymnaeidae		2			2	8
Physa sp.	6	2			8	31
Gyraulus sp.	3	1	1		5	20
Pisidium sp.						
Dugesia sp.						
Polycelis coronata						
Crangonyx sp.						
Lumbricidae						
Tubificidae w/out hair chaetae						
Nematoda		1			1	4
Totals	**445**	**529**	**650**		**1624**	**6313**

Table A4. Macroinvertebrate data collected from site CR-aC on 29 Oct 2018.

Colorado River						
CR-aC		Sample				
29 October 2018	1	2	3		Totals	Mean #/m²
Ephemeroptera (mayflies)						
Acentrella sp.						
Baetis (*tricaudatus*)	312	203	181		696	2698
Diphetor hageni						
Drunella grandis						
Ephemerella dorothea infrequens	334	221	233		788	3055
Epeorus sp.	5	1	2		8	31
Heptagenia sp.	6	1			7	28
Rhithrogena sp.	24	22	6		52	202
Tricorythodes explicatus	17	13	14		44	171
Paraleptophlebia sp.	10	40	32		82	318
Plecoptera (stoneflies)						
Claassenia sabulosa		1	2		3	12
Perlodidae (*Cultus* sp.)	2	1	4		7	28
Isoperla sp.	2	1	2		5	20
Pteronarcys californica	1	4	5		10	39
Trichoptera (caddisflies)						
Brachycentrus americanus						
Brachycentrus occidentalis	4	5	4		13	51
Culoptila sp.	3	2	2		7	28
Glossosoma sp.						
Protoptila sp.	3	4			7	28
Helicopsyche borealis	3				3	12
Arctopsyche grandis						
Cheumatopsyche sp.	18	52	39		109	423
Hydropsyche cockerelli			48		48	186
Hydropsyche occidentalis	20	28			48	186
Hydropsyche oslari	6	2	17		25	97
Hydroptila sp.	31	6	5		42	163
Leucotrichia pictipes	6	2	1		9	35
Lepidostoma sp.	1	2			3	12
Oecetis sp.	1	2			3	12
Rhyacophila coloradensis						
Diptera (true flies)						
Chironomidae (chironomids)						
Cardiocladius sp.						
Cricotopus/Orthocladius sp.						
Eukiefferiella sp.		4	4		8	31
Lopescladius sp.						
Microtendipes sp.	1	3	3		7	28
Pagastia sp.			1		1	4
Parametriocnemus sp.		1			1	4
Polypedilum sp.						
Potthastia sp.						
Thienemannimyia group	1	2			3	12
Tvetenia sp.			1		1	4
Other Diptera (true flies)						
Atherix pachypus		4	2		6	24
Chelifera/Neoplasta sp.						
Hemerodromia sp.		1			1	4
Simulium sp.	7	86	159		252	977
Antocha sp.						

Table A4. cont. Macroinvertebrate data collected from site CR-aC on 29 Oct 2018.

Coleoptera (beetles)						
Dubiraphia sp.	1				1	4
Microcylloepus sp.	4	5	6		15	59
Optioservus sp.	22	24	24		70	272
Zaitzevia parvula	9	28	33		70	272
Lepidoptera (butterflies & moths)						
Petrophila sp.	2	3			5	20
Odonata (dragonflies & damselflies)						
Ophiogomphus sp.	1				1	4
Miscellaneous						
Hygrobates sp.						
Lebertia sp.						
Sperchon sp.	8	8	5		21	82
Ferrissia sp.	4	2	8		14	55
Lymnaeidae						
Physa sp.	3	1			4	16
Gyraulus sp.	9	5	1		15	59
Pisidium sp.						
Dugesia sp.						
Polycelis coronata			1		1	4
Crangonyx sp.		1			1	4
Lumbricidae			4		4	16
Tubificidae w/out hair chaetae		1			1	4
Nematoda		6	1		7	28
Totals	**881**	**798**	**850**		**2529**	**9822**

Table A5. Macroinvertebrate data collected from site CR-bRD on 29 Oct 2018.

Colorado River						
CR-bRD		Sample				
29 October 2018	1	2	3		Totals	Mean #/m²
Ephemeroptera (mayflies)						
Acentrella sp.						
Baetis (*tricaudatus*)	499	194	198		891	3454
Diphetor hageni						
Drunella grandis						
Ephemerella dorothea infrequens	120	168	179		467	1811
Epeorus sp.						
Heptagenia sp.	7	1	9		17	66
Rhithrogena sp.	7	5			12	47
Tricorythodes explicatus	18	8	22		48	186
Paraleptophlebia sp.	16	5	42		63	245
Plecoptera (stoneflies)						
Claassenia sabulosa	1	1	4		6	24
Perlodidae (*Cultus* sp.)		3	1		4	16
Isoperla sp.	3	1	8		12	47
Pteronarcys californica	1				1	4
Trichoptera (caddisflies)						
Brachycentrus americanus						
Brachycentrus occidentalis	21	19	34		74	287
Culoptila sp.	17	27	20		64	249
Glossosoma sp.						
Protoptila sp.	3				3	12
Helicopsyche borealis	1		3		4	16
Arctopsyche grandis		1	2		3	12
Cheumatopsyche sp.	5	12	10		27	105
Hydropsyche cockerelli		5	2		7	28
Hydropsyche occidentalis	39	99	81		219	849
Hydropsyche oslari		1	3		4	16
Hydroptila sp.	32	9	5		46	179
Leucotrichia pictipes						
Lepidostoma sp.		1			1	4
Oecetis sp.	1	1	8		10	39
Rhyacophila coloradensis			1		1	4
Diptera (true flies)						
Chironomidae (chironomids)						
Cardiocladius sp.		1			1	4
Cricotopus/Orthocladius sp.						
Eukiefferiella sp.	9	1	2		12	47
Lopescladius sp.			1		1	4
Microtendipes sp.	5	1			6	24
Pagastia sp.						
Parametriocnemus sp.						
Polypedilum sp.	1				1	4
Potthastia sp.						
Thienemannimyia group	2	1			3	12
Tvetenia sp.	13	3	11		27	105
Other Diptera (true flies)						
Atherix pachypus			1		1	4
Chelifera/Neoplasta sp.						
Hemerodromia sp.	1	2			3	12
Simulium sp.	194	95	29		318	1233
Antocha sp.						

Table A5. cont. Macroinvertebrate data collected from site CR-bRD on 29 Oct 2018.

Coleoptera (beetles)						
Dubiraphia sp.						
Microcylloepus sp.	56	52	28		136	528
Optioservus sp.	15	9	20		44	171
Zaitzevia parvula	9	41	44		94	365
Lepidoptera (butterflies & moths)						
Petrophila sp.						
Odonata (dragonflies & damselflies)						
Ophiogomphus sp.						
Miscellaneous						
Hygrobates sp.						
Lebertia sp.						
Sperchon sp.	6	2	1		9	35
Ferrissia sp.						
Lymnaeidae						
Physa sp.	1				1	4
Gyraulus sp.						
Pisidium sp.						
Dugesia sp.	15	16	19		50	194
Polycelis coronata						
Crangonyx sp.			1		1	4
Lumbricidae						
Tubificidae w/out hair chaetae						
Nematoda		2	2		4	16
Totals	**1118**	**787**	**791**		**2696**	**10466**

Appendix B

Pebble Count Raw Data – Fall 2018

Table B1. Pebble Count data collected from site CR-PH on 28 Oct 2018.

Station ID	River	Site Description	Date
CR-PH	Colorado River	at Pumphouse	10/28/2018

Bank>>>	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	T I	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12
T1	<2	<180	<2	>180 A	<64	>180	>180 A	<90	<90	>180	>180	>180
T2	<128	<128	<128	<180 A	<128	<4	>180 A	>180 A	<5.6	<11	<180 A	<32
T3	>180	<128	<2	<128	<90	<128	<128	<32	<128	<90 A	<45	<2
T4	>180	>180	<180	>180	>180	<90	<22.6	<128 A	<128	<128 A	<8	>180
T5	<64	<64		<90	<128	>180	<128	<128 A		<90 A	<128	<2
T1	>180	<90	<64	<90	>180	<180	<45	<128 A	<128 A	<64 A	>180 A	<90
T2	<90	<16	<2	>180	>180	<180	<90	<64	<2.8	<5.6	<8	<128
T3	<2	>180	<128	<128	<32	<90	<128	<128	<45	<64	<128	<8
T4	<64	<128	<90	<64	>180	<64	<45	<90 A	<2.8	<128	<16	<2
T5	<22.6	<45		<22.6	>180	<128	<128	<32		<128	>180 A	>180
T1	<180	<64	<180	>180 A	<64	>180 A	<90	<128	<90	<32	<16	>180
T2	<2	<2	>180	>180 A	<11	<4	<128	<180 A	<4	<4	<128 A	<64
T3	<90	<128	<64	>180	>180	>180 A	<128 A	<4	<4	>180 A	<22.6	<180
T4	<128	<90	<90	<128	<45	>180 A	>180 A	<45	<128 A	>180 A	<4	<45
T5	<180	>180		>180	<180	>180 A	>180 A	<180 A		<128 A	>180 A	<128
T1	<64	<180	<90	<180	>180	>180 A	<180 A	<128	>180 A	<5.6	>180 A	>180
T2	<2	<180	<128	>180	<64	<45	<22.6	<4	<22.6	<4	<128	>180
T3	<64	<64	<90	>180	>180	<11	>180 A	<22.6	<128 A	<90 A	<180 A	<2
T4	>180	<5.6	<45	<128	<90	>180 A	<16	<128 A	>180 A	<128 A	<45	<2
T5	>180	<2		<4	>180	>180 A	<128	<32		<5.6	<128	<2
T1	<64	<128	<90	<180	<90	<90	<64	<180 A	<2	<180 A	<90	<90
T2	<2	>180	>180	<45	<64	<90	<180 A	<32	<4	<5.6	<180 A	<2
T3	<90	<128	<90	<90	<128	>180 A	<2.8	<90 A	>180 A	>180 A	<64 A	<2
T4	<128	<32	<128	<180	<90	<64	<180	<8	<128 A	<45 A	<128	>180
T5	<90	<90		<180	>180	<45	<4	<11		<180	<2	<22.6
Bank>>>	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB

Table B2. Pebble Count data collected from site CR-Rad on 28 Oct 2018.

Station ID	River	Site Description	Date
CR-Rad	Colorado River	at Radium	10/28/2018

Bank>>>	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	T I	**T 2**	**T 3**	**T 4**	**T 5**	**T 6**	**T 7**	**T 8**	**T 9**	**T 10**	**T 11**	**T 12**
T1	<32	<45	<45	<64	<128	<180	<128	<128	<90	<180	<90	>180
T2	<64	<64	<45	<128	<90	<90	<128	<180	<128	<11	<128	>180
T3	<45	<32	<90	<8	<64	<32	<45 A	<128 A	<45	<128 A	<64	<90
T4	<45	<2	<22.6	<128	<22.6	<90	<90 A	<128	<64	<45	<64	<180
T5	<2	<2.8		<64	<90 A	<64	<180 A	<90		<64	<45	<64
T1	<32	<32	<16	<16	<45	<4	<11	<128 A	<180 A	<128	<22.6	>180
T2	<22.6	<32	<2	<45	<90	<128	<128 A	>180	<128	<64	<128	>180
T3	<64	<64	<22.6	<64	<64	<128	<64	<22.6	<64	<180	<128	<2
T4	<11	<45	<64	<32	<45	<32	<180	>180	<64	<180 A	<90	<2
T5	<90	<90		<64	<64	<64	<128 A	<11		<180 A	<90	>180
T1	<2	<90	<8	<64 A	<128	<5.6	<8	<90	<128	<32	<128 A	>180
T2	<64	<90	<128	<64	<5.6	<45	<45	<45	<45	<16	<90	<128
T3	<32	<128	<2	<90	<64	<32	<90	<128	<90 A	<11	<45	>180
T4	<64	<32	<5.6	<45	<90	<45	<11	<128	<32	<128	<90	>180
T5	<64	<45		<45	<128	<32	<128	<128 A		<90	<2.8	>180
T1	<64	<45	<64	<32	<5.6	<45	<90	<64	<128 A	<90	>180	>180
T2	<22.6	<32	<22.6	<128	<64	<128	<22.6	<45	<32	<8	>180 A	>180
T3	<32	<2.8	<128	<45	<32	<64	<180	<128	<64	<128	<128	<2
T4	<64	<2	<45	<128 A	<90	<11	<180	<64	<128	<128	>180 A	<180
T5	<32	<90		<32	<8	>180	<180 A	<128 A		>180 A	<180	<2
T1	<2	<2	<22.6	<90	<4	<90	<90 A	>180 A	<64	<90 A	<180	<2
T2	<45	<45	<32	<90	<128	<128	<90	<180	<128 A	>180 A	<180 A	>180
T3	<22.6	<90	<64	<45	<64 A	<180	<90 A	<180	<16	<90	<32	<2
T4	<2	<22.6	<2	<16	<45 A	<64	<180 A	<128 A	<90	<64	<64	<128
T5	<128	<4		<2.8	<90 A	<90	<128	<64		<90	<45	>180
Bank>>>	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB

Table B3. Pebble Count data collected from site CR-SB on 28 Oct 2018.

Station ID	River	Site Description	Date
CR-SB	Colorado River	at State Bridge	10/29/2018

Bank>>>	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	T I	**T 2**	**T 3**	**T 4**	**T 5**	**T 6**	**T 7**	**T 8**	**T 9**	**T 10**	**T 11**	**T 12**
T1	<2	<32 A	<128	<4	<45	<128	<90	<45	>180	<45	<11	<32
T2	<22.6	<90 A	<180 A	<64	<45	>180	>180	<5.6	<32	<16	<45	<32
T3	<2	>180 A	<128	<128 A	<180	<128	<32	<45	<128	<128	<32	<64
T4	<2	>180 A	<128 A	<32	<8	<90	<180	<128	<32	<128	<22.6	<45
T5	<2.8	<22.6		<11	>180 A	<128 A	<22.6	<90		<8	<64	<2
T1	<2	>180 A	>180	>180 A	<90	<128 A	<64	<45	<45	<45	<22.6	>180
T2	<4	>180 A	>180	<5.6	<90	<180 A	<128	<5.6	<45	<16	<45	>180
T3	<16	>180 A	>180 A	<90 A	>180	<180	>180	<128	<16	<5.6	<90	<45
T4	<16	<128 A	<16	<180 A	<128	<90	<45	<16	<90	<90	<128	<45
T5	<2	<128 A		<22.6	>180 A	>180 A	<64	<32		<180	<90	<16
T1	<11	>180 A	>180	>180	<128 A	<2.8	>180	<22.6	<22.6	<45	<32	<180
T2	<11	<45 A	<128	<45	<90	<32	<11	<90	<64	<64	<64	<180
T3	<16	>180 A	<128 A	<64 A	<16	<128	<4	<32	<90	<16	<128	<45
T4	<22.6	>180 A	>180	>180 A	<64	<180 A	<2	<90	<64	<32	<4	<45
T5	<16	<64		<128	>180	<8	<128	<180		<45	<45	<128
T1	<11	<90 A	>180	<4	>180	>180 A	<5.6	<2	<45	<90	<45	<32
T2	<8	>180 A	<128	<128 A	>180 A	>180	>180 A	<4	<90	<64	<32	<45
T3	<11	>180 A	<180	<128 A	<45	<5.6	<45	<90	<64	<45	<90	<45
T4	<5.6	<64	<128	>180 A	>180	<180 A	<128 A	<90	>180	<22.6	<64	<16
T5	<16	>180 A		<180 A	>180 A	<180 A	<45	<90		<22.6	<90	<16
T1	<16	>180 A	<180 A	<128	<128	<45	<22.6	<90	<128	<32	<16	<5.6
T2	<11	>180	>180 A	<128 A	>180	<128 A	<16	<90	>180	>180 A	<32	<64
T3	<16	<45	>180	>180 A	<64	<90	<128	<2	<90	<90	<32	<22.6
T4	<8	>180 A	<90	>180	>180	<180 A	<180 A	<32	<128	<5.6	<128	<22.6
T5	<5.6	<64		<128 A	<128	<180	<90	<90		<128	<64	<45
Bank>>>	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB

Table B4. Pebble Count data collected from site CR-aC on 29 Oct 2018.

Station ID	River	Site Description	Date
CR-aC	Colorado River	above Catamount	10/29/2018

Bank>>>	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	T 1	**T 2**	**T 3**	**T 4**	**T 5**	**T 6**	**T 7**	**T 8**	**T 9**	**T 10**	**T 11**	**T 12**
T1	<2	<128	<180	<11	<90	<4	<128	>180	<128 A	<2	<90	<180
T2	<2	<180	<45	<32	<90	<90	<64	<45	<45	<22.6	<90	<2
T3	<128	<64	<180	<90	<128 A	<32	<90	<22.6	<180 A	<45	<128 A	<128
T4	<180	<180	>180	<16	<128	<4	<180	<45	<45	>180	<180 A	<64
T5	<180	<45		<90	<180	<128	<64	<180		>180	<64	<2
T1	<128	<32	<32	<90	>180	>180	<90	<11	<128 A	<64	<180 A	<180
T2	<90	<64	<5.6	>180 A	<11	<8	<64	<32	<4	<90	<90	<8
T3	<128	<128	<90	<128	<128	<128	>180	<5.6	<45 A	<64	>180 A	<64
T4	<2	<128	<128	<64	>180	<90	<128	>180	>180 A	<90 A	<45 A	<2
T5	<90	>180		>180	>180	<180	<180	<8		<90 A	<45	<2
T1	<180	<90	<45	>180	>180	<90	<180	<90	<5.6	<128 A	<128 A	<2
T2	<2	<180	<90	>180	<128	<128	<128	<45	<90	<128 A	>180	<2
T3	<180	<90 A	<32	<90	<128	<11	>180	>180	<4	>180	>180 A	<128
T4	<128	<45	>180	<180	>180	<128	>180	>180	<128 A	<32	<180	<2
T5	<2	<128		<2	<32	<128	>180	>180		<128	<128	<64
T1	<128	<64	<32	>180	<128	<16	<2	<90	>180 A	<2	<128 A	<128
T2	<128	<22.6	<64	<2	<128	<90	<90	<90	<90	>180	<22.6	<64
T3	<180	<180 A	<180 A	<128	<64	<8	<90	>180	>180	>180 A	>180 A	<32
T4	<90	<64	<45	>180	<90	<128	<128	>180	<90 A	<32	<128	<128
T5	<180	<90		<128	<2	<64	<180	<64		>180 A	<2	<2
T1	<64	<32	>180	>180	<2.8	<64	<90	>180	<90 A	<32	>180	<2
T2	<180	<90	>180	<128	<16	<180	<180	<128	<64	<2	<128	<128
T3	<2	<90 A	>180	<4	<128	<22.6	<8	<128 A	<64 A	<128 A	<90	<128
T4	<2	<90	<11	<128	<180	<2	<4	<128	<32	<128	>180	<64
T5	<128	>180		<64	<2.8	<64	<128	<128 A		<90 A	>180	<2
Bank>>>	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB

Table B5. Pebble Count data collected from site CR-bRD on 29 Oct 2018.

Station ID	River	Site Description	Date
CR-bRD	Colorado River	below Red Dirt	10/29/2018

Bank>>>	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
	T I	**T 2**	**T 3**	**T 4**	**T 5**	**T 6**	**T 7**	**T 8**	**T 9**	**T 10**	**T 11**	**T 12**
T1	<11	<128 A	<32 A	<64	<4	<128 A	<128	>180 A	<2.8	<2.8	<128 A	<180
T2	<11	<128 A	<90 A	<128 A	<128 A	<128 A	<128 A	<4	<2	<2	<128 A	<64
T3	<8	<8	<11	<64 A	<90 A	<5.6	<128 A	<2.8	<4	<5.6	>180 A	>180
T4	<8	<4	<8	<180 A	<90 A	>180 A	<22.6	<2	<2	<2.8	>180 A	>180
T5	<4	<90 A		<4	<128 A	>180 A	<90 A	<2.8		<2	<4	<90
T1	<16	<64 A	>180 A	<8	<180 A	>180 A	>180 A	<2.8	<2.8	<2.8	<128 A	>180
T2	<11	<128 A	<90 A	<64 A	<32	<180 A	<90 A	>180	<2	>180 A	<2	<128
T3	<2	<90 A	>180 A	<64 A	<5.6	<2.8	<128 A	>180 A	<2.8	>180 A	>180 A	<45
T4	<8	<2	>180 A	<128 A	<128	<2	<90 A	>180 A	>180 A	<2.8	<2	<180
T5	<2	<2		<128 A	<2	<64 A	<2	<128 A		<2	<2	>180
T1	<2	<45 A	<64 A	<128 A	>180 A	<45 A	<2	<128 A	<2.8	<128 A	<4	>180
T2	<2	<90 A	<5.6	<11	>180 A	>180 A	>180 A	>180 A	<4	>180 A	>180 A	<90
T3	<5.6	<128 A	<4	>180 A	<4	>180 A	<45	<2.8	<4	<4	>180 A	<180
T4	<5.6	<128 A	<45 A	<90 A	<45	>180 A	>180 A	<2	<32 A	<2	<90	<180
T5	<11	<180 A		<8	<4	<128	>180 A	<4		<128 A	<180 A	<90
T1	<2	<2	<90 A	<128 A	<90 A	<180 A	<128 A	<2	>180 A	<2	<2	<180
T2	<2	<2	<5.6	<4	>180 A	<5.6	<180 A	<128 A	>180 A	<90 A	<180 A	<128
T3	<45	<90 A	<90 A	<2	<64 A	>180 A	<90 A	<4	<128 A	>180 A	<2	<180
T4	<2	<90 A	<11	<128 A	<90 A	>180 A	>180 A	<2	<11	>180 A	>180 A	<128
T5	<2	<128 A		<128 A	>180 A	<2	<180 A	<2.8		<2.8	<2.8	<90
T1	<2	<128 A	<45 A	<2	<45	<128 A	<90	<2.8	<64 A	<2	>180 A	>180
T2	<128	<128 A	<32 A	<128 A	>180 A	<16	<2	<4	<2.8	<2	<64 A	<180
T3	<2	<64 A	<128 A	<2	<128 A	>180 A	>180 A	>180 A	<2	<2.8	<128	<128
T4	<2	<2	<4	<128 A	<180 A	>180 A	<32	>180 A	>180 A	<2.8	<45	<22.6
T5	<180	<2		<90 A	<22.6	>180 A	>180 A	<2		<2	<128 A	>180
Bank>>>	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB	RB

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