# Characterization of Selected Biological, Chemical, and Physical Conditions at Fixed Sites in the Upper Colorado River Basin, Colorado, 1995–98

By Jeffrey R. Deacon, Scott V. Mize, and Norman E. Spahr

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# FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for a specific contamination problem; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional and national policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 59 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 59 study units, and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.

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Chief Hydrologist

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# Characterization of Selected Biological, Chemical, and Physical Conditions at Fixed Sites in the Upper Colorado River Basin, Colorado, 1995–98

*By* Jeffrey R. Deacon, Scott V. Mize, *and* Norman E. Spahr

## ABSTRACT

Biological community samples were collected at 15 sites in the Upper Colorado River Basin (UCOL) in Colorado as part of the National Water-Quality Assessment (NAWQA) Program. Sites sampled in two physiographic provinces, the Southern Rocky Mountains and the Colorado Plateau, represented agriculture, mining, urban and recreation, and mixed land uses and background conditions. Nine measures of water quality, which include information on nutrients, specific conductance (a surrogate for salinity), trace elements in streambed sediment, pesticides in fish tissue, fish communities, and macroinvertebrate richness and composition and stream habitat were used for comparisons among sites within the two physiographic provinces. Sampling sites from three other NAWQA study units— the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin study units—were categorized on the basis of land use and stream size in order to develop a larger data set for comparison to sites in the UCOL. Three categories of land use—forested (includes mining, urban and recreation, and background), agriculture, and mixed—were used for comparison to the UCOL fixed sites.

Results indicated that all sites other than the Colorado River below Baker Gulch (a background site) showed some water-quality characteristics to be significantly affected. Results indicated that the concentrations of cadmium and zinc in streambed sediment at mining land-use sites in the Southern Rocky Mountains physiographic province generally were orders of magnitude higher than streambed-sediment concentrations at the background site. Streambed-sediment concentrations at mining land-use sites in the UCOL were greater than the $75^{th}$ percentile of concentrations from sites in the three other NAWQA study units. Fish communities and habitat conditions were degraded at mining land-use sites compared to the background site. Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness and the percentage of EPT were lower at mining land-use sites than at the background site and were less than the $50^{th}$ percentile of those for sites from the three other NAWQA study units.

Nutrient concentrations at urban and recreation sites in the Southern Rocky Mountain physiographic province generally were greater than concentrations at the background site and generally were between the $25^{th}$ and $90^{th}$ percentile of concentrations for sites from the three other NAWQA study units. Habitat conditions and fish communities at urban and recreation sites were slightly degraded compared to the background site. EPT richness and the percentage of EPT were lower at urban and recreation sites than at the background site and were between the $25^{th}$ and $75^{th}$ percentile of those for sites from the three other NAWQA study units. The percentage of Chironomidae, which may be indicative of pollutant-tolerant organisms, was higher at urban and recreation sites than at the background site.

Mixed land-use sites in the Southern Rocky Mountains physiographic province had similar

nutrient concentrations and similar cadmium and zinc streambed-sediment concentrations. Fish-community degradation index values were very different among the three mixed land-use sites in the Southern Rocky Mountains physiographic province. Larger percentages of omnivores and anomalies such as lesions and deformities at two mixed land-use sites resulted in higher degradation values of the fish community.

Agriculture land-use sites had higher concentrations of nutrients and selenium than the background site in the Colorado Plateau physiographic province. Concentrations of *p,p'*-DDE in fish tissue at agriculture sites were higher than the 75$^{th}$ percentile of concentrations for sites from the three other NAWQA study units. Fish communities had degradation values near the 75$^{th}$ percentile for agriculture sites. The percentage of EPT was low at agriculture sites when compared to the background site.

Two mixed land-use sites in the Colorado Plateau physiographic province had similar concentrations of nutrients, selenium, and *p,p'*-DDE, and similar EPT richness and composition. These two sites were located downstream from agricultural and urban activities. Some water-quality measures at these two sites indicated degradation compared to a mixed land-use site upstream from most of the agriculture and urban activities in the Colorado Plateau physiographic province.

## INTRODUCTION

The National Water-Quality Assessment (NAWQA) Program is a long-term program of the U.S. Geological Survey (USGS) that is designed to describe the status and trends in the quality of the Nation's surface- and ground-water resources and to provide an understanding of the natural and human factors that can affect the quality of these resources (Leahy and others, 1990). The program is interdisciplinary and integrates biological, chemical, and physical data to assess the Nation's water quality at local, regional, and national levels.

The NAWQA Program is designed to use multiple lines of evidence to assess water quality. The use of more than one sampling medium to characterize water quality is important. Conventional water-quality methods for sampling water may not provide enough information to make a complete assessment of water quality. Therefore, sampling several types of media at a site will provide an opportunity to integrate information to get a more complete description of water quality that may not be evident with one sampling medium.

The NAWQA Program focuses on a broad spectrum of constituents and sampling approaches for surface water, including information on (1) trace-element and organic contaminants in organism tissue and streambed sediment; (2) biological information (algae, macroinvertebrate, and fish communities); and (3) stream habitat characterization (Gurtz, 1994). Biological community surveys are one of the few means of directly assessing the biological integrity of a site and one approach that is sensitive to changes in water chemistry and changes in physical habitat (Meador and Gurtz, 1994).

Macroinvertebrates are continuously exposed to varying water-quality conditions, which allows for these organisms to integrate those conditions over time and provides for a direct measure of water quality (Clements, 1994). Macroinvertebrates provide information on water quality from months to years. Biological metrics (for example, taxonomic richness and composition measures) can be used to relate macroinvertebrate communities to water quality. The biological metrics have an expected response to changes and differences in water quality among sites (Barbour and others, 1997).

A fish community is a group of fish that inhabit the same area of a stream and interact with each other. The structure of a fish community is determined by the species present, their relative abundances, their life stages and size distributions, and their distributions in space and time (Meador and others, 1993a). Although fish communities may have a high degree of natural variability, they can be useful indicators of ecosystem health (Moyle, 1994). One important aspect of relating biological communities to water quality is the assessment of available habitat for aquatic organisms. Habitat is the physical environment in which aquatic organisms live. Biological communities may be affected by habitat quality as well as water quality. Types of substrate, percentage of embeddedness of the

substrate, riparian vegetation, stream width and depth, and other geomorphic features are used to characterize habitat (Meador and others, 1993b; Fitzpatrick and others, 1998).

The Upper Colorado River Basin (UCOL) was selected to be part of the national water-quality assessment. Fourteen surface-water fixed sites (Spahr and others, 1996) and one additional biological sampling site were selected for characterizing water quality. Surface-water samples generally were collected once per month during the study period. Biological samples generally were collected once per year during low-flow conditions. The surface-water network was designed to integrate the water chemistry and biological information.

## Purpose and Scope

The objectives of this report are to: (1) characterize biological communities at sampling sites; (2) determine the relation between biological communities (macroinvertebrates and fish) and chemical and physical conditions and relate those factors to background conditions, land use, and natural factors at each site; and (3) compare selected water-quality measures at sampling sites to those in three other NAWQA study units with similar land-use and stream characteristics. Biological assessments were conducted at 15 sites during low-flow conditions in August of 1996 and 1997. A subset consisting of 10 of the 15 sites was sampled during low-flow conditions in August 1998. Qualitative and quantitative habitat measures also were documented during the 3-year data-collection period. Sites were chosen to represent agriculture, mining, urban and recreation, and mixed land uses and background conditions.

## Description of Study Unit

The UCOL study unit has a drainage area of about 17,800 $mi^2$ with varied climate, geology, topography, and hydrology. The primary river in the study unit, the Colorado River, originates in the mountains of central Colorado and flows about 230 miles southwest into Utah (fig. 1) and beyond. Its headwaters and most of the tributaries originate in the mountains that form the eastern and southern boundaries of the study unit (Driver, 1994).

The UCOL study unit is divided almost equally into two physiographic provinces: the Southern Rocky Mountains in the eastern, high-elevation part and the Colorado Plateau in the western, low-elevation part. Stream habitats range from cool, clear, and forested headwater streams that have crystalline bedrock, high gradients, and coarse substrates in the Southern Rocky Mountains to warm, sluggish, less vegetated, and saline streams that have low gradients and fine substrates in the Colorado Plateau. Stream habitat and water quality reflect the extreme differences in elevation, climate, vegetation, and geology across the study unit, which have an associated effect on biological communities. A more detailed description of the two physiographic provinces and their environmental settings in the UCOL study unit are described in Apodaca and others (1996).

Predominant land uses in the study unit are forest and rangeland (fig. 1). Other land uses within the forest and rangeland settings are agriculture, mining, urban and recreation, and mixed. Agricultural activities include the production of alfalfa, fruits, grains, hay, and vegetables (Apodaca and others, 1996). Past and present mining activities have included the extraction of metals (copper, gold, lead, molybdenum, nickel, silver, vanadium, and zinc) and energy fuels (coal, gas, oil, and uranium). Urban and recreation represent one of the smaller land uses in the study unit. A number of urban and recreation areas are associated with growth resulting from the expansion of the ski industry and from energy development in the 1980's.

The NAWQA study design includes two types of fixed sites: indicator sites and integrator sites (Gilliom and others, 1995). Indicator sites are selected to represent water-quality conditions of streams in relatively homogeneous areas. These sites also are termed "agriculture, mining, and urban and recreation" land-use sites in this report. Integrator sites are selected to represent water-quality conditions of rivers in heterogeneous, large basins that are affected by complex combinations of environmental settings. These sites also are termed "mixed" land-use sites in this report. A background site was selected in each physiographic province to represent conditions that have minimal disturbance from human activities.

The Southern Rocky Mountains physiographic province has mining, urban and recreation, and mixed land-use sites. Environmental setting and instream habitat conditions (that is, types and size of substrate;

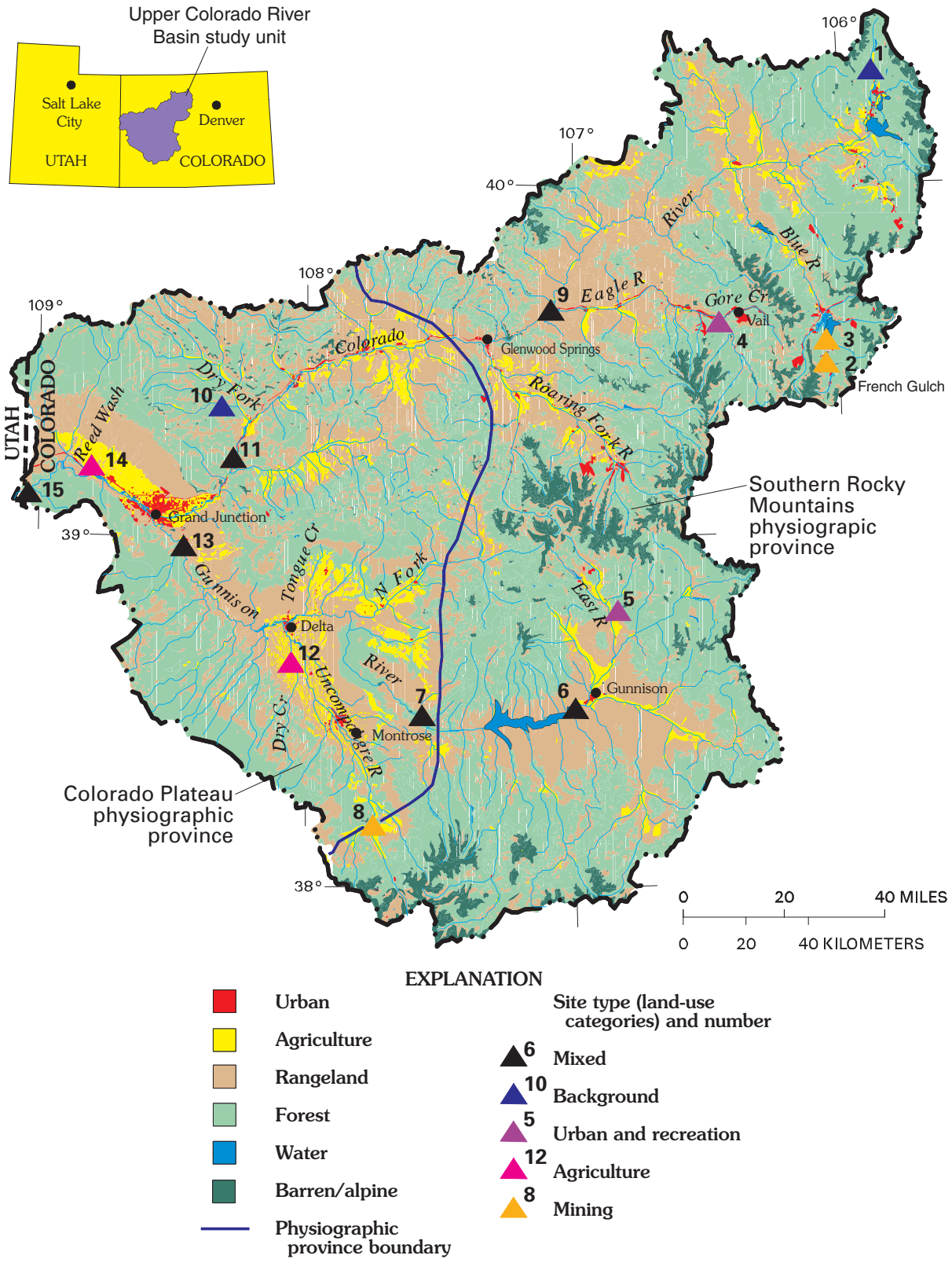


**Figure 1**. Sampling sites in the Upper Colorado River Basin study unit.

and riffle, run, and pool ratios) were very similar among the Southern Rocky Mountains physiographic province indicator sites and generally were similar among Southern Rocky Mountains physiographic province integrator sites.

The Colorado Plateau physiographic province has agricultural and mixed land-use sites. Environmental setting and instream habitat conditions were very similar among the Colorado Plateau physiographic province indicator sites and among Colorado Plateau physiographic province integrator sites.

Differences in the environmental setting between the two physiographic provinces reflect the differences in water-quality issues. For example, factors such as elevation, drainage area, stream gradient, bank stability, temperature, specific conductance, dissolved solids, suspended sediment, and other factors change between the two physiographic provinces (table 1). With the exception of selenium, trace elements generally are more of a water-quality issue in the Southern Rocky Mountains physiographic province due to the crystalline bedrock geology favoring mining activity. Selenium is more of a water-quality issue in the Colorado Plateau physiographic province mainly due to the Mancos Shale of Cretaceous age in the area. Pesticides generally are more of an issue in the Colorado Plateau physiographic province where agricultural activities are predominant. Although physiographic provinces, geology, and land use were the environmental factors used in the stratification scheme (fig. 2) for the Upper Colorado River Basin, other factors such as physical habitat and hydrologic conditions are important components of the environmental setting that affect water quality.

## Acknowledgments

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# METHODS OF DATA COLLECTION AND ANALYSIS

## Sample Collection and Analysis

Biological samples were collected once each year during low-flow conditions in August of 1996, 1997, and 1998. Collection and field processing of macroinvertebrate and fish communities and qualitative and quantitative habitat measures followed established NAWQA protocols (Cuffney and others, 1993; Meador and others, 1993a; Meador and others, 1993b). A stream reach that consisted of at least two each of different geomorphic channel units (riffles, runs, pools) and at least 150 meters (m) at wadeable sites and 750 m at nonwadeable sites was selected at 15 sites (table 1). Macroinvertebrate samples were collected in riffle areas of the stream reach to represent the richest targeted habitat (Cuffney and others, 1993). Fish collection was done by electrofishing the entire stream reach. Qualitative habitat measures (that is, types and size of substrate; embeddedness of substrate; riffle, run, and pool ratios; and so forth) were documented at six transects within the stream reach, and quantitative measures (that is, stream width and depth, bank height and width, flood-plain width, and so forth) consisted of a detailed survey of the entire stream reach (Meador and others, 1993b). Complete lists of the macroinvertebrate and fish taxa and numbers of taxa collected for each fixed site during the three sampling periods are in Appendixes A and B, respectively.

Water-chemistry samples were collected using established NAWQA protocols (Shelton, 1994). Water-chemistry samples generally were collected once each month, and additional samples were collected during extreme events. Results of water-quality samples for the fixed sites are in the USGS National Water Information System (NWIS).

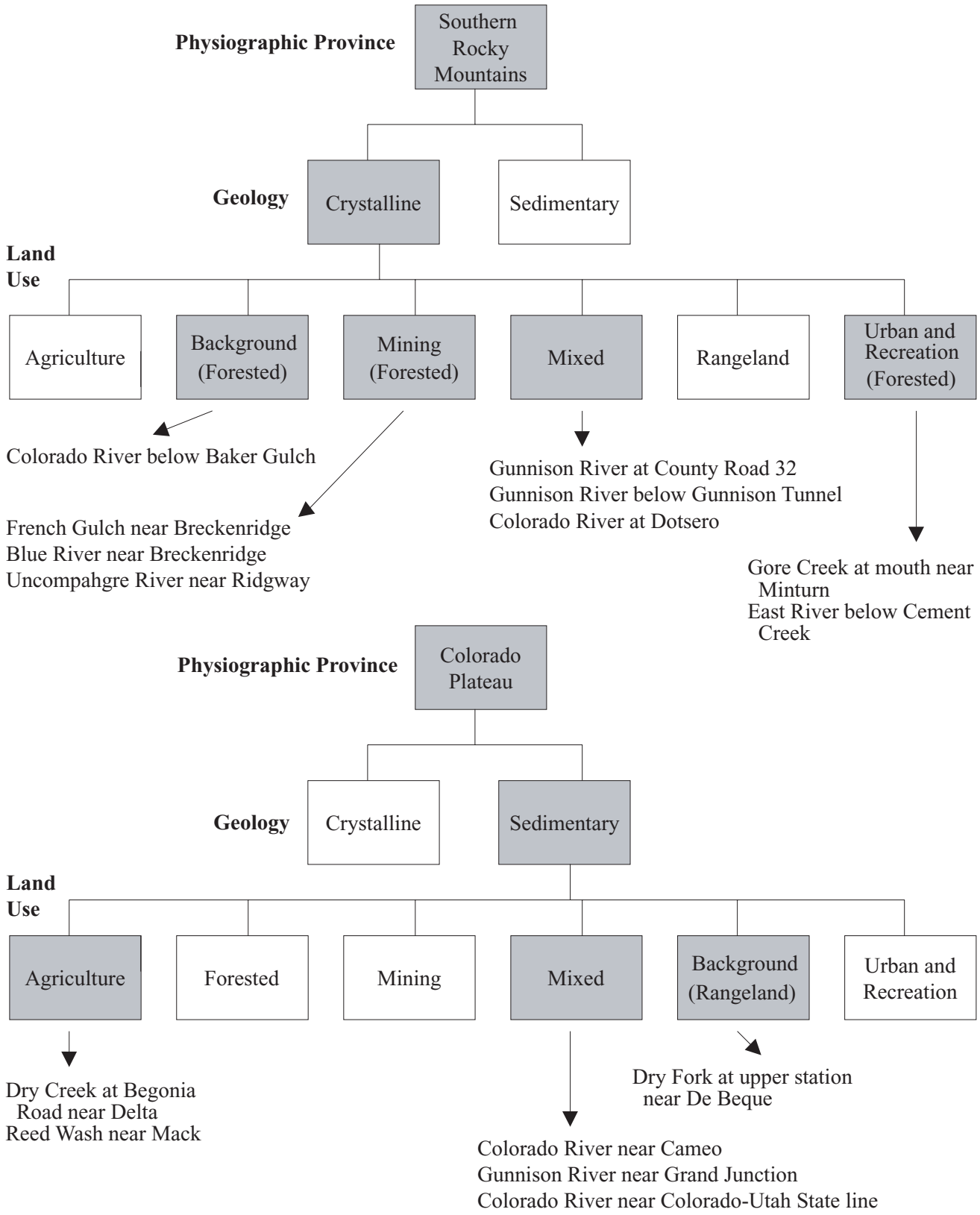


**Figure 2.** Physiographic province, general geology, and land use for fixed sites in the Upper Colorado River Basin study unit.

Streambed-sediment and fish tissue samples were collected for trace element and pesticide analysis in August through October 1995 using methods developed for the NAWQA Program (Shelton and Capel, 1994; Crawford and Luoma, 1993). Results of selected trace elements in streambed sediment and fish liver are in Deacon and Stephens (1998). Results of selected pesticides in streambed sediment and whole-body fish are in Stephens and Deacon (1997).

Quality-assurance and quality-control results for the macroinvertebrate samples were within the USGS National Water Quality Laboratory quality-assurance guidelines of 20 percent for picking effectiveness (less than 6 percent for UCOL samples). Picking effectiveness is a process to ensure that the original sample was picked adequately. Quality-assurance and quality-control results were within 10 percent for taxonomy identification (less than 7 percent for UCOL samples). Taxonomy identification is the process where macroinvertebrates are identified with the use of a microscope to the lowest taxonomic level, when applicable (Steve Moulton, U.S. Geological Survey, written commun., 1999). Interim quality-assurance and quality-control results for surface-water sampling are described in Spahr and Boulger (1997).

## Selection of Data for Analysis

Nine measures of water quality, which include information on nutrients in the water column, specific conductance (used as a surrogate for salinity), trace elements in streambed sediment, pesticides in fish tissue, fish communities, macroinvertebrate richness and composition, and measures of stream habitat, were used for comparisons. Table 1 of this report lists additional habitat and water-quality characteristics, not included in this comparison, among sites in the UCOL. The nine measures of water quality and the habitat measures were selected for comparison among sites owing to consistent data among NAWQA study units. Median values were used for selected water-quality measures, when available. Some selected water-quality measures were represented by a single sample. For example, trace elements in streambed sediment and pesticides in fish tissue were sampled once during the 3-year sampling period. Therefore, the single value, as opposed to a median value, was used for those measures. Table 2 of this report lists the median or single concentrations or values used for comparison to the range of median or single concentrations or values from the Rio Grande Valley, South Platte River Basin, and Upper Snake River Basin study units. In addition, table 2 compares water-quality characteristics among sites in the UCOL.

Nitrite plus nitrate and total phosphorus were used as a measure of nutrients, and specific conductance was a used as a measure of salinity among sites in both physiographic provinces. Zinc and cadmium concentrations in streambed sediment were used as a measure of trace elements among sites in the Southern Rocky Mountains physiographic province, and selenium in streambed sediment was used as a measure of trace elements among sites in the Colorado Plateau physiographic province. Dichloro diphenyl dichloroethylene (*p,p'*-DDE) in fish tissue was used as a measure of pesticides among sites in the Colorado Plateau. The total concentration in fish tissue was normalized by dividing by lipid content. This normalization decreases the bias that might result from comparing different species in the fish-tissue data set (Gilliom and others, 1997).

Fish-community and habitat-degradation indices were used to compare habitat conditions and fish communities among sites (Gilliom and others, 1997). Both degradation indices are based on the sum of four criteria. Each of the four criteria for each index is scored as 1 (low), 3, or 5 (high) to represent levels of degradation. There may be instances where one of the four criteria can be omitted and, in such cases, the scores of the three criteria combined are multiplied by 1.33 to yield a final rating (Gilliom and others, 1997). The indices represent an assessment of the fish communities and habitat conditions at one point in time; therefore, interpretations may be coarse. The fish-community degradation index is based on percentages of four groups: the percentage of tolerant individuals, omnivores, non-native species, and anomalies (lesions, eroded fins, deformities, and so forth). Several sites consist of large numbers of non-native species (introduced) and therefore may affect the scoring criteria. The habitat-degradation index is based on stream modification, bank erosion, vegetative stability, and relative density of riparian vegetation. The focus of the habitat-degradation index is on degradation of the channel and riparian zone. Thus, the index is designed to reflect large-scale stream modifications that are most likely to be observed over time and is not designed to reflect aspects of instream habitat that are more likely to reflect short-term condi-

**Table 1**. Selected site characteristics for fixed sites in the Upper Colorado River Basin study unit

[USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; ft/mi, feet per mile; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, no data available]

| Site number (fig. 1) | Site name | Site abbreviation | USGS number | Latitude | Longitude | Elevation (feet) | Drainage area (square miles) | Physio-graphic province[1] | Site type | Mean stream-flow[3] ($ft^3/s$) | Mean width[3] (feet) | Mean depth[3] (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Colorado River below Baker Gulch | Baker | 09010500 | 40° 19' 33" | 105° 51' 22" | 8,750 | 53 | SRM | Back-ground | 82 | 48.7 | 2.1 |
| 2 | French Gulch near Breckenridge | French | 09046530 | 39° 29' 35" | 106° 02' 39" | 9,485 | 11 | SRM | Mining | 11 | 17.3 | 1.2 |
| 3 | Blue River near Breckenridge | Blue | 392944106024400 | 39° 29' 44" | 106° 02' 44" | 9,480 | 97 | SRM | Mining | -- | 25.7 | 1.4 |
| 4 | Gore Creek at mouth near Minturn | Gore | 09066510 | 39° 36' 34" | 106° 26' 50" | 7,730 | 102 | SRM | Urban/ recre-ation | 164 | 31.2 | 1.6 |
| 5 | East River below Cement Creek | East | 09112200 | 38° 47' 03" | 106° 52' 13" | 8,006 | 238 | SRM | Urban/ recre-ation | 384 | 61.8 | 1.5 |
| 6 | Gunnison River at County Road 32 | Gunn32 | 383103106594200 | 38° 31' 03" | 106° 59' 42" | 7,570 | 2,128 | SRM | Mixed | 1,050 | 157 | 3.7 |
| 7 | Gunnison River below Gunnison Tunnel | GunnTun | 09128000 | 38° 31' 45" | 107° 38' 54" | 6,526 | 3,965 | SRM[2] | Mixed | 1,560 | 144 | 6.1 |
| 8 | Uncompahgre River near Ridgway | Ridgway | 09146200 | 38° 11' 02" | 107° 44' 43" | 6,878 | 149 | SRM | Mining | 183 | 39.0 | 1.6 |
| 9 | Colorado River at Dotsero | Dotsero | 09070500 | 39° 38' 38" | 107° 04' 38" | 6,130 | 4,394 | SRM | Mixed | 2,720 | 312 | 9.6 |
| 10 | Dry Fork at upper station near De Beque | DryFk | 09095300 | 39° 22' 29" | 108° 19' 02" | 5,385 | 97 | CP | Back-ground | 5 | 6.4 | 0.5 |
| 11 | Colorado River near Cameo | Cameo | 09095500 | 39° 14' 20" | 108° 16' 00" | 4,813 | 8,050 | CP | Mixed | 4,910 | 284 | 7.0 |
| 12 | Dry Creek at Begonia Road near Delta | DryCr | 09149480 | 38° 38' 45" | 108° 02' 54" | 5,215 | 175 | CP | Agricul-ture | 71 | 22.9 | 1.4 |
| 13 | Gunnison River near Grand Junction | GunnGJ | 09152500 | 38° 59' 00" | 108° 27' 00" | 6,526 | 7,928 | CP | Mixed | 3,180 | 312 | 5.7 |
| 14 | Reed Wash near Mack | Reed | 09153290 | 39° 12' 41" | 108° 48' 11" | 4,505 | 16 | CP | Agricul-ture | 41 | 16.1 | 1.5 |
| 15 | Colorado River near Colorado-Utah State line | State line | 09163500 | 39° 07' 58" | 109° 01' 35" | 4,325 | 17,843 | CP | Mixed | 8,290 | 355 | 10 |

**Table 1**. Selected site characteristics for fixed sites in the Upper Colorado River Basin study unit—Continued

[USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; ft/mi, feet per mile; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, no data available]

| Site abbreviation | Stream type | Stream gradient (ft/mi) | Sinuosity[4] | Predominant substrate[5] | Embeddedness[6] | Bank stability[7] | Percentage open canopy[8] | Temperature[9] (°C) | pH[11] (standard units) | Dissolved oxygen[11] (mg/L) | Dissolved solids[11] (mg/L) | Suspended sediments[11] (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baker | Meandering | 19.5 | 2.06 | Cobble/gravel | 4 | 3.8 | 46 | 9.6 | 7.3 | 9.35 | 44 | 2.0 |
| French | Channelized | 163 | 1.15 | Cobble | 3 | 3.0 | 69 | 6.3 | 7.6 | 9.4 | 158 | 1.0 |
| Blue | Channelized | 89.7 | 1.17 | Cobble | 3 | 3.6 | 84 | -- | -- | -- | -- | -- |
| Gore | Channelized | 57.9 | 1.17 | Cobble/gravel | 3 | 3.0 | 69 | 9.1 | 8.5 | 10 | 154 | 3.0 |
| East | Meandering | 32.5 | 1.24 | Cobble | 4 | 2.5 | 65 | 11.5[10] | 8.3 | 9.5 | 148 | 4.0 |
| Gunn32 | Straight | 21.0 | 1.15 | Cobble | 3 | 2.6 | 71 | 14.3 | 8.2 | 9.2 | 117 | 6.0 |
| GunnTun | Meandering | 38.9 | 1.34 | Cobble | 4 | 3.0 | 42 | 10.4[10] | 8.0 | 9.7 | 104 | 2.0 |
| Ridgway | Meandering | 40.1 | 1.30 | Cobble | 3 | 3.0 | 53 | 11.8 | 8.0 | 9.1 | 387 | 28 |
| Dotsero | Braided | 7.04 | 1.14 | Cobble | 3 | 2.3 | 89 | 16.0[10] | 8.1 | 9.2 | 234 | 24 |
| DryFk | Meandering | 68.4 | 1.35 | Gravel/silt | 2 | 1.0 | 62 | 16.7 | 8.5 | 9.05 | 1,655 | 184 |
| Cameo | Meandering | 16.6 | 1.21 | Cobble | 3 | 2.7 | 73 | 16.4 | 8.3 | 9.15 | 452.5 | 60 |
| DryCr | Meandering | 14.4 | 1.67 | Cobble/sand | 3 | 2.8 | 73 | 16.6 | 8.3 | 9.9 | 847 | 106 |
| GunnGJ | Straight | 17.5 | 1.15 | Cobble/sand | 2 | 2.6 | 76 | 17.1 | 8.3 | 8.9 | 404 | 98 |
| Reed | Channelized | 17.1 | 1.17 | Gravel/silt | 2 | 1.5 | 66 | 18.6 | 8.0 | 8.6 | 1,020 | 684 |
| State line | Meandering | 9.09 | 1.33 | Cobble | 2 | 2.8 | 82 | 18.5 | 8.3 | 9.3 | 508 | 105 |

[1]SRM = Southern Rock Mountains; CP = Colorado Plateau.

[2]Site 7 is physically located in the Colorado Plateau but is hydrologically represented as a Southern Rock Mountains sampling site.

[3]For period of study, October 1996–September 1998.

[4]River distance divided by a straight-line distance; a value of 1.00 is a straight line.

[5]Predominant substrate sampled for macroinvertebrates.

[6]Mean value from 18 measurements at a site. Rated on a scale from 1 (signifying more than 75 percent of surface area of gravel, cobble, and boulder particles covered by fine sediments) to 5 (signifying less than 5 percent of surface area of gravel, cobble, and boulder particles covered by fine sediment).

[7]Mean value from 12 measurements at a site. Rated on a scale from 1 (signifying less than 25 percent of banks are covered with vegetation or gravel or larger material) to 4 (signifying more than 80 percent of banks are covered with vegetation or gravel or larger material).

[8]Expressed as a percentage of open viewing angle; 100 percent indicates no canopy.

[9]Mean daily temperature for June, July, and August in water year 1997.

[10]Mean daily temperature for June, July, and August in water year 1998.

[11]Median value for period of study, October 1996–September 1998.

**Table 2.** Selected chemical and biological measures for fixed sites in the Upper Colorado River Basin study unit

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/g, micrograms per gram; EPT, Ephemeroptera, Plecoptera, Trichoptera; µg/kg, micrograms per kilogram; <, less than; --, no data available]

| Site number (fig. 1) | Site name | Physio-graphic province[1] | Nitrite plus nitrate[2] (mg/L) | Total phos-phorus[2] (mg/L) | Specific conduc-tance[2] (µS/cm) | Cadmium in streambed sediment[3] (µg/g) | Zinc in streambed sediment[3] (µg/g) | Selenium in streambed sediment[3] (µg/g) |
|---|---|---|---|---|---|---|---|---|
| 1 | Colorado River below Baker Gulch | SRM | 0.08 | < 0.01 | 70 | 0.5 | 150 | 0.8 |
| 2 | French Gulch near Breckenridge | SRM | 0.09 | < 0.01 | 260 | 57 | 9,000 | 2.1 |
| 3 | Blue River near Breckenridge | SRM | -- | -- | -- | 11 | 3,000 | 1.1 |
| 4 | Gore Creek at mouth near Minturn | SRM | 0.26 | 0.05 | 287 | 0.4 | 190 | 1.3 |
| 5 | East River below Cement Creek | SRM | 0.10 | < 0.01 | 266 | 4.3 | 610 | 1.9 |
| 6 | Gunnison River at County Road 32 | SRM | 0.08 | 0.03 | 214 | 1.9 | 310 | 1.2 |
| 7 | Gunnison River below Gunnison Tunnel | SRM | 0.08 | 0.01 | 176 | 0.7 | 180 | 0.9 |
| 8 | Uncompahgre River near Ridgway | SRM | 0.13 | 0.02 | 609 | 2.5 | 790 | 1.1 |
| 9 | Colorado River at Dotsero | SRM | 0.12 | 0.03 | 412 | 1.2 | 330 | 1.8 |
| 10 | Dry Fork at upper station near De Beque | CP | 0.54 | 0.05 | 2,300 | 0.2 | 71 | 0.5 |
| 11 | Colorado River near Cameo | CP | 0.13 | 0.03 | 805 | 0.6 | 120 | 0.6 |
| 12 | Dry Creek at Begonia Road near Delta | CP | 3.75 | 0.10 | 1,198 | 0.6 | 120 | 1.1 |
| 13 | Gunnison River near Grand Junction | CP | 0.56 | 0.08 | 616 | 0.7 | 120 | 2.5 |
| 14 | Reed Wash near Mack | CP | 1.70 | 0.60 | 1,498 | 1.8 | 130 | 5.6 |
| 15 | Colorado River near Colorado-Utah State line | CP | 0.42 | 0.10 | 840 | 0.6 | 100 | 1.7 |

| Site number (fig. 1) | Site name | *p,p'*-DDE in fish tissue[3] (µg/kg) | *p,p'*-DDE/ lipid content in fish tissue (µg/kg lipid) | Fish degra-dation index[2] | Habitat degra-dation index[4] | EPT rich-ness[2] | Percent EPT[2] | Percent Chiron-omidae[2] |
|---|---|---|---|---|---|---|---|---|
| 1 | Colorado River below Baker Gulch | 11 | 229 | 8.0 | 6.65 | 32 | 67 | 10 |
| 2 | French Gulch near Breckenridge | -- | -- | -- | 11.97 | 7 | 16 | 68 |
| 3 | Blue River near Breckenridge | <5.0 | -- | 8.6 | 9.31 | 16 | 33 | 61 |
| 4 | Gore Creek at mouth near Minturn | 8.2 | 95 | 9.3 | 11.97 | 17 | 38 | 58 |
| 5 | East River below Cement Creek | 6.0 | 111 | 9.3 | 9.31 | 23 | 49 | 25 |
| 6 | Gunnison River at County Road 32 | 6.3 | 92 | 13.3 | 11.97 | 28 | 40 | 40 |
| 7 | Gunnison River below Gunnison Tunnel | <5.0 | -- | 8.6 | 9.31 | 7 | 58 | 31 |
| 8 | Uncompahgre River near Ridgway | 5.9 | 128 | 8.6 | 9.31 | 15 | 34 | 44 |
| 9 | Colorado River at Dotsero | 16 | 253 | 19.0 | 11.97 | 24 | 57 | 27 |
| 10 | Dry Fork at upper station near De Beque | -- | -- | -- | 14.63 | 5 | 46 | 23 |
| 11 | Colorado River near Cameo | 5.5 | 48 | 19.0 | 11.97 | 23 | 63 | 31 |
| 12 | Dry Creek at Begonia Road near Delta | 700 | 7,446 | 17.3 | 11.97 | 4 | 11 | 18 |
| 13 | Gunnison River near Grand Junction | 130 | 1,666 | 18.0 | 11.97 | 4 | 9 | 45 |
| 14 | Reed Wash near Mack | 290 | 4,833 | 17.0 | 19.95 | 5 | 18 | 35 |
| 15 | Colorado River near Colorado-Utah State line | 190 | 1,283 | 18.6 | 11.97 | 6 | 3 | 76 |

[1] SRM = Southern Rocky Mountains; CP = Colorado Plateau.
[2] Median value for period of study, October 1996–September 1998.
[3] Single value from streambed sediment and fish tissue occurrence and distribution study, 1995.
[4] Single value for habitat assessment, 1996.

tions (for example, depth, velocity, and instream cover).

Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness is a measure of organisms that generally are intolerant to pollution or disturbance. EPT richness is expected to decrease with water-quality degradation. The percentage of EPT and the percentage of Chironomidae are composition measures and can be used to relate to water-quality conditions. The percentage of EPT (generally intolerant organisms) is expected to decrease with water-quality degradation, and the percentage of Chironomidae (generally tolerant organisms) is expected to increase with water-quality degradation (Barbour and others, 1997).

## Data Analysis

The relative status of water quality (water chemistry and biology) for sites in the UCOL was determined by aggregating data from three other NAWQA study units. Data from sampling sites in the Rio Grande Valley (RIOG), the South Platte River Basin (SPLT), and the Upper Snake River Basin (USNK) NAWQA study units were used to develop a larger data set for comparison to sites in the UCOL (fig. 3). A list of sampling sites and selected site characteristics from the other three NAWQA study units used in the analysis of this report is in Appendix C.

Sampling sites in the RIOG, SPLT, and USNK were categorized on the basis of land use and stream size. Three categories of land use (forested, agriculture, and mixed) were used for comparison to the UCOL fixed sites. Data from the forested sites (sites located in the Southern, Northern, or Middle Rocky Mountain ecoregions) (Omernik, 1987) were used for comparison to forested sites in the UCOL Southern Rocky Mountain physiographic province. Forested sites are a combination of background, mining, and urban and recreation sites that may be located in any three of the Rocky Mountain ecoregions within the three study units. The number of samples used in the forested-site data set ranged from 5 (fish community) to 162 (water chemistry). Agricultural sites from the three study units, located in the plains or plateaus, were used for comparison to the UCOL agricultural land-use sites in the Colorado Plateau physiographic province. The number of samples used in the agricultural site data set ranged from 6 (habitat characterization and fish communities) to 187 (water chemistry). All mixed land-use sites from the three study units, regardless of physiographic province, were used for comparison to mixed land-use sites in the UCOL. The number of samples for the mixed land-use data set ranged from 8 (habitat characterization) to 407 (water chemistry). Further categorization of mixed land use for separate comparisons to Southern Rocky Mountains physiographic province sites and Colorado Plateau physiographic province sites is more difficult and was not done in this report. The ranges of data are specific to each land-use category. Forested and mixed land-use sites were represented from each of the study units. Agricultural sites were predominantly represented from the SPLT and USNK.

Data from the UCOL were related to the three-study-unit data set and were summarized by land use by using box plots (figs. 4, 6, 8, 10, and 12). These figures show where the UCOL data fell in relation to the larger data sets determined by aggregating data from the three other NAWQA study units. Most box plots in figures 4, 6, 8, 10, and 12 display the $10^{th}$, $25^{th}$, $50^{th}$, $75^{th}$, and $90^{th}$ percentiles for use in comparison to the UCOL data; however, some box plots display only the $25^{th}$, $50^{th}$, and $75^{th}$ percentiles where data were too limited to provide the $10^{th}$ and $90^{th}$ percentiles.

A single graphical display (figs. 5, 7, 9, 11, and 13) was used to compare and contrast sites for a particular land use. For figures 5, 7, 9, 11, and 13, each measure for the UCOL sites was ranked as to whether it is minimally affected (lower values), moderately affected (mid-range values), or significantly affected (higher values) by land use, depending on where the values fell within the larger range of data from the three other NAWQA study units. With the exception of EPT richness and the percentage of EPT, if concentrations or values were less than the $25^{th}$ percentile of the larger data set from the other three study units, then it was considered to be minimally affected (lower concentrations) by land use. If concentrations or values were between the $25^{th}$ and $75^{th}$ percentiles of the larger data set from the other three study units, then it was considered to be moderately affected (mid-range concentrations) by land use. If concentrations or values were greater than the $75^{th}$ percentile of the larger data set from the other three study units, then it was considered to be significantly affected (higher concentrations) by land use. Classification breakpoints for EPT richness and the percentage of EPT were

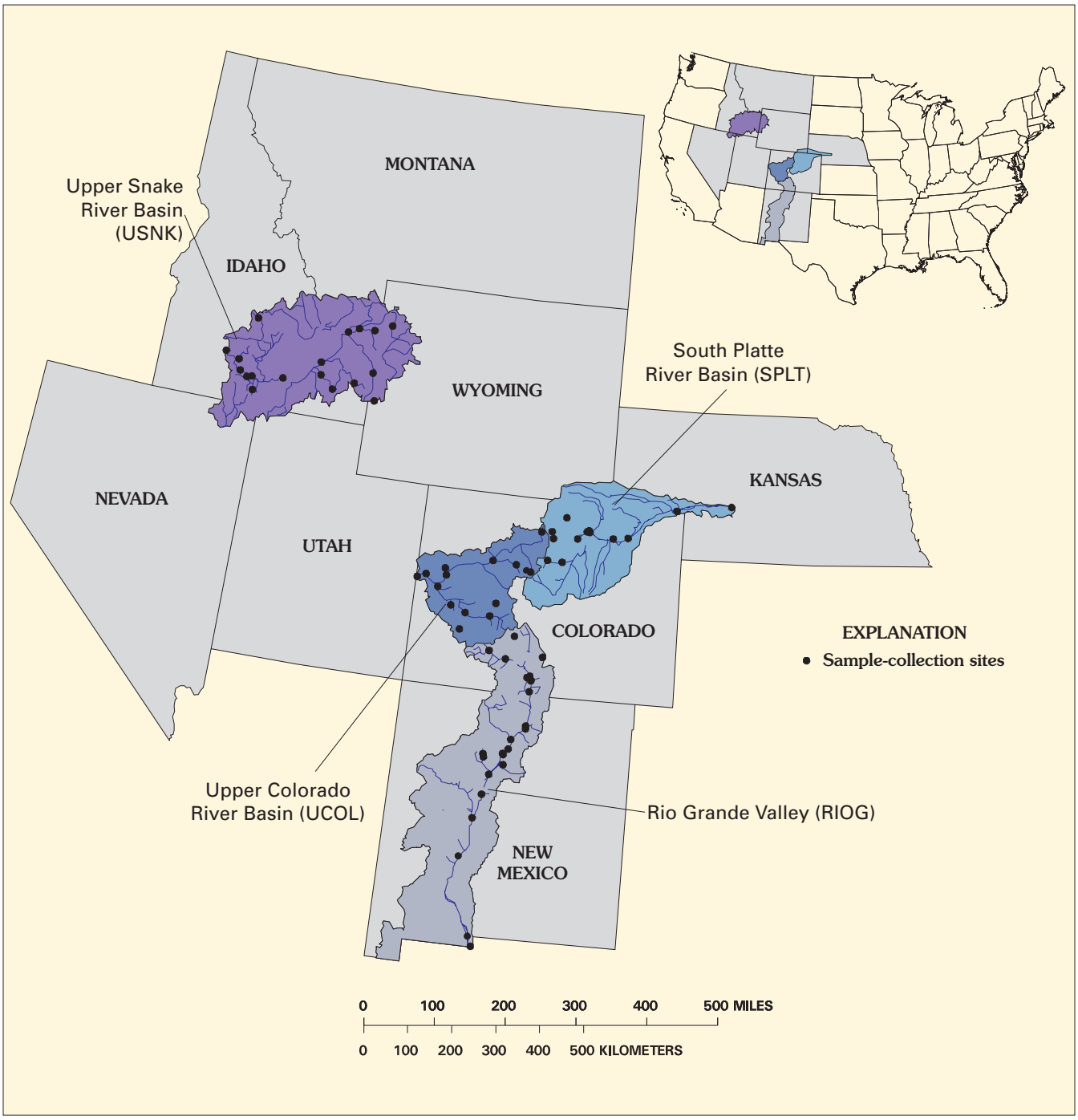


**Figure 3**. Sampling sites from the Rio Grande Valley (RIOG), the South Platte River Basin (SPLT), the Upper Snake River Basin (USNK), and the Upper Colorado River Basin (UCOL) study units.

greater than the 75th percentile for minimally affected and less than the 25th percentile for significantly affected. Specific conductance was added to these displays to incorporate issues that may be associated with salinity in parts of the basin. This graphic is meant to present a picture of the selected water-quality measures at each site. This also allows for comparison among sites within each land-use category.

## CHARACTERIZATION OF FIXED SITES

The characterizations of fixed sites in the UCOL are separated by physiographic province and land use in order to provide a better site-to-site comparison within each land-use category. Natural factors such as elevation, geology, and temperature can affect water chemistry and the biology of streams, thus making comparisons between sites in the two physiographic provinces difficult. Therefore, when making site-to-site comparisons in the UCOL, sites in the same physiographic province and land-use type were compared.

### Southern Rocky Mountains Physiographic Province Indicator Sites

Indicator sites (sites 1, 2, 3, 4, 5, and 8) in the Southern Rocky Mountains physiographic province are all located within a forested setting (fig. 1). The Colorado River below Baker Gulch (site 1) is located in Rocky Mountain National Park and was selected to represent background conditions for the Southern Rocky Mountains physiographic province indicator sites. Background sites are those that represent water-quality conditions considered to be minimally affected by land use. The watershed upstream from the site is mostly composed of forest, tundra, and meadows. The French Gulch near Breckenridge (site 2), Blue River near Breckenridge (site 3), and Uncompahgre River near Ridgway (site 8) sites were selected to represent mining land-use sites. The Blue River near Breckenridge site was sampled for biological communities because the French Gulch near Breckenridge site, directly upstream, did not have fish present. Fish were present at the Blue River near Breckenridge site. The Blue River near Breckenridge site was not part of the surface-water fixed-site network and does not have water-quality data to be used for analysis in some sections of this report. Although these sites were selected to represent mining land-use effects on water quality, the watersheds upstream from these sites are predominantly forest and tundra. Mining activities within the forested setting are present upstream from each site. Gore Creek near Minturn (site 4) and East River below Cement Creek (site 5) were selected to represent urban and recreation land-use sites. Even though these sites were selected to represent urban and recreation land-use effects on water quality, the watersheds upstream from these sites are predominantly forest and tundra. However, urban and recreation activities within the forested setting are present upstream from each site.

Figure 4 shows median and single concentrations or values for the selected water-quality measures for the UCOL Southern Rocky Mountains background site and the UCOL mining land-use sites and the range of concentrations or values (box plots) from forested sites from the RIOG, SPLT, and USNK NAWQA study units. The selected water-quality measures at the Colorado River below Baker Gulch site should represent minimally disturbed conditions in the Southern Rocky Mountains physiographic province. Median nutrient concentrations in the water column and cadmium and zinc concentrations in streambed sediment were low compared to other sites in the Southern Rocky Mountains physiographic province (table 2).

Fish and habitat indices had low degradation values. The EPT richness and the percentage of EPT were high, and the percentage of Chironomidae was low. Although the fish and habitat degradation indices are a coarse measure, and the measures for the macroinvertebrate communities are general, the values of these measures indicate minimally disturbed water-quality conditions at this site.

Nutrient concentrations at the mining land-use sites (French Gulch and Uncompahgre River) were generally low. Cadmium and zinc concentrations were much higher at the mining land-use sites when compared to concentrations at the background site. French Gulch near Breckenridge had the highest concentrations of cadmium and zinc of the mining land-use sites in the UCOL and higher than the 90th percentile of the range of data from the three other NAWQA study units. The Blue River near Breckenridge site, also a mining site, had concentrations that generally were an order of magnitude higher than concentrations at the UCOL background site. The Uncompahgre River near Ridgway site also had elevated concentrations of cadmium and zinc. All

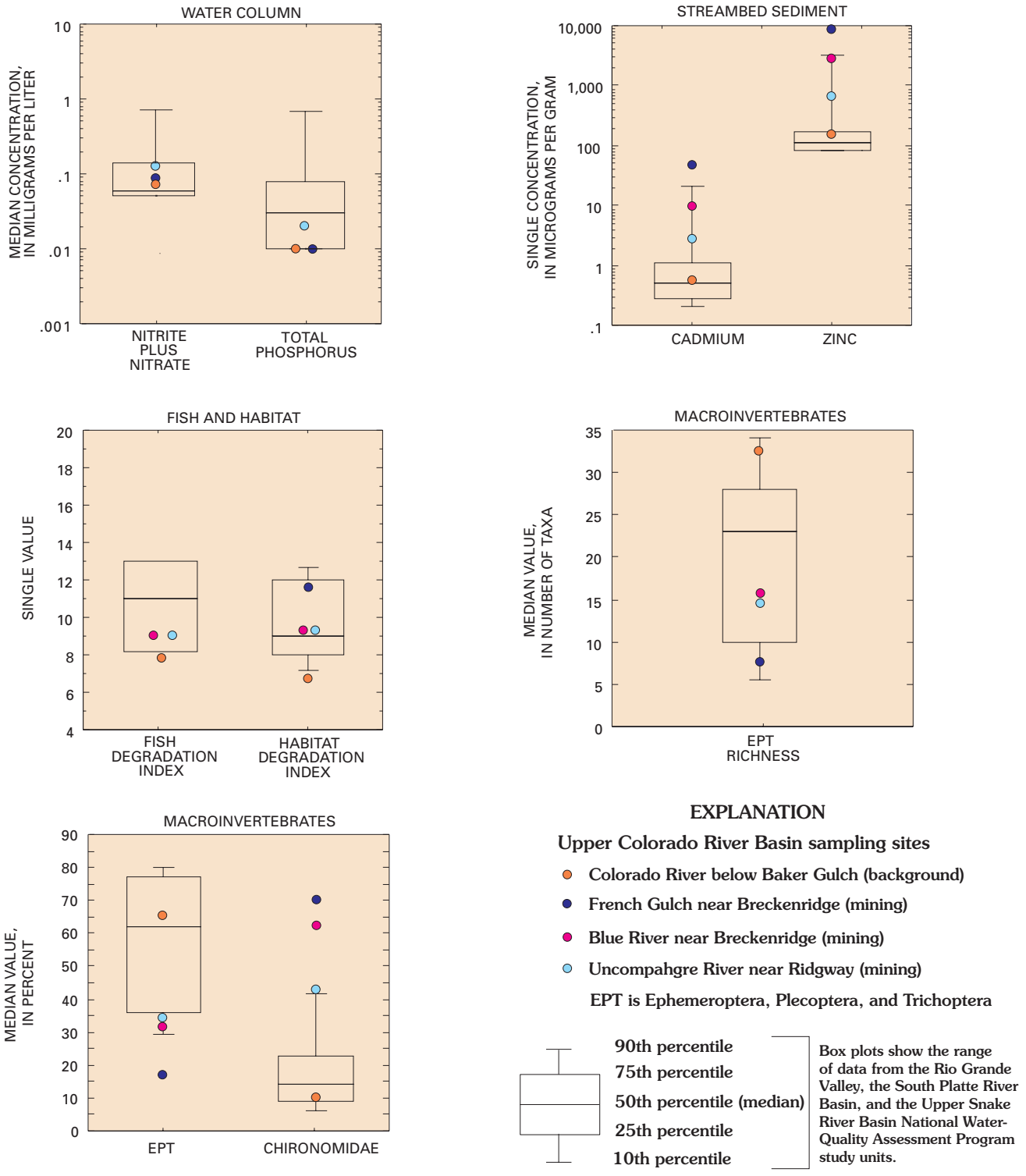


**Figure 4.** Median and single concentrations or values for selected water-quality measures for the Upper Colorado River Basin forested background and mining indicator sites in relation to the range of median and single concentrations or values for the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin study units forested indicator sites.

three sites had concentrations that were greater than the 75$^{th}$ percentile of the range of concentrations from the three other NAWQA study units.

Fish- and habitat-degradation indices were higher at the mining sites than the values from the background site, indicating that some degradation has occurred. However, when compared to the range of values from the three other NAWQA study units, these values were between the 25$^{th}$ and 75$^{th}$ percentiles, indicating that these values may be more typical of fish and habitat conditions when compared to other sites with similar characteristics. Although habitat seemed suitable, the French Gulch site did not contain fish, probably due to water-chemistry conditions.

Macroinvertebrate communities from the three mining sites also were degraded when compared to the background site. The EPT richness and the percentage of EPT were lower at the three mining sites and the percentage of Chironomidae was higher at the three mining sites than at the background site. EPT richness and the percentage of EPT for the mining sites were less than the 50$^{th}$ percentile from forested sites from the three other NAWQA study units. The percentage of Chironomidae at the mining sites was greater than the 90$^{th}$ percentile when compared to sites from the three other NAWQA study units.

Trace elements are the major water-quality issue at these sites and may be the major factor for degradation in the biological communities. The selected water-quality measures indicated that the UCOL background site is minimally disturbed, and the biological communities at the mining land-use sites may be affected by water-chemistry conditions more than habitat conditions.

Figure 5 shows a single graphical display of the site-condition rankings for the Southern Rocky Mountains physiographic province background site and the mining land-use sites. Details on how the water-quality measures were ranked are shown in table 3. Water-quality measures at the forested background site were ranked as minimally to moderately affected (fig. 5). With the exception of phosphorus at the French Gulch site, water-quality measures at mining land-use sites were ranked as moderately to significantly affected. Habitat conditions were ranked as moderately affected (based on the four criteria). Trace-element concentrations are high, and the biological community measures are low. Having moderate habitat conditions at the mining land-use sites may indicate that trace elements were the major factor affecting biological communities. Although forest is the predominant land cover in the basin, other land uses such as mining may have a larger effect on water quality than the predominant land cover.

Figure 6 shows median and single concentrations or values for the selected water-quality measures for the Colorado River below Baker Gulch background site and the urban and recreation land-use sites and the range of concentration or values (box plots) from the RIOG, SPLT, and USNK NAWQA study unit forested sites. Nutrient concentrations at the Gore Creek near Minturn site were elevated when compared to the background site. Nutrient concentrations at the East River site were similar to those of the background site. None of the samples from the Gore Creek near Minturn and the East River below Cement Creek sites had concentrations of nitrate in excess of the U.S. Environmental Protection Agency (USEPA) water-quality standard of 10 mg/L (maximum contaminant level in drinking water) (U.S. Environmental Protection Agency, 1990). The median concentration for total phosphorus at the Gore Creek near Minturn site and the East River below Cement Creek site did not exceed the desired goal for control of eutrophication of 0.1 mg/L for total phosphorus (U.S. Environmental Protection Agency, 1986).

Cadmium and zinc concentrations in streambed sediment at the East River below Cement Creek site were higher than the background site and the Gore Creek near Minturn site (fig. 6). With the exception of cadmium at the Gore Creek near Minturn site, trace-element concentrations at the urban and recreation sites were greater than the 50$^{th}$ percentile of concentrations at sites from the three other NAWQA study units.

Fish- and habitat-degradation index values indicate some degradation. Although urban and recreation sites had an abundance of fish, the percentage of anomalies and non-native fish increased and resulted in a higher value for the fish-degradation index at these sites. Although fish-degradation index values increased, the values of these sites were less than the 50$^{th}$ percentile of sites in the three other NAWQA study units. Habitat conditions were affected by channelization at the Gore Creek site and large amounts of bank erosion at the East River site. These factors resulted in a higher value for the habitat-degradation index compared to the background site. These values

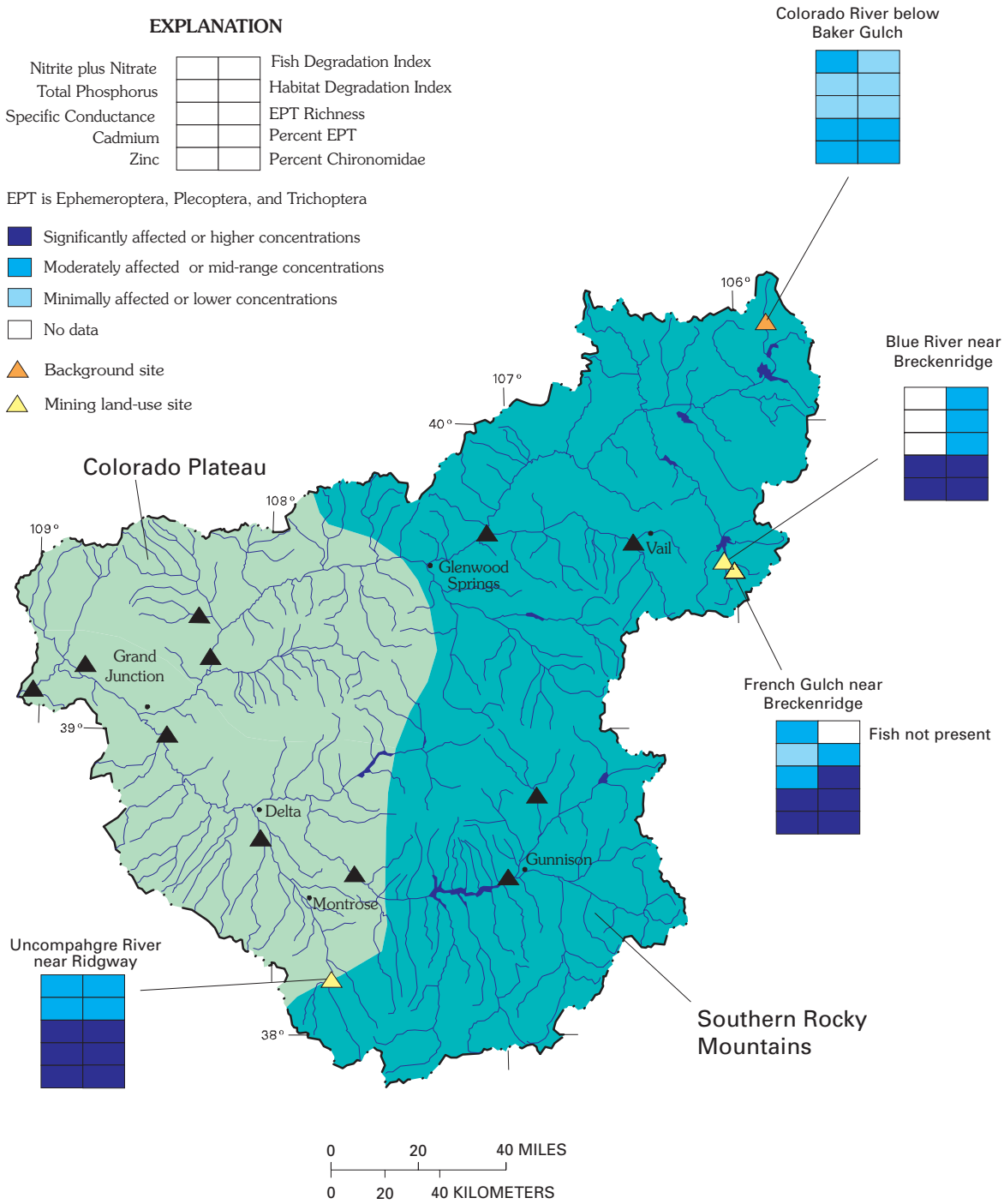


**Figure 5.** Site-condition rankings for the Southern Rocky Mountains physiographic province background and mining land-use sites in the Upper Colorado River Basin study unit.

**Table 3.** Classification rankings of water-quality measures for forested indicator sites

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/g, micrograms per gram; <, less than; >, greater than; EPT, Ephemeroptera, Plecoptera, and Trichoptera; RIOG, SPLT, and USNK are defined in fig. 3]

| Water-quality indicators | Minimally affected or lower concentrations[1] | Moderately affected or mid-range concentrations[2] | Significantly affected or higher concentrations[3] |
|---|---|---|---|
| Nitrite plus nitrate | < 0.05 mg/L | 0.05–0.14 mg/L | > 0.14 mg/L |
| Total phosphorus | < 0.01 mg/L | 0.01–0.08 mg/L | > 0.08 mg/L |
| Specific conductance (salinity) | < 116 µS/cm | 116–283 µS/cm | > 283 µS/cm |
| Cadmium (streambed sediment) | < 0.25 µg/g | 0.25–1.1 µg/g | > 1.1 µg/g |
| Zinc (streambed sediment) | < 84 µg/g | 84–165 µg/g | > 165 µg/g |
| Fish-degradation index | < 8.2 | 8.2–13 | > 13 |
| Habitat-degradation index | < 8 | 8.0–12 | > 12 |
| EPT richness[4] | > 28 | 10–28 | < 10 |
| Percent EPT[4] | > 78 | 39–78 | < 39 |
| Percent Chironomidae | < 9 | 9–3 | > 23 |

[1] Classification breakpoint is the 25th percentile of the data set from the RIOG, SPLT, and USNK study units.
[2] Classification breakpoints are between the 25th and 75th percentiles of the data set from the RIOG, SPLT, and USNK study units.
[3] Classification breakpoint is the 75th percentile of the data set from the RIOG, SPLT, and USNK study units.
[4] Classification breakpoints for this measure are greater than the 75th percentile for minimally affected, between the 25th and 75th percentiles for moderately affected, and less than the 25th percentile for significantly affected of the data set from the RIOG, SPLT, and USNK study units.

for the Gore Creek and East River sites were greater than the 50th percentile. The EPT richness and the percentage of EPT were less at urban and recreation sites than at the background site. The percentage of Chironomidae was higher at the urban and recreation sites than at the background site. Slightly greater nutrient concentrations (particularly the Gore Creek site) at the urban and recreational sites may have allowed for larger amounts of algal growth on the substrate, thus increasing instream habitat for Chironomidae and decreasing suitable habitat for EPT organisms (Hynes, 1964).

Figure 7 shows a single graphical display of the site condition rankings for the Southern Rocky Mountains physiographic province background site and the urban and recreation sites. Details on how water-quality measures were ranked are shown in table 3. Water-quality measures at the forested background site were ranked as minimally to moderately affected. With the exception of total phosphorus at the East River site, water-quality measures at the urban and recreation land-use sites were ranked as moderately to significantly affected.

More water-quality measures were ranked as significantly affected at the Gore Creek near Minturn site than at the East River below Cement Creek site. The increased urban development at the Gore Creek site (about 8 percent) compared to the East River site (about 0.6 percent) may be one factor causing the increase in significantly affected water-quality measures. Algal biomass, as determined from chlorophyll-*a* indicated that the Gore Creek near Minturn site (7.6 milligrams per square meter [mg/m$^2$]) had higher biomass values than the East River below Cement Creek site (3.2 mg/m$^2$). As shown in figure 7, nutrients were higher at the Gore Creek site than at the East River site. This may be one factor for higher biomass values at the Gore Creek site. Although the two urban and recreation sites were ranked as significantly affected in the same category for the percentage of Chironomidae, the Gore Creek near Minturn site had 58 percent Chironomidae and the East River below Cement Creek site had 25 percent Chironomidae (fig. 7). Although forest is the predominant land use at these sites, other land uses such as urban and recreation may be a factor for changes in water-quality measures at these sites compared to the background site.

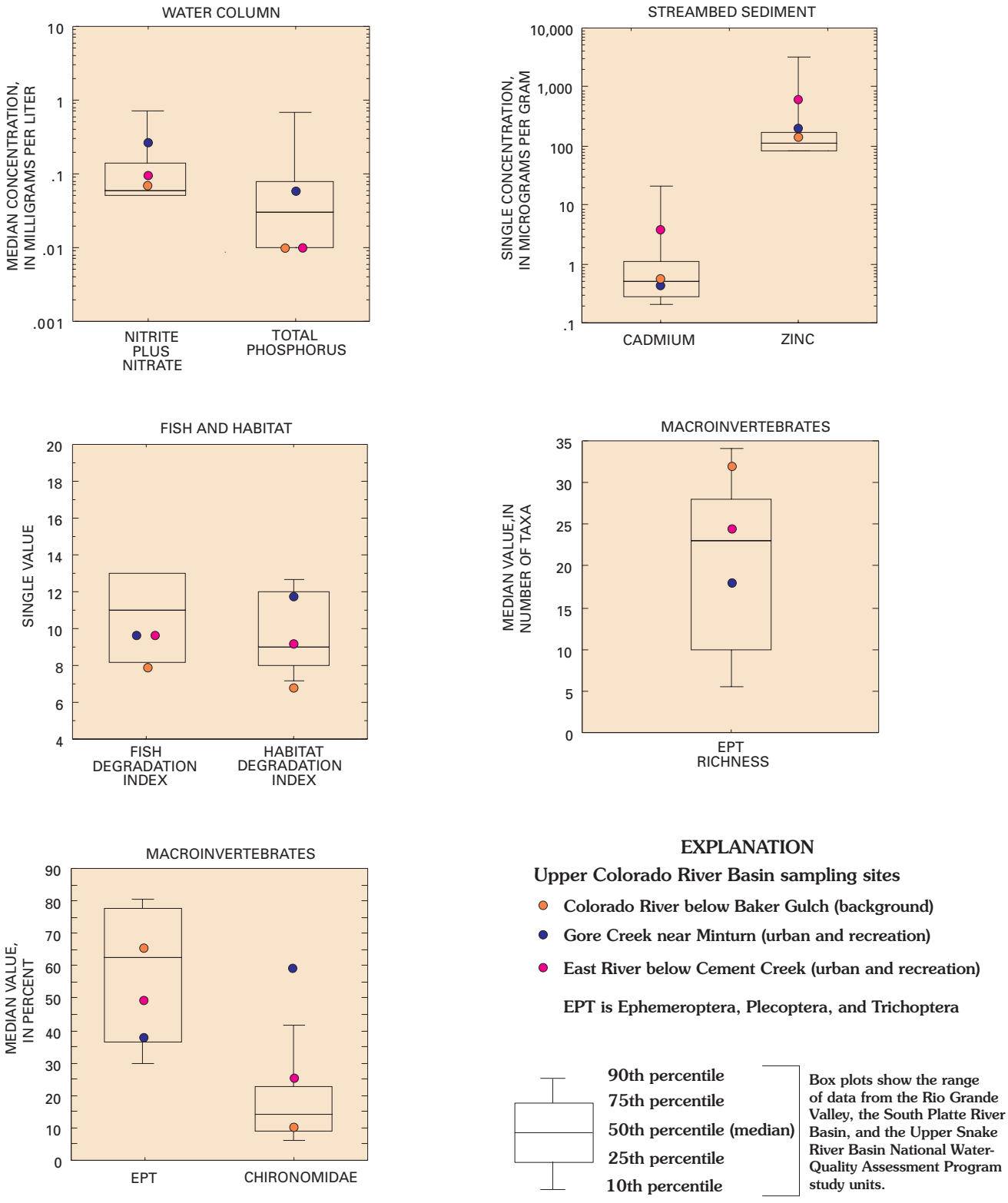


**Figure 6.** Median and single concentrations or values for selected water-quality measures for the Upper Colorado River Basin forested background and urban and recreation indicator sites in relation to the range of median and single concentrations or values for the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin study units forested indicator sites.

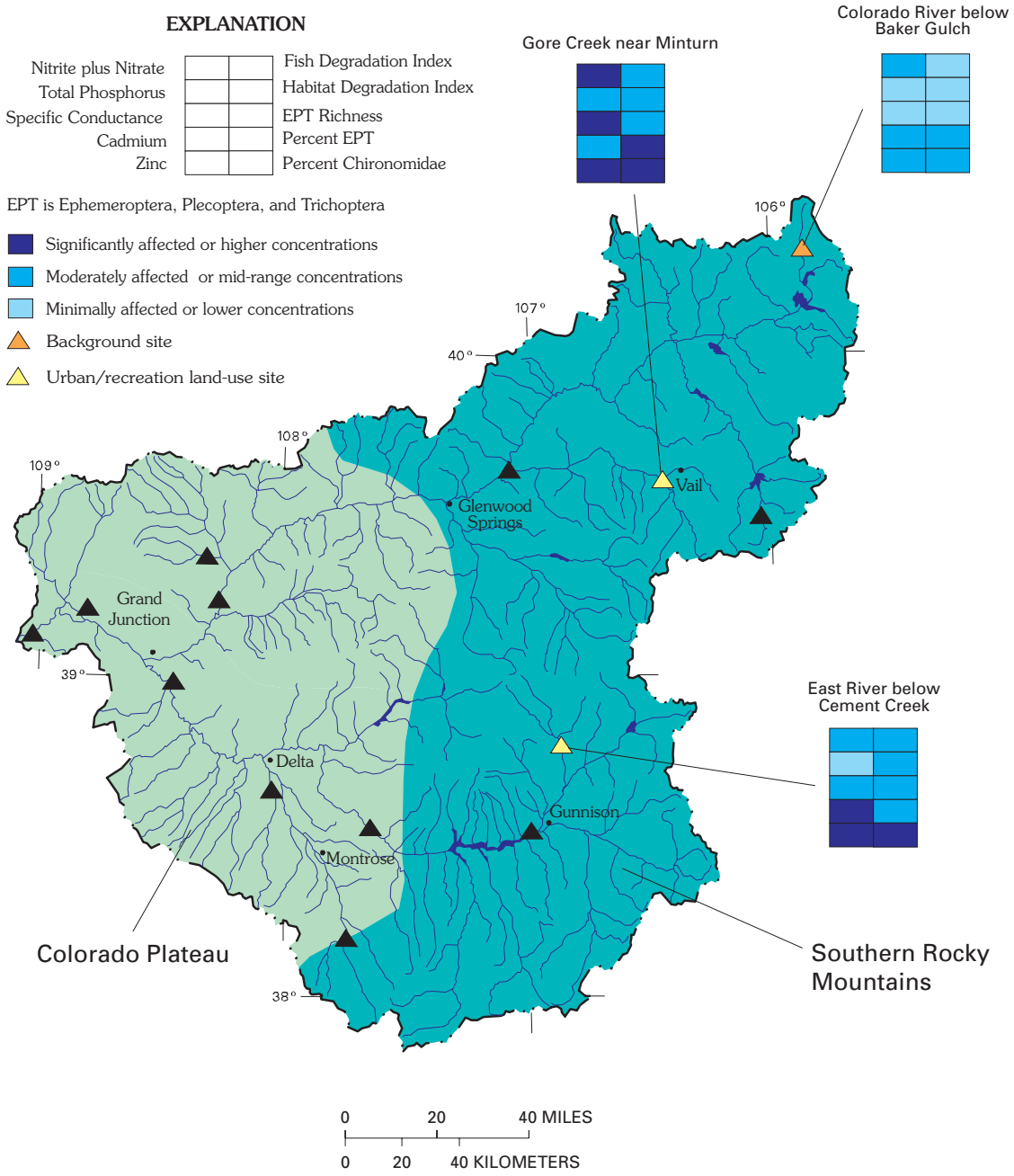


**Figure 7.** Site condition rankings for the Southern Rocky Mountains physiographic province background and urban/recreation land-use sites in the Upper Colorado River Basin study unit.

## Southern Rocky Mountains Physiographic Province Integrator Sites

Three integrator (mixed land-use) sites were selected in the Southern Rocky Mountains physiographic province. Gunnison River at County Road 32 and Gunnison River below Gunnison Tunnel (sites 6 and 7) are located on the Gunnison River, the largest tributary in the study unit, and Colorado River at Dotsero (site 9) is located on the Colorado River (fig. 1). These sites represent an integration of many factors that influence water quality.

Figure 8 shows median and single concentrations or values for selected water-quality measures for the Southern Rocky Mountains mixed land-use sites and the range of concentrations and values (box plots) from the RIOG, SPLT, and USNK NAWQA study unit integrator sites. Because of stream size, background conditions were difficult to represent at mixed land-use sites; therefore, a background site is not included in the comparison. Nutrient concentrations generally were similar among the mixed land-use sites. Nitrite plus nitrate concentrations were less than the median concentration compared to sites from the three other NAWQA study units. Total phosphorus concentrations were at or less than the $25^{th}$ percentile of concentrations from the three other NAWQA study units. None of the samples exceeded the USEPA maximum contaminant level for drinking water for nitrate or the desired goal for control of eutrophication for total phosphorus (U.S. Environmental Protection Agency, 1986; 1990). Cadmium and zinc concentrations had similar ranges among the three sites and were greater than the $75^{th}$ percentile of concentrations for all three sites compared to sites from the three other NAWQA study units.

Fish-degradation index values were very different among the mixed land-use sites. Higher values for the Colorado River near Dotsero and the Gunnison River at County Road 32 sites were due to larger abundances of omnivores and larger percentages of anomalies than at the Gunnison River below the Gunnison Tunnel site. The Gunnison River below the Gunnison Tunnel site had a lower habitat-degradation index than the other two mixed land-use sites. Habitat indices at the three mixed land-use sites were at or less than the $25^{th}$ percentile of those for other mixed land-use sites in the three other NAWQA study units. Although EPT richness was low at the Gunnison River below the Gunnison Tunnel site, that site had the largest percentage of EPT composition. Although there was not an abundance of different types of organisms present, the largest percentage of organisms that were present were generally intolerant to pollution. EPT richness was high at the other two mixed land-use sites, and the percentage of EPT was higher at the Colorado River near Dotsero site than at the Gunnison River at County Road 32 site. The percentage of Chironomidae generally was similar among all three mixed land-use sites.

Figure 9 shows a single graphical display of site-condition rankings for mixed land-use sites in the Southern Rocky Mountains physiographic province. Details on how water-quality measures were ranked are shown in table 4. Water-quality measures at mixed land-use sites ranked as minimally to significantly affected. The Gunnison River below the Gunnison Tunnel had more water-quality measures ranked as minimally affected than did the other two mixed land-use sites. All three sites had concentrations of cadmium and zinc ranked as significantly affected. The composition of the surficial geology in the Upper Colorado River Basin may cause increased cadmium and zinc concentrations. Cadmium and zinc concentrations at these sites generally were much lower than at mining land-use sites in the UCOL. However, the upper reaches of both watersheds, the Colorado River and the Gunnison River, had mining activities in the past. Specific land-use effects are not as obvious at mixed land-use sites because many cumulative natural and human effects can take place in larger stream settings.

## Colorado Plateau Physiographic Province Indicator Sites

Indicator sites (sites 10, 12, and 14) in the Colorado Plateau physiographic province are located within a rangeland and agricultural setting (fig. 1). Land use at Dry Fork at upper station near De Beque site (site 10) is predominantly forest and rangeland. The site was selected to represent minimally disturbed conditions (background conditions). The basin is 97 square miles ($mi^2$) and is composed mostly of sage and pinyon-juniper with a few agricultural areas that are typically used as hay meadows. Dry Creek near Begonia Road (site 12) and Reed Wash near Mack (site 14) were selected to represent agriculture land-use sites. Headwater areas of the Dry Creek near

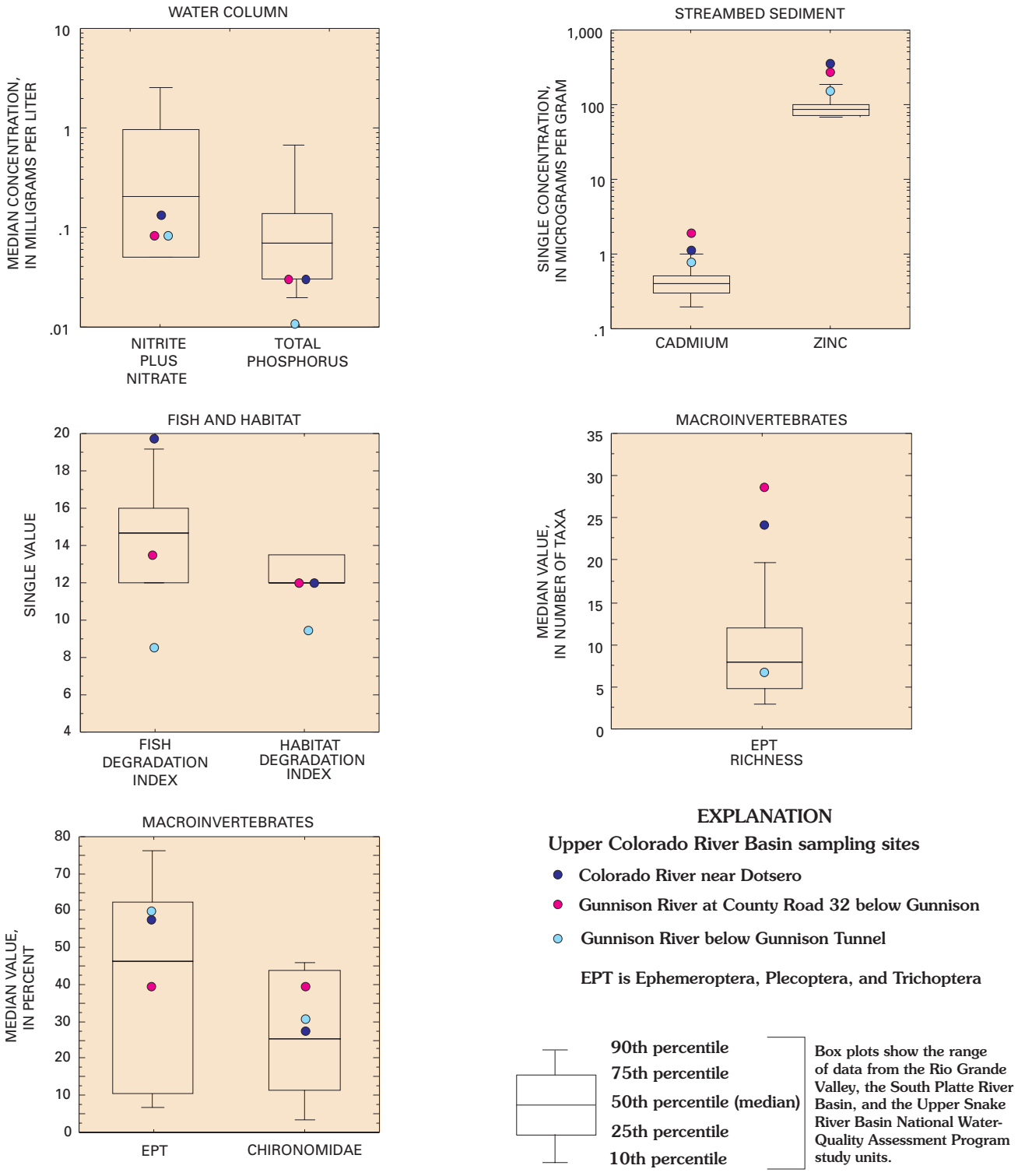


**Figure 8.** Median and single concentrations or values for selected water-quality measures for the Upper Colorado River Basin Southern Rocky Mountains physiographic province mixed land-use integrator sites in relation to range of median and single concentrations or values for the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin study units mixed land-use integrator sites.

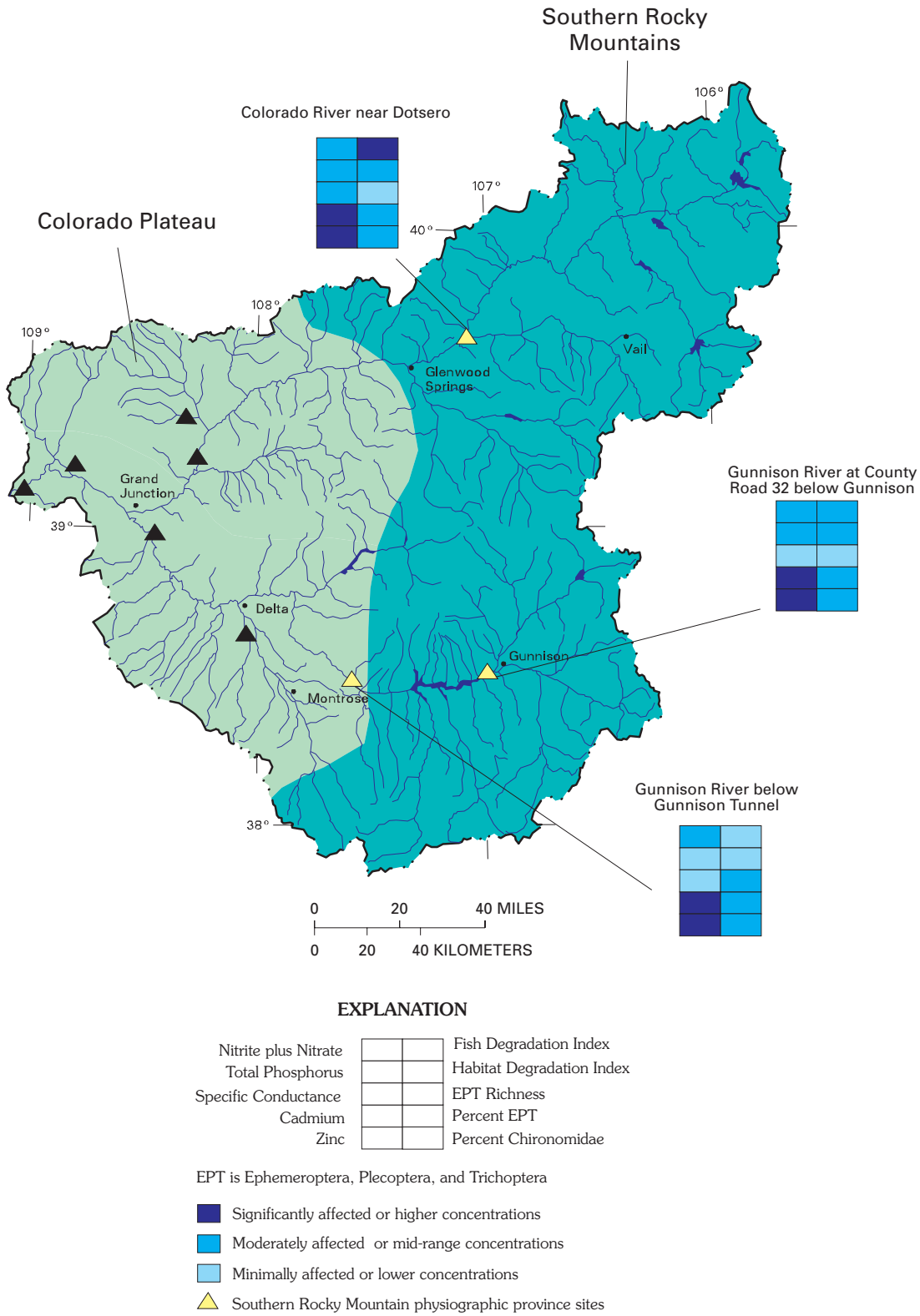


**Figure 9.** Site condition rankings for Southern Rocky Mountains physiographic province mixed land-use sites in the Upper Colorado River Basin study unit.

**Table 4.** Classification rankings of water-quality measures for mixed land-use integrator sites

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/g, micrograms per gram; µg/kg, micrograms per kilogram; <, less than; >, greater than; EPT, Ephemeroptera, Plecoptera, and Trichoptera; RIOG, SPLT, and USNK defined in fig. 3]

| Water-quality indicators | Minimally affected or lower concentrations[1] | Moderately affected or mid-range concentrations[2] | Significantly affected or higher concentrations[3] |
|---|---|---|---|
| Nitrite plus nitrate | < 0.05 mg/L | 0.05–0.97 mg/L | > 0.97 mg/L |
| Total phosphorus | < 0.03 mg/L | 0.03–0.14 mg/L | > 0.14 mg/L |
| Specific conductance (salinity) | < 273 µS/cm | 273–678 µS/cm | > 678 µS/cm |
| Cadmium (streambed sediment) | < 0.3 µg/g | 0.3–0.5 µg/g | > 0.5 µg/g |
| Selenium (streambed sediment) | < 0.4 µg/g | 0.4–1.2 µg/g | > 1.2 µg/g |
| Zinc (streambed sediment) | < 72 µg/g | 72–100 µg/g | > 100 µg/g |
| *p,p'*-DDE[4]/lipid content (fish tissue) | < 770 µg/kg lipid | 770–3,700 µg/kg lipid | > 3,700 µg/kg lipid |
| Fish-degradation index | < 12 | 12–16 | > 16 |
| Habitat-degradation index | < 11.97 | 11.97–13.5 | > 13.5 |
| EPT richness[5] | > 11 | 5–11 | < 5 |
| Percent EPT[5] | > 62 | 10–62 | < 10 |
| Percent Chironomidae | < 11 | 11–43 | > 43 |

1Classification breakpoint is the 25th percentile of the data set from the RIOG, SPLT, and USNK study units.

[2] Classification breakpoints are between the 25th and 75th percentiles of the data set from the RIOG, SPLT, and USNK study units.

[3] Classification breakpoint is the 75th percentile of the data set from the RIOG, SPLT, and USNK study units.

[4] Results for this measure are reported as wet weight concentration divided by lipid content.

[5] Classification breakpoints for this measure are greater than the 75th percentile for minimally affected, between the 25th and 75th percentiles for moderately affected, and less than the 25th percentile for significantly affected of the data set from the RIOG, SPLT, and USNK study units.

Begonia Road site are composed of forest and rangeland with intensive agriculture along the lower stream reaches of the basin. The Reed Wash near Mack basin, which is small (16 $mi^2$), is intensively farmed and ranched. Water is transported into and out of these sites through irrigation canals and ditches for agricultural purposes.

Figure 10 shows median and single concentrations or values for selected water-quality measures for the UCOL Colorado Plateau background site and the UCOL agriculture land-use sites and the range of concentrations and values (box plots) from agricultural sites from the RIOG, SPLT, and USNK NAWQA study units. The selected water-quality measures at the Dry Fork at upper station near De Beque site should represent minimally disturbed conditions for small streams in the Colorado Plateau physiographic province. The selected water-quality measures from this site were compared to the agricultural data because rangeland data were limited among the three other NAWQA study units. Nitrite plus nitrate concentrations were less than the 25th percentile, and total phosphorus concentrations were less than the 50th percentile at the Dry Fork at upper station near De Beque. Selenium concentration was at the 25th percentile of concentrations from agricultural data from the three other NAWQA study units. The Dry Fork at upper station near De Beque site does not have a value for *p,p'*-DDE in fish tissue or a fish-degradation index value because this site did not contain fish. Because of small stream size and some periods of intermittent streamflow, habitat conditions may be the major factor for the absence of fish at this site. EPT richness was low, but the percentage of EPT was relatively high, near the 75th percentile in the range of data from the three other NAWQA study units. The low value for EPT richness may be baseline for the Colorado Plateau physiographic province. The percentage of Chironomidae was higher than the median value from agricultural data from the three other NAWQA study units.

Nutrient concentrations at the two agricultural land-use sites were higher than at the background site. The Dry Creek near Begonia Road site had higher nitrite plus nitrate concentrations than the Reed Wash near Mack site and was greater than the 75th percentile of concentrations from the range of data from other agricultural sites. None of the samples exceeded the

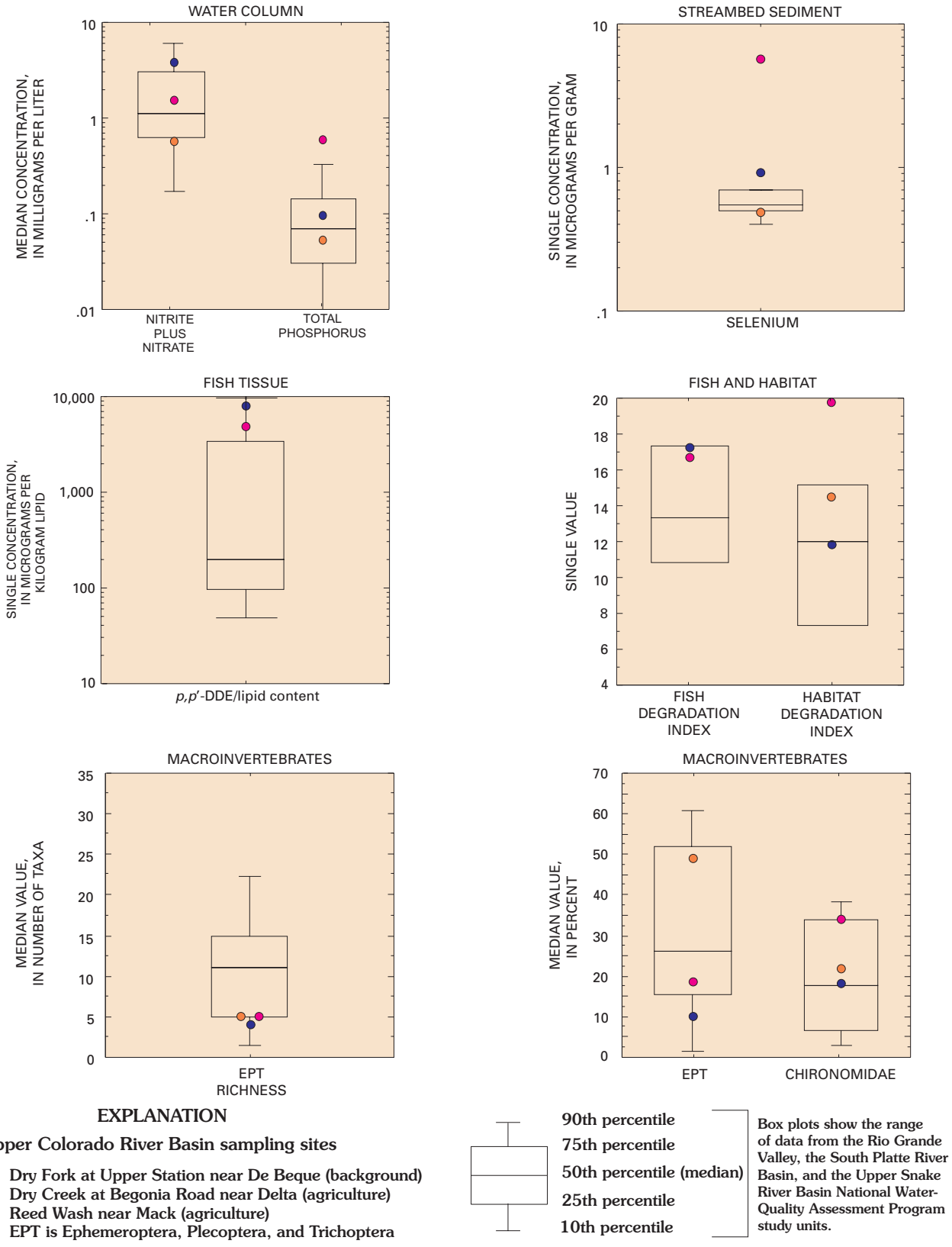


**Figure 10.** Median and single concentrations or values for selected water-quality measures for the Upper Colorado River Basin background and agricultural indicator sites in relation to the range of median and single concentrations or values for the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin study units agricultural indicator sites.

USEPA maximum contaminant level for drinking water for nitrate (U.S. Environmental Protection Agency, 1986). The Reed Wash near Mack site had higher total phosphorus concentrations than the Dry Creek near Begonia Road site and was greater than the 90$^{th}$ percentile of concentrations from the range of data from other agricultural sites. Median total phosphorus concentration at the Dry Creek site (0.1 mg/L) was at the USEPA desired goal for control of eutrophication of 0.1 mg/L. Median total phosphorus concentration at the Reed Wash site (0.6 mg/L) exceeded the USEPA desired goal for control of eutrophication (U.S. Environmental Protection Agency, 1986).

Selenium concentrations at the two agricultural sites were higher than at the background site and were higher than the 75$^{th}$ percentile of concentrations from the range of data from the three other NAWQA study units. Although both sites had higher concentrations of selenium than the background site and from other agricultural sites, the Reed Wash near Mack site had a much larger concentration than the Dry Creek near Begonia Road site. A higher concentration of selenium at the Reed Wash near Mack site may be influenced by geology (Mancos Shale of Cretaceous age) and the irrigation return flows interacting with ground water (Butler and others, 1996). Selenium concentration at the Reed Wash site (5.6 µg/g) exceeded the high hazard level of 4 µg/g for the protocol for aquatic hazard assessment of selenium (Lemly, 1995). The *p,p'*-DDE concentration in fish tissue was higher at the Dry Creek near Begonia Road site (700 µg/kg in white sucker) than at the Reed Wash near Mack site (290 µg/kg in flannelmouth sucker). Both samples (normalized for lipid content) from the agricultural sites were greater than the 75$^{th}$ percentile of concentrations from the range of normalized data based on lipid content from the three other NAWQA study unit agricultural sites (fig. 10). The values in figure 10 are reported as wet weight concentration normalized by dividing by lipid content. This normalization decreases the bias that might result from comparing different species in the fish-tissue data set.

Both sites had similar fish-community-degradation index values and were near the 75$^{th}$ percentile of concentrations from the range of data from agricultural sites in the three other NAWQA study units. The habitat at the Dry Creek near Begonia Road site had a lower degradation index value than at the background site and the Reed Wash near Mack site. Compared to the larger range of data from other agricultural sites, the habitat-degradation index value for the Dry Creek near Begonia Road site was closer to the median value than the background site and the Reed Wash near Mack site. The habitat-degradation index value for the Reed Wash near Mack site was higher than the 75$^{th}$ percentile, meaning that habitat conditions at this site were degraded compared to agricultural sites from the three other NAWQA study units. EPT richness was low at both agricultural sites; however, these values were similar to those at the background site. The percentage of EPT decreased at the agricultural sites compared to the background site. The percentage of Chironomidae was higher at the Reed Wash near Mack site than at the Dry Creek near Begonia Road site. Although not selected for comparison among sites, the mean percentage of non-insects accounted for the majority of the macroinvertebrate community at the Dry Creek near Begonia Road site (70 percent) and some portion of the macroinvertebrate community at the Reed Wash near Mack site (15 percent). Non-insects are generally perceived as tolerant to a wide range of environmental conditions and can increase with increased disturbance in habitat or degradation in water quality (Barbour and others, 1997).

Figure 11 shows a single graphical display of site-condition rankings for the Colorado Plateau physiographic province background site and the two agricultural land-use sites. Details on how water-quality measures were ranked are shown in table 5. Selected water-quality measures at these sites were ranked as moderately to significantly affected; however, the two agricultural land-use sites had more water-quality measures ranked as significantly affected than did the background site. The specific conductance was high at the background site, probably due to natural conditions such as the sedimentary geology in the basin. The significantly affected rankings of phosphorus at the Reed Wash near Mack site and nitrite plus nitrate at the Dry Creek at Begonia Road site, selenium and *p,p'*-DDE at both sites, habitat and the percentage of Chironomidae at the Reed Wash near Mack site, and EPT richness and the percentage of EPT at the Dry Creek at Begonia Road site provide multiple lines of evidence that land use may be affecting water quality at the two agricultural sites.

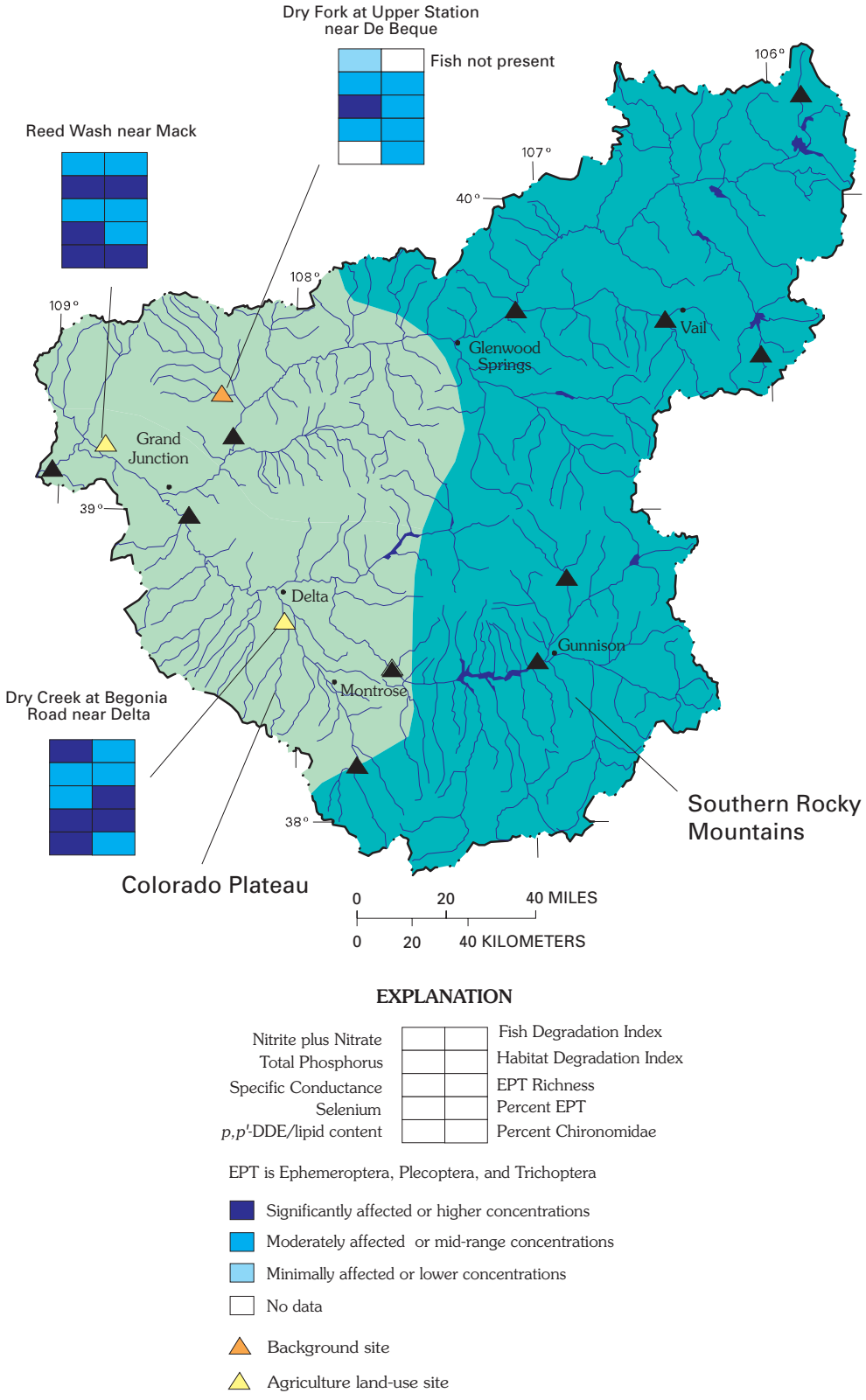


**Figure 11.** Site-condition rankings for the Colorado Plateau physiographic province background and agricultural land-use sites in the Upper Colorado River Basin study unit.

**Table 5.** Classification rankings of water-quality measures for agricultural indicator sites

[mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/g, micrograms per gram; µg/kg, micrograms per kilogram; <, less than; >, greater than; EPT, Ephemeroptera, Plecoptera, and Trichoptera; RIOG, SPLT, and USNK are defined in fig. 3]

| Water-quality measures | Minimally affected or lower concentrations[1] | Moderately affected or mid-range concentrations[2] | Significantly affected or higher concentrations[3] |
|---|---|---|---|
| Nitrite plus nitrate | < 0.62 mg/L | 0.62–3 mg/L | > 3 mg/L |
| Total phosphorus | < 0.03 mg/L | 0.03–0.15 mg/L | > 0.15 mg/L |
| Specific conductance (salinity) | < 440 µS/cm | 440–1,510 µS/cm | > 1,510 µS/cm |
| Selenium (streambed sediment) | < 0.5 µg/g | 0.5–0.7 µg/g | > 0.7 µg/g |
| *p,p'*-DDE[4]/lipid content (fish tissue) | < 92 µg/kg lipid | 92–3,260 µg/kg lipid | > 3,260 µg/kg lipid |
| Fish-degradation index | < 10.8 | 10.8–17.4 | > 17.4 |
| Habitat-degradation index | < 7.3 | 7.3–15.2 | > 15.2 |
| EPT richness[5] | > 15 | 5–15 | < 5 |
| Percent EPT[5] | > 52 | 15–52 | < 15 |
| Percent Chironomidae | < 7 | 7–34 | > 34 |

[1] Classification breakpoint is the 25th percentile of the data set from the RIOG, SPLT, and USNK study units.
[2] Classification breakpoints are between the 25th and 75th percentiles of the data set from the RIOG, SPLT, and USNK study units.
[3] Classification breakpoint is the 75th percentile of the data set from the RIOG, SPLT, and USNK study units.
[4] Results for this measure are reported as wet weight concentration divided by lipid content.
[5] Classification breakpoints for this measure are greater than the 75th percentile for minimally affected, between the 25th and 75th percentiles for moderately affected, and less than the 25th percentile for significantly affected of the data set from the RIOG, SPLT, and USNK study units.

## Colorado Plateau Physiographic Province Integrator Sites

Three integrator sites were selected in the Colorado Plateau physiographic province. Colorado River near Cameo (site 11) and Colorado River near Colorado-Utah State line (site 15) were located on the Colorado River. Gunnison River near Grand Junction (site 13) was located on the Gunnison River near the outlet to the Colorado River (fig. 1). These sites represent an integration of many factors that influence water quality.

Figure 12 shows median or single concentrations or values for the selected water-quality measures for the Colorado Plateau physiographic province mixed land-use sites and the range of values (box plots) from mixed land-use sites from the RIOG, SPLT, and USNK NAWQA study unit integrator sites. Due to stream size, background conditions are difficult to represent at mixed land-use sites; therefore, a background site is not included in the comparison. Median nutrient concentrations were lowest at the Colorado River near Cameo site and were similar among the Gunnison River near Grand Junction and Colorado River near Colorado-Utah State line sites. The median concentration of total phosphorus at the Colorado River near Colorado-Utah State line site (0.1 mg/L) was at the USEPA desired goal for control of eutrophication of 0.1mg/L. The concentration of total phosphorus at the Gunnison River near Grand Junction site (0.08 mg/L) was slightly below the USEPA desired goal for control of eutrophication. The Gunnison River near Grand Junction site and the Colorado River near Colorado-Utah State line site are downstream from urban and agricultural activities. This may be one factor for increased nutrient concentrations compared to the Colorado River near Cameo site, which is upstream from most urban and agricultural activity in the Colorado Plateau physiographic province. Median nutrient concentrations for the three UCOL mixed land-use sites were between the 25th and 75th percentiles of concentrations from the range of data from the other three NAWQA study units. Selenium concentration was lowest at the Colorado River near Cameo site compared to the other two UCOL sites. The selenium concentration at the Colorado River near Cameo site was at the 50th percentile compared to other mixed land-use sites in the three other NAWQA study units. Selenium concentrations were highest at the Gunnison River near Grand Junc-

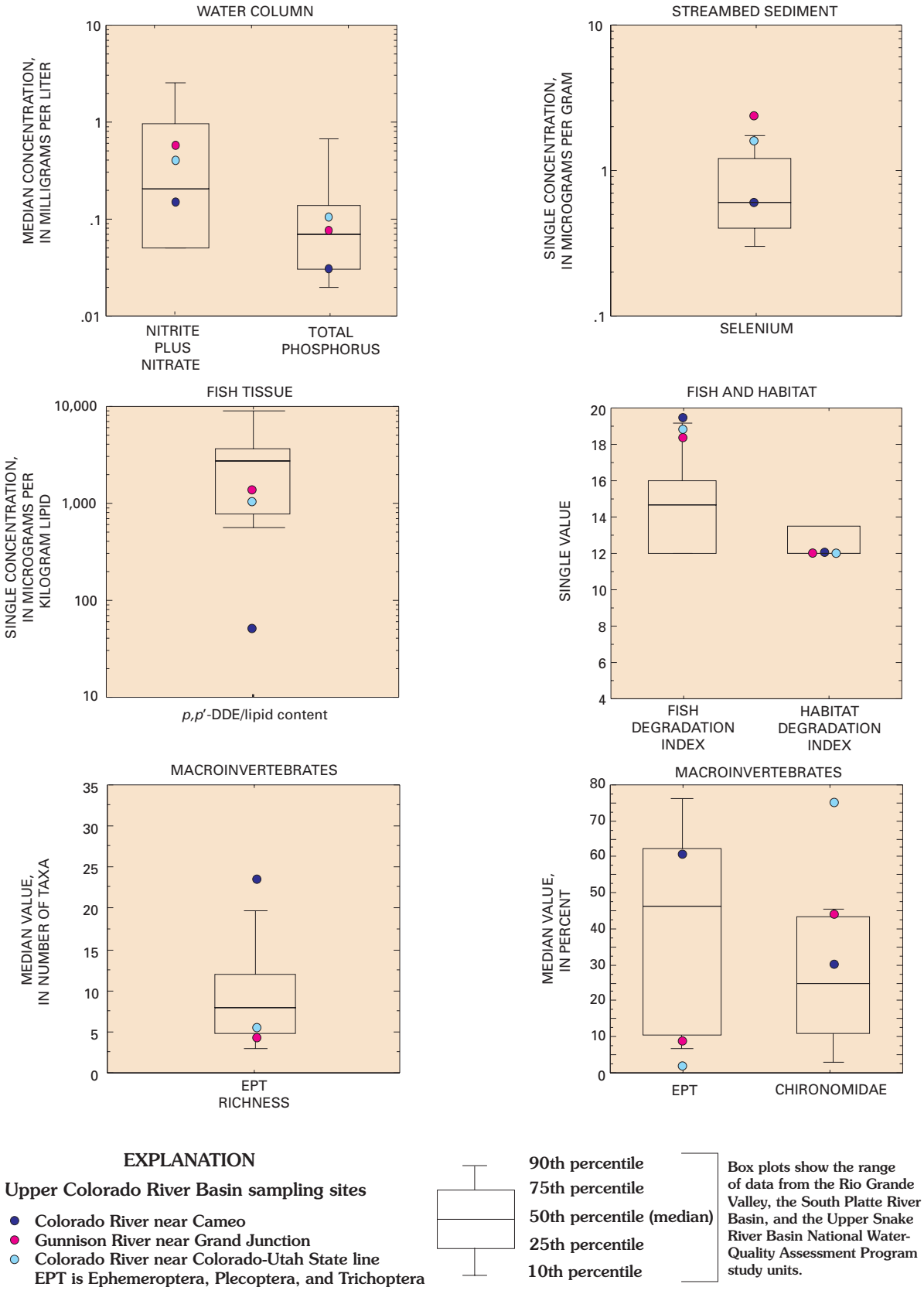


**Figure 12.** Median and single concentrations or values for selected water-quality measures for the Upper Colorado River Basin Colorado Plateau physiographic province mixed land-use integrator sites in relation to the range of median and single concentrations or values for the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin mixed land-use integrator sites.

tion site. The Gunnison River near Grand Junction site and the Colorado River near the Colorado-Utah State line site had concentrations greater than the 75$^{th}$ percentile compared to the three other NAWQA study units. The Mancos Shale of Cretaceous age in this area of the study unit (Butler and others, 1996) and irrigation practices remobilizing selenium are probably the largest factors for increased selenium concentrations at these sites. No concentration exceeded the high hazard level for the protocol for aquatic hazard assessment of selenium (Lemly, 1995). *p,p'*-DDE concentration in fish tissue was lowest at the Colorado River near Cameo site (5.5 µg/kg in bluehead sucker) and had similar values at the Gunnison River near Grand Junction site (130 µg/kg in bluehead sucker) and the Colorado River near Utah-State line site (190 µg/kg in bluehead sucker). All three samples (normalized for lipid content) from the mixed land-use sites were less than the 50$^{th}$ percentile compared to the range of normalized data based on lipid content from the three other NAWQA study units. The values in figure 12 are reported as wet weight concentration normalized by dividing by lipid content. This normalization decreases the bias that might result from comparing different species in the fish-tissue data set.

Fish- and habitat-degradation index values were similar among the three mixed land-use sites. Fish-degradation values were high (near and greater than the 90$^{th}$ percentile) compared to values from the three other NAWQA study units. High degradation values at these sites were affected by anomalies, the large percentage of omnivores, and the non-native species. Habitat degradation values were at the 25$^{th}$ percentile of values from the three other NAWQA study units. EPT richness and the percentage of EPT were highest and inversely the percentage of Chironomidae was lowest at the Colorado River near Cameo site. EPT richness at the Colorado River near Cameo site was greater than the 90$^{th}$ percentile of values from sites in the three other NAWQA study units. EPT richness and the percentage of EPT were similar among the Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites. EPT richness and percentage of EPT at these sites were near and less than the 25$^{th}$ percentile of values from the three other study units. The percentage of Chironomidae was near the 75$^{th}$ percentile for the Gunnison River near Grand Junction and greater than the 90$^{th}$ percentile for the Colorado River near Colorado-Utah State line. The Colorado River near Cameo site had the lowest nutrient, selenium, and pesticide concentrations and had similar fish- and habitat-degradation values compared to the other two mixed land-use sites. The macroinvertebrate measures at the Colorado River near Cameo site indicated suitable water-quality conditions. Because of similar instream habitat conditions among the three sites, the decrease in EPT richness and percentage of EPT and the increase in Chironomidae at the Gunnison River near Grand Junction site and the Colorado River near Colorado-Utah State line sites indicate that water-chemistry conditions may be the largest factor for degraded macroinvertebrate communities at these two sites.

Figure 13 shows a single graphical display of the site-condition rankings for mixed land-use sites in the Colorado Plateau physiographic province. Details on how water-quality measures were ranked for mixed land-use sites are shown in table 4. Water-quality measures at the Colorado River near Cameo site were ranked as minimally to significantly affected. Water-quality measures at the Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites were ranked as moderately to significantly affected. Nutrient concentrations were similar among the three sites. Specific conductance, used as a measure of salinity, was higher at the Colorado River sites than at the Gunnison River site. Selenium concentration was lower at the Colorado River near Cameo site compared to the two other UCOL mixed land-use sites and the range of data from the three other NAWQA study units. Fish- and habitat-degradation index values were similar, and the macroinvertebrate measures were less affected at the Colorado River near Cameo site than at the two other mixed land-use sites. The use of more than one sampling medium indicates that the Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites may be more affected by the cumulative effects of more than one land use than the Colorado River near Cameo site. Although mixed land-use sites are more difficult to relate to a specific land-use effect, all of the information from different sampling media combined helps to provide a more complete assessment of water quality.

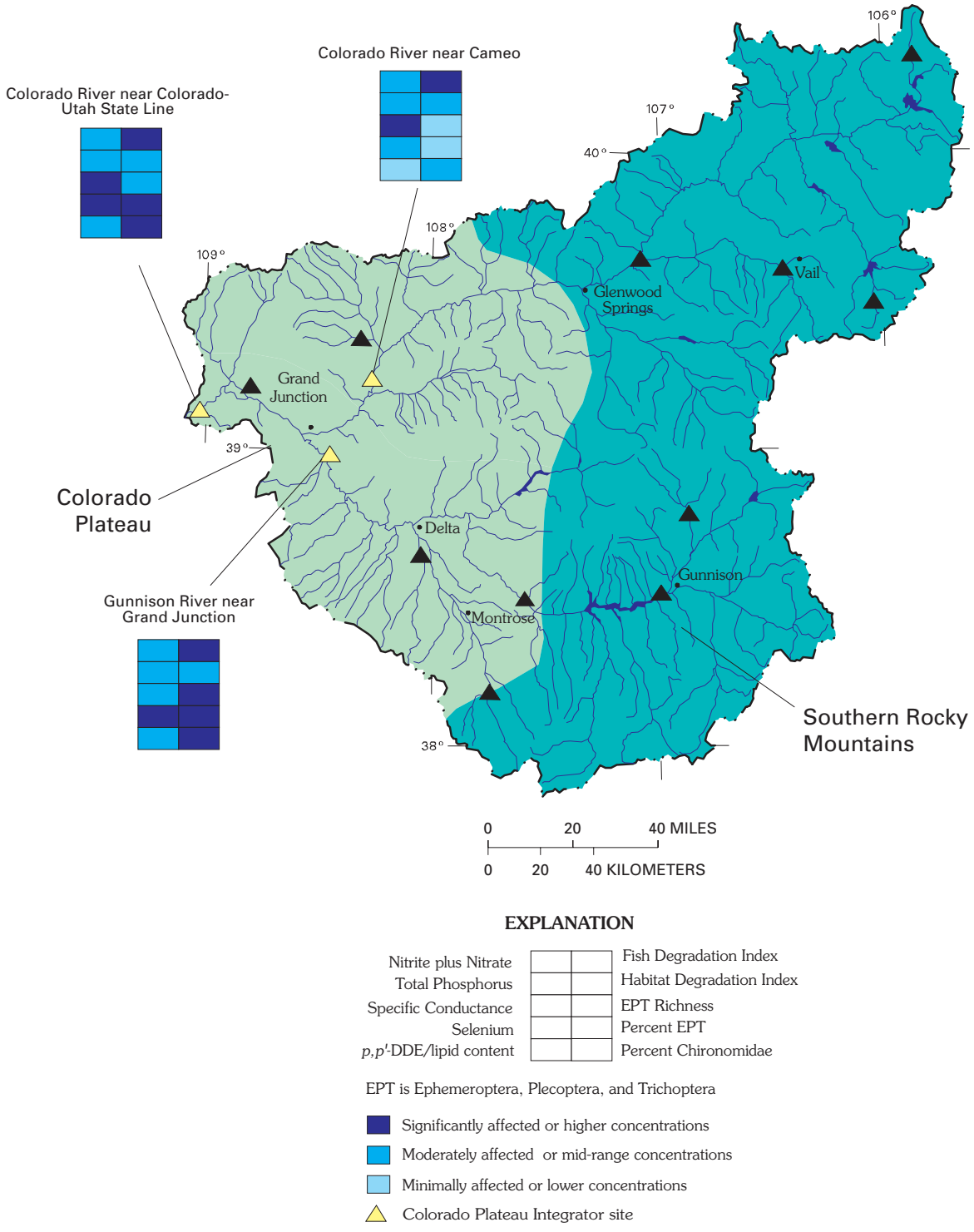


**Figure 13.** Site-condition rankings for the Colorado Plateau physiographic province mixed land-use sites in the Upper Colorado River Basin study unit.

## SUMMARY

The National Water-Quality Assessment (NAWQA) Program is a long-term program of the U.S. Geological Survey designed to describe the status and trends in the quality of the Nation's surface- and ground-water resources and to provide an understanding of the natural and human factors that can affect the quality of these resources (Leahy and others, 1990). The program is interdisciplinary and integrates chemical, physical, and biological data to assess the Nation's water quality at local, regional, and national levels.

The Upper Colorado River Basin (UCOL) was selected for the national water-quality assessment. One component of the program is to characterize biological communities and their relation to water chemistry and stream habitat at fixed sites in the Upper Colorado River Basin (UCOL). Biological assessments were conducted at 15 sites during low-flow conditions in August of 1996 and 1997. A subset consisting of 10 of the 15 sites was sampled during low-flow conditions in August 1998. Qualitative and quantitative habitat measures also were documented during the 3-year period. Sites sampled represented agriculture, mining, urban and recreation, and mixed land uses and background conditions.

Mining, urban and recreation, and mixed land-use sites were located in the Southern Rocky Mountains physiographic province. Agriculture and mixed land-use sites were located in the Colorado Plateau physiographic province. The environmental settings of the two physiographic provinces are characterized by differences in elevation, drainage area, stream gradient, temperature, specific conductance, concentrations of dissolved solids and suspended sediment, fish and macroinvertebrate communities, and other factors. With the exception of selenium, trace elements generally are more of a water-quality concern in the Southern Rocky Mountains physiographic province due to the crystalline bedrock geology, which favors mining activity. Selenium is a trace element of concern in the Colorado Plateau physiographic province mainly due to the sedimentary geology of the area (especially the Mancos Shale of Cretaceous age). Pesticides generally are more of a water-quality concern in the Colorado Plateau physiographic province where agricultural activities are more common. Although physiographic provinces, geology, and land use were the environmental factors used in the selection of sites for the Upper Colorado River Basin, other factors, such as physical habitat and hydrologic conditions, are important components of the environmental setting that affect water chemistry and biology.

The relative status of water quality (water chemistry and biology) for sites in the UCOL was determined by aggregating data from three other NAWQA study units. Data from sampling sites in the Rio Grande Valley, the South Platte River Basin, and the Upper Snake River Basin NAWQA study units were used to develop a larger data set for comparison to sites in the UCOL.

In the Southern Rocky Mountains physiographic province, nutrient concentrations in the water column at mining land-use sites generally were low and similar to those at the background site. Cadmium and zinc concentrations in streambed sediment generally were orders of magnitude higher at mining land-use sites than at the background site and were greater than the 75$^{th}$ percentile of concentrations at sites from the three other NAWQA study units. Fish were not present at the French Gulch near Breckenridge site; other mining land-use sites had low fish-degradation index values. Habitat conditions at mining land-use sites were slightly degraded compared to the background site. Measures of the macroinvertebrate community indicated that it was degraded compared to the background site and sites from the three other NAWQA study units. The selected water-quality measures indicated that the UCOL background site is minimally disturbed and that biological communities at mining land-use sites may be affected by water-chemistry conditions.

Nutrient concentrations in the water column at the Gore Creek near Minturn (urban and recreation) site were higher than those at the background site. Nutrient concentrations at the East River below Cement Creek (urban and recreation) site were similar to those at the background site. Cadmium and zinc concentrations in streambed sediment were highest at the East River below Cement Creek site, probably because of past mining activities in the upper reaches of the watershed. Although urban and recreation sites had an abundance of fish, the percentage of non-native fish and anomalies in fish were greater than at the background site. Habitat conditions are affected by channelization at the Gore Creek site and large amounts of bank erosion at the East River below Cement Creek site. EPT richness and the percentage of EPT were lower, and the percentage of Chirono-

midae was higher at urban and recreation sites than at the background site. The slightly increased nutrient concentrations at the urban sites may have allowed for larger amounts of algal growth on the substrate, thus increasing instream habitat for Chironomidae and decreasing suitable habitat for EPT organisms.

Nutrient concentrations in the water column generally were similar among the three Southern Rocky Mountains physiographic province mixed land-use sites. Cadmium and zinc concentrations in streambed sediment were similar in range at the sites. Fish-degradation index values were very different among the sites. Higher values associated with the fish community at the Colorado River near Dotsero and the Gunnison River at County Road 32 sites are due to larger abundances of omnivores and larger percentages of anomalies in fish. Although EPT richness was low at the Gunnison River below the Gunnison Tunnel site, that site had the largest percentage of EPT composition among the three sites. The percentage of Chironomidae was generally similar among the sites. Specific land-use effects are not as obvious at mixed land-use sites because of the many cumulative natural and human effects that occur in larger stream settings.

Nutrient concentrations in the water column and selenium concentrations in streambed sediment at the Colorado Plateau physiographic province background site were less than those at agricultural land-use sites. EPT richness was low at the agricultural and background sites, but the percentage of EPT at the background site was relatively high. Nutrient concentrations in the water column and selenium concentrations in streambed sediment were elevated at the two agricultural land-use sites. Although both agricultural land-use sites had higher selenium concentrations than the background site, the Reed Wash near Mack site had a much higher selenium concentration than the Dry Creek near Begonia Road site. Higher concentrations of selenium at the Reed Wash near Mack site may be influenced by the surficial geology (Mancos Shale of Cretaceous age) and the irrigation return flows interacting with ground water. *p,p'*-DDE concentrations in fish tissue were higher at the Dry Creek near Begonia Road site than at the Reed Wash near Mack site, but both were greater than the 75$^{th}$ percentile of concentrations from agricultural sites from the three other NAWQA study units. The Dry Creek near Begonia Road site had a lower habitat-degradation index value than the background site or the Reed Wash near Mack site. Habitat-degradation index value for the Reed Wash near Mack site was higher than the 75$^{th}$ percentile of values from the other NAWQA study units, meaning that habitat conditions at that site were significantly degraded. Both agricultural sites had similar fish-degradation index values. EPT richness was low at both agricultural sites; however, these values were similar to those at the background site. The percentage of EPT was lower at agricultural sites than at the background site.

Among the mixed land-use sites in the Colorado Plateau physiographic province, nutrient concentrations in the water column were lowest at the Colorado River near Cameo site and were similar at the Gunnison River near Grand Junction site and Colorado River near Colorado-Utah State line site. The Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites are downstream from urban and agricultural areas, which might account for increased nutrient concentrations compared to the Colorado River near Cameo site, which is upstream from most of the urban and agricultural activity in the Colorado Plateau. Selenium concentrations in streambed sediment were lowest at the Colorado River near Cameo site. The sedimentary geology (especially the Mancos Shale of Cretaceous age) and irrigation return flows in the Colorado Plateau physiographic province are probably the largest factors for increased selenium concentrations at the Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites. Pesticide concentrations in fish tissue were lowest at the Colorado River near Cameo site and were similar in concentration at the two other mixed land-use sites. The high fish-community-degradation index values at the three sites were caused by the large percentage of omnivores and non-native species. EPT richness and the percentage of EPT were highest and the percentage of Chironomidae was lowest at the Colorado River near Cameo site. EPT richness and the percentage of EPT were similar at the Gunnison River near Grand Junction and the Colorado River near Colorado-Utah State line sites.

The use of more than one sampling medium to characterize water quality is desirable because conventional water-quality methods for sampling water may not provide enough information to make a complete assessment of water quality. Therefore, the use of several types of sampling media at a site can provide an opportunity to integrate information in order to get a more complete description of water quality than may be evident with one sampling medium.

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# APPENDIXES

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit

[Site abbreviations are used in this appendix. See table 1 for full site names. Densities are rounded according to Britton and Greeson, 1987. --, species not collected]

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| **INSECTA (insects)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPHEMEROPTERA (mayflies) | -- | 10 | -- | -- | 2 | -- | -- | -- | -- | -- | 20 | -- | -- | -- | -- |
| Ameletidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ameletus sp.* | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Baetidae | 614 | 479 | 553 | 19 | 6 | 14 | 307 | 96 | 51 | 1380 | 26 | 278 | 2310 | 3710 | 363 |
| *Acentrella insignificans* | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- | -- | -- | -- | 40 |
| *Acentrella turbida* | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- | -- | -- | 322 | -- | -- |
| *Acentrella sp.* | 34 | 10 | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 242 | 32 | -- |
| *Baetis bicaudatus* | 17 | -- | 74 | -- | 96 | 19 | 32 | 42 | 6 | -- | -- | -- | 81 | -- | 81 |
| *Baetis flavistriga* | 59 | 107 | 553 | 5 | -- | -- | -- | -- | 32 | -- | -- | -- | 887 | 1 | 121 |
| *Baetis intercalaris* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis tricaudatus* | 9 | 10 | 18 | 80 | -- | -- | 58 | -- | 13 | 157 | -- | 138 | 430 | -- | -- |
| *Baetis sp.* | -- | 186 | 18 | -- | -- | -- | -- | 78 | -- | -- | 22 | -- | -- | 522 | -- |
| *Labiobaetis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paracloeodes minuts* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| Ephemerellidae | 126 | 498 | 424 | -- | -- | 77 | 19 | -- | 51 | -- | -- | -- | -- | 258 | -- |
| *Attenella margarita* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella coloradensis* | 60 | 11 | 1 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | 1 | -- |
| *Drunella doddsi* | 126 | 21 | 110 | -- | -- | 24 | 26 | 28 | 26 | -- | -- | 6 | 54 | -- | 40 |
| *Drunella grandis* | 160 | -- | 442 | -- | -- | 5 | -- | -- | -- | 11 | -- | -- | 514 | -- | 122 |
| *Drunella tuberculata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- |
| *Drunella sp.* | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella aurivilli* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella inermis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22 | 13 | -- | -- | -- | -- |
| *Ephemerella sp.* | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Serratella micheneri* | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- |
| *Serratella tibialis* | 34 | -- | 18 | -- | -- | -- | -- | -- | 6 | -- | -- | -- | 107 | -- | 81 |
| *Serratella sp.* | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | 2 | -- |
| *Timpanoga hecuba* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| Heptageniidae | 128 | 138 | 74 | -- | -- | -- | -- | 11 | -- | -- | -- | 10 | -- | -- | -- |
| *Cinygmula sp.* | 59 | 291 | 129 | -- | -- | -- | -- | 4 | -- | -- | 6 | -- | -- | -- | -- |
| *Epeorus albertae* | 177 | -- | 37 | -- | -- | -- | 19 | -- | -- | -- | -- | 3 | -- | -- | 40 |
| *Epeorus longimanus* | 34 | -- | 92 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | 40 |
| *Eperous sp.* | 160 | 85 | 37 | -- | -- | -- | -- | 54 | 6 | -- | -- | -- | -- | 102 | -- |
| *Heptagenia solitaria* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heptagenia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhithrogena sp.* | 110 | 29 | 166 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- |
| Leptophlebiidae | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- |
| *Choroterpes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paraleptophlebia sp.* | -- | 37 | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- |
| *Traverella albertana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tricorythidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tricorythodes corpulentus group* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tricorythodes minutus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tricorythodes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLECOPTERA (stoneflies) | -- | 10 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- |
| Capniidae | 34 | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chloroperlidae | 93 | 37 | 202 | 14 | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | 40 |
| *Suwallia sp.* | 9 | 10 | 74 | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | 175 | 40 |
| *Sweltsa sp.* | 26 | 158 | 92 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | 32 | 81 |
| Leuctridae | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nemouridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Amphinemura sp.* | -- | 1 | -- | -- | -- | -- | 13 | 15 | 397 | -- | -- | -- | -- | -- | -- |
| *Zapada sp.* | 17 | 10 | 55 | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| Perlidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Claassenia sabulosa* | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hesperoperla pacifica* | -- | -- | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| Perlodidae | 9 | 46 | 110 | 5 | -- | -- | 64 | -- | 45 | -- | -- | -- | 54 | 32 | 40 |
| *Isogenoides zionensis* | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Megarcys signata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Skwala americana* | -- | -- | -- | -- | -- | -- | -- | 48 | 6 | -- | -- | -- | -- | -- | -- |
| *Skwala sp.* | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32 | -- |
| Pteronarcyidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pteronarcella badia* | 34 | -- | 37 | -- | -- | -- | 19 | -- | 6 | 34 | -- | 10 | 81 | -- | -- |
| *Pteronarcella sp.* | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| Taeniopterygidae | -- | -- | -- | -- | 2 | -- | 26 | -- | -- | -- | -- | -- | -- | -- | -- |
| TRICHOPTERA (caddisflies) | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | 6 | -- | -- | -- |
| Brachycentridae | -- | 37 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brachycentrus americanus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | 1770 | 68 | -- |
| *Brachycentrus occidentalis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | 6 | -- | -- | -- |
| *Brachycentrus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 58 | 1 | 3 | 430 | 290 | 202 |
| *Micrasema sp.* | 34 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Glossosomatidae | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agapetus sp.* | 17 | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Culoptila sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glossosoma verdonum* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glossosoma sp.* | 286 | 18 | 221 | -- | -- | -- | -- | -- | -- | -- | 110 | 38 | -- | -- | -- |
| Hydropsychidae | 76 | 10 | 110 | -- | -- | -- | -- | 4 | 6 | 280 | 84 | 54 | 27 | 65 | -- |
| *Arctopsyche grandis* | 22 | 3 | 2 | -- | -- | -- | -- | 1 | -- | 134 | -- | 26 | 3 | -- | -- |
| *Arctopsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- |
| *Ceratopsyche oslari* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- |
| *Ceratopsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cheumatopsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydropsyche occidentalis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydropsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Hydroptilidae | -- | 11 | -- | -- | -- | -- | -- | -- | -- | 22 | -- | 6 | -- | -- | -- |
| *Hydroptila consimilis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- |
| *Hydroptila sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Mayatrichia ayama* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| *Neotrichia halia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neotrichia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochrotrichia logana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- |
| *Ochrotrichia sp.* | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 11 | 4 | 3 | -- | -- | -- |
| *Oxyethira sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| *Stactobiella brustia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stactobiella delira* | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lepidostomatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lepidostoma sp.* | -- | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Leptoceridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Oecetis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Limnephilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dicosmoecus atripes* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Onocosmoecus unicolor* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Limnephiloidea | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychomyiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Psychomyia flavida* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Rhyacophilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila angelita* | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila coloradensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| *Rhyacophila sp.* | 18 | 12 | 38 | 5 | 3 | -- | 40 | 27 | 6 | -- | -- | -- | 54 | -- | -- |
| Uenoidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neophylax sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neothremma alicia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- |
| COLEOPTERA (beetles) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| Curculionidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- |
| Dryopidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Helichus striatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dytiscidae | -- | 1 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- |
| *Agabus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydroporus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- |
| Elmidae | 186 | 93 | 110 | -- | -- | -- | 6 | -- | 6 | 11 | 4 | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| *Cleptelmis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterlimnius corpulentus* | 76 | -- | 37 | -- | -- | -- | 13 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterlimnius sp.* | 236 | 193 | 184 | 5 | -- | -- | 6 | -- | -- | -- | -- | -- | 27 | 1 | -- |
| *Microcylloepus pusillus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microcylloepus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Optioservus catanipennis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- |
| *Optioservus divergens* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Optioservus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22 | -- | 6 | -- | -- | -- |
| *Zaitzevia parvula* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydraenidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochthebius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DIPTERA (true flies) | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| Blephariceridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agathon sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ceratopogonidae | -- | 37 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40 |
| *Bezzia / Palpomyia sp.* | 17 | -- | 37 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dasyhelea sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Forcipomyiinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chironomidae | 9 | 28 | 37 | 50 | 2 | 10 | 5 | 111 | 13 | 22 | 38 | 3 | 27 | -- | 322 |
| *Ablabesmyia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brillia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| *Cardiocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 67 | -- | 32 | -- | -- | -- |
| *Chaetocladius sp.* | -- | -- | -- | -- | 19 | 38 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chironominae*** | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 107 | -- | -- |
| Chironomini**** | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | 40 |
| *Chironomus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cryptochironomus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cladotanytarsus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Corynoneura sp.* | -- | 10 | 18 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| *Cricotopus bicinctus group* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- |
| *Cricotopus trifascia group* | -- | -- | 18 | -- | -- | -- | -- | -- | -- | 179 | -- | -- | -- | -- | -- |
| *Cricotopus / Orthocladius sp.* | 134 | 212 | 129 | 230 | 58 | 341 | 403 | 104 | 429 | 1040 | 811 | 102 | 2020 | 5200 | 11900 |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| Diamesinae*** | -- | 38 | -- | -- | -- | -- | -- | 4 | -- | -- | 4 | -- | -- | -- | -- |
| *Diamesa sp.* | -- | -- | -- | 91 | 30 | 115 | 6 | 4 | 13 | -- | -- | -- | -- | -- | -- |
| *Eukiefferiella sp.* | -- | -- | 37 | -- | -- | -- | 26 | 11 | 13 | 627 | 164 | 77 | -- | -- | 121 |
| *Eukiefferiella/Tvetenia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 34 | -- | -- | -- | -- |
| *Heterotrissocladius sp.* | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydrobaenus sp.* | -- | -- | -- | -- | -- | 307 | 678 | 8 | 230 | -- | -- | -- | -- | 129 | 766 |
| *Krenosmittia sp.* | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Micropsectra sp.* | 26 | -- | -- | -- | -- | -- | 19 | 34 | 45 | -- | -- | -- | -- | 65 | 121 |
| *Microtendipes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Nanocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | 4 | -- | -- | -- | 40 |
| *Odontomesa sp.* | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| Orthocladiinae*** | 84 | 28 | 37 | 53 | 151 | 38 | 275 | 169 | 64 | 582 | 111 | 13 | 591 | 292 | 645 |
| *Orthocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pagastia sp.* | -- | 30 | 37 | 91 | 2 | 19 | 32 | 34 | 102 | -- | -- | -- | 887 | 2040 | 242 |
| *Paracladopelma sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parakiefferiella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | 4 | -- | -- | 32 | -- |
| *Parametriocnemus sp.* | -- | 10 | -- | -- | 2 | -- | -- | 8 | -- | 101 | 4 | -- | 54 | -- | 40 |
| *Paraphaenocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paratanytarsus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parorthocladius sp.* | -- | -- | -- | -- | -- | 5 | 90 | -- | 26 | -- | -- | -- | -- | -- | -- |
| *Pentaneura sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Pentaneurini**** | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Phaenopsectra sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Polypedilum sp.* | -- | -- | -- | -- | -- | 5 | 13 | 4 | -- | 56 | -- | 3 | 107 | 162 | 40 |
| *Potthastia sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- |
| *Pseudodiamesa sp.* | -- | -- | -- | 5 | -- | 5 | 6 | 4 | -- | -- | -- | -- | -- | -- | -- |
| *Pseudosmittia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rheocricotopus sp.* | 34 | 18 | -- | 19 | 123 | 86 | 1390 | 88 | 262 | -- | 4 | 3 | 54 | 226 | 766 |
| *Rheotanytarsus sp.* | -- | 28 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Sergentia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stempellinella sp.* | -- | 10 | -- | -- | -- | -- | -- | 8 | 6 | -- | -- | -- | -- | 129 | -- |
| *Subletta sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| *Synendotendipes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Synorthocladius sp.* | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tanypodinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40 |
| Tanytarsini**** | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- |
| *Tanytarsus sp.* | -- | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thienemanniella sp.* | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thienemannimyia group* | -- | -- | -- | -- | -- | -- | -- | 4 | 6 | -- | -- | -- | 27 | -- | -- |
| *Tribelos sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tvetenia sp.* | 93 | 46 | 221 | 5 | 2 | 10 | 141 | 8 | 26 | 157 | 4 | -- | -- | -- | 121 |
| Culicidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- |
| Deuterophlebiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Deuterophlebia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dixidae | -- | -- | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychodidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pericoma / Telmatoscopus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Simuliidae | 134 | 83 | 3780 | 10 | -- | 10 | 58 | 34 | 6 | 123 | -- | 3 | 81 | 66 | 162 |
| *Prosimulium sp.* | 17 | 1 | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Simulium sp.* | -- | 46 | 534 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | 27 | 1 | -- |
| Tanyderidae | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Tipulidae | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Antocha sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 30 | 1 | -- |
| *Dicranota sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hexatoma sp.* | 10 | 14 | 1 | -- | -- | -- | -- | -- | -- | 12 | 6 | -- | -- | -- | -- |
| *Rhabdomastix sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tipula sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Brachycera** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Athericidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Atherix pachypus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- |
| *Atherix sp.* | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- |
| Empididae | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22 | -- | -- | -- | -- | -- |
| *Chelifera sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 650 | 130 | 64 | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| *Chelifera / Hemerodromia sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | 101 | 1 | -- | -- | -- | -- |
| *Clinocera sp.* | -- | -- | -- | 29 | 33 | 58 | 26 | 30 | -- | -- | 1 | -- | -- | -- | -- |
| *Hemerodromia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ephydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Muscidae | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Syrphidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMIPTERA (true bugs, leaf hoppers) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Corixidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Gerridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Veliidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microvelia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LEPIDOPTERA (butterflies) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEGALOPTERA (dobson-flies/hellgrammites) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Corydalidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Corydalus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ODONATA (damsel/dragonfly) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Calopterygidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hetaerina sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Coenagrionidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- |
| *Argia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Gomphidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ophiogomphus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| COLLEMBOLA (springtails) | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- |
| **CHELICERATA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ACARI (water mites) | 186 | 120 | 110 | 19 | 22 | 24 | 19 | 27 | 58 | 358 | 110 | 13 | 860 | 129 | 242 |
| **MALACOSTRACA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| AMPHIPODA (scuds, shrimp) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Gammaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gammarus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hyalellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hyalella azteca* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| ISOPODA (aquatic sow bugs) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Asellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lirceus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DECAPODA (crayfish, shrimp) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cambaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Orconectes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **OLIGOCHAETA (aquatic worms)** | -- | 18 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| ENCHYTRAEIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Enchytraeidae | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | 4 | 10 | 188 | 32 | 242 |
| TUBIFICIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Naididae | 9 | 19 | -- | -- | -- | -- | 51 | -- | -- | 11 | -- | 3 | 215 | 226 | 1170 |
| Tubificidae | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | 26 | -- | -- | -- | -- |
| LUMBRICULIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lumbriculidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- |
| *Megadrili sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **HIRUDINEA (leeches)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARHYNCHOBDELLAE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Erpobdellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **HYDROZOA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HYDROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydra sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **GASTROPODA (snails, limpets)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BASOMMATOPHORA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ancylidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ferrissia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lymnaeidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- |
| *Fossaria/Stagnicola sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Physidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 6 | -- | -- | -- |
| *Physa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Physella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Planorbidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gyraulus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 13 | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | | |
| **BIVALVIA (bivalve molluscs)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| VENEROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sphaeriidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **NEMATODA (roundworms)*** | 9 | 10 | 147 | -- | 25 | -- | -- | 5 | -- | 56 | 21 | 22 | 54 | -- | 40 |
| **NEMATOMORPHA (horse-hair worms)*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **ENOPLA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HOPLONEMERTEA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tetrastemmatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Prostoma sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **TURBELLARIA (flatworms)** | -- | -- | -- | 53 | 38 | 62 | 19 | 15 | 38 | -- | -- | -- | 27 | 66 | 121 |

*Phylum
**Suborder
***Subfamily
****Tribe

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit —Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| **INSECTA (insects)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPHEMEROPTERA (mayflies) | -- | 23 | 23 | 32 | -- | 56 | 32 | -- | -- | 11 | 19 | -- | -- | -- |
| Ameletidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ameletus sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| Baetidae | 678 | 414 | 438 | 838 | 937 | 347 | 8190 | 2580 | 2060 | 1660 | 1060 | 22 | 317 | 1500 |
| *Acentrella insignificans* | -- | 92 | 115 | 129 | 226 | 168 | -- | -- | -- | 11 | 138 | -- | -- | -- |
| *Acentrella turbida* | 226 | 23 | -- | 32 | -- | -- | -- | -- | -- | 34 | 138 | -- | -- | -- |
| *Acentrella sp.* | 32 | -- | -- | -- | -- | -- | -- | -- | -- | 81 | -- | -- | -- | -- |
| *Baetis bicaudatus* | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis flavistriga* | 32 | 184 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis intercalaris* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis tricaudatus* | 226 | 115 | 92 | 226 | -- | 123 | 1740 | -- | 4600 | 138 | 322 | -- | -- | 254 |
| *Baetis sp.* | -- | -- | -- | -- | 387 | -- | -- | 1190 | -- | -- | 10 | -- | 121 | 4 |
| *Labiobaetis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| *Paracloeodes minuts* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ephemerellidae | 226 | -- | 23 | 32 | 387 | -- | 32 | -- | -- | 69 | 18 | 2 | -- | -- |
| *Attenella margarita* | -- | -- | -- | -- | -- | 179 | -- | -- | -- | 23 | 10 | -- | -- | -- |
| *Drunella coloradensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella doddsi* | 129 | 947 | 438 | 32 | 129 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella grandis* | -- | -- | 138 | 258 | -- | 34 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella tuberculata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella sp.* | -- | 46 | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella aurivilli* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| *Ephemerella inermis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella sp.* | -- | -- | -- | 32 | 65 | -- | -- | 16 | -- | -- | -- | -- | -- | -- |
| *Serratella micheneri* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Serratella tibialis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Serratella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 18 | -- | -- | -- |
| *Timpanoga hecuba* | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Heptageniidae | 806 | 461 | 138 | -- | -- | 11 | -- | 16 | -- | 46 | 10 | -- | -- | -- |
| *Cinygmula sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Epeorus albertae* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| *Epeorus longimanus* | 32 | 185 | 92 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Eperous sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heptagenia solitaria* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- |
| *Heptagenia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhithrogena sp.* | 129 | 530 | 138 | 1 | 129 | 22 | -- | -- | -- | 93 | 37 | -- | -- | -- |
| Leptophlebiidae | 32 | -- | -- | 32 | -- | 34 | 32 | -- | 81 | -- | -- | -- | -- | -- |
| *Choroterpes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paraleptophlebia sp.* | -- | -- | -- | -- | 32 | 101 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Traverella albertana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tricorythidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tricorythodes corpulentus group* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- |
| *Tricorythodes minutus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 102 | -- | -- | -- |
| *Tricorythodes sp.* | -- | -- | -- | 97 | 162 | 392 | -- | -- | -- | 81 | 28 | 2 | -- | -- |
| PLECOPTERA (stoneflies) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Capniidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chloroperlidae | 97 | 24 | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Suwallia sp.* | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Sweltsa sp.* | 226 | 139 | 254 | -- | 194 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Leuctridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nemouridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Amphinemura sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Zapada sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perlidae | -- | -- | 69 | -- | 32 | 34 | 162 | -- | -- | -- | -- | -- | -- | -- |
| *Claassenia sabulosa* | 32 | 1 | -- | 2 | 68 | 14 | -- | -- | -- | 13 | 1 | -- | -- | -- |
| *Hesperoperla pacifica* | 66 | 27 | 2 | 130 | 34 | 22 | 1 | 69 | 85 | -- | -- | -- | -- | -- |
| Perlodidae | 419 | 162 | 184 | 97 | 32 | -- | -- | -- | -- | 23 | 18 | -- | -- | -- |
| *Isogenoides zionensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Megarcys signata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Skwala americana* | -- | -- | -- | -- | -- | -- | -- | 258 | -- | 1 | -- | -- | -- | -- |
| *Skwala sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Pteronarcyidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pteronarcella badia* | 32 | -- | 23 | 32 | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| *Pteronarcella sp.* | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Taeniopterygidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRICHOPTERA (caddisflies) | -- | -- | 69 | -- | -- | 34 | -- | -- | -- | -- | -- | -- | -- | -- |
| Brachycentridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brachycentrus americanus* | 162 | 139 | 392 | -- | 98 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brachycentrus occidentalis* | -- | -- | -- | 194 | 162 | 202 | -- | -- | -- | 82 | 4 | -- | -- | -- |
| *Brachycentrus sp.* | -- | -- | 115 | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Micrasema sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- |
| Glossosomatidae | -- | -- | -- | 33 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agapetus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Culoptila sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glossosoma verdonum* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glossosoma sp.* | -- | -- | 23 | 162 | 97 | 78 | -- | -- | -- | 34 | 10 | -- | -- | -- |
| Hydropsychidae | 291 | 207 | 207 | 485 | 97 | 202 | -- | -- | -- | 578 | 774 | 211 | -- | 42 |
| *Arctopsyche grandis* | 294 | 280 | 94 | 549 | 194 | 134 | -- | -- | -- | 12 | -- | -- | -- | -- |
| *Arctopsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ceratopsyche oslari* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ceratopsyche sp.* | -- | -- | -- | 32 | 1 | 213 | -- | -- | -- | 49 | 102 | -- | -- | -- |
| *Cheumatopsyche sp.* | -- | -- | -- | -- | 162 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydropsyche occidentalis* | -- | -- | -- | -- | 1 | 11 | -- | -- | -- | 2 | 1 | -- | -- | 8 |
| *Hydropsyche sp.* | -- | -- | -- | -- | 744 | -- | -- | -- | -- | -- | -- | 5 | -- | -- |
| Hydroptilidae | -- | -- | -- | 32 | -- | 11 | -- | -- | 40 | -- | -- | -- | -- | -- |
| *Hydroptila consimilis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydroptila sp.* | -- | -- | -- | -- | -- | 56 | -- | -- | -- | -- | 37 | -- | -- | -- |
| *Mayatrichia ayama* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neotrichia halia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neotrichia sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochrotrichia logana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochrotrichia sp.* | -- | -- | -- | -- | 162 | -- | -- | 65 | 81 | -- | 10 | -- | -- | -- |
| *Oxyethira sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stactobiella brustia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| *Stactobiella delira* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| Lepidostomatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lepidostoma sp.* | 356 | 1220 | 645 | 388 | 1290 | 403 | -- | -- | -- | -- | -- | -- | -- | -- |
| Leptoceridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Oecetis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Limnephilidae | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dicosmoecus atripes* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Onocosmoecus unicolor* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Limnephiloidea | -- | 299 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychomyiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Psychomyia flavida* | -- | -- | -- | 32 | -- | 11 | -- | -- | -- | 11 | -- | -- | -- | -- |
| Rhyacophilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila angelita* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila coloradensis* | -- | -- | 23 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila sp.* | -- | -- | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- |
| Uenoidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neophylax sp.* | 2260 | -- | 1290 | -- | -- | 45 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neothremma alicia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| COLEOPTERA (beetles) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- |
| Curculionidae | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| Dryopidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Helichus striatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- |
| Dytiscidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| *Agabus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 |
| *Hydroporus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Elmidae | 32 | 23 | -- | 97 | 98 | -- | -- | 16 | 40 | 34 | -- | -- | -- | -- |
| Cleptelmis sp. | -- | -- | -- | -- | 451 | -- | -- | 16 | -- | -- | -- | -- | -- | -- |
| *Heterlimnius corpulentus* | -- | -- | -- | -- | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterlimnius sp.* | -- | -- | -- | -- | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microcylloepus pusillus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microcylloepus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Optioservus catanipennis* | 65 | 23 | 46 | 32 | -- | 34 | 1 | -- | -- | 23 | 28 | 1 | -- | -- |
| *Optioservus divergens* | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| *Optioservus sp.* | 65 | 23 | -- | 129 | -- | 45 | -- | -- | 40 | -- | 37 | 2 | -- | -- |
| *Zaitzevia parvula* | -- | -- | -- | -- | 32 | -- | -- | -- | -- | 11 | 10 | -- | -- | -- |
| Hydraenidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochthebius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| DIPTERA (true flies) | -- | 69 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| Blephariceridae | -- | 46 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agathon sp.* | 32 | -- | 162 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ceratopogonidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 34 | 41 | -- |
| *Bezzia / Palpomyia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- |
| *Dasyhelea sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| Forcipomyiinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| Chironomidae | 142 | 27 | 138 | 197 | 298 | 56 | 451 | 499 | 121 | 74 | 28 | 7 | 14 | 4 |
| *Ablabesmyia sp.* | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brillia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cardiocladius sp.* | 32 | -- | 23 | 129 | -- | -- | 65 | -- | -- | -- | -- | -- | -- | -- |
| *Chaetocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Chironominae**** | -- | 69 | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- |
| *Chironomini***** | -- | -- | -- | 65 | -- | 56 | 32 | 16 | 40 | 23 | 18 | -- | -- | -- |
| *Chironomus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cryptochironomus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cladotanytarsus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 23 | 10 | -- | -- | -- |
| *Corynoneura sp.* | -- | 23 | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cricotopus bicinctus group* | -- | -- | -- | 32 | -- | 11 | -- | -- | -- | -- | -- | -- | -- | 4 |
| *Cricotopus trifascia group* | -- | -- | -- | 65 | 322 | 269 | -- | 32 | 121 | 69 | 46 | -- | -- | -- |
| *Cricotopus / Orthocladius sp.* | 162 | 92 | 322 | 2550 | 1390 | 1320 | 871 | 758 | 5730 | 461 | 470 | 86 | 102 | 46 |
| Diamesinae*** | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- |
| *Diamesa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 4 |
| *Eukiefferiella sp.* | 65 | 23 | 207 | 290 | 226 | 67 | 678 | 242 | 1770 | -- | 10 | -- | 20 | 11 |
| *Eukiefferiella/Tvetenia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterotrissocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydrobaenus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Krenosmittia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| *Micropsectra sp.* | 516 | 69 | 23 | 162 | 65 | 34 | 129 | 48 | -- | -- | -- | -- | -- | -- |
| *Microtendipes sp.* | -- | -- | -- | 32 | -- | 101 | -- | -- | -- | 230 | 240 | -- | -- | -- |
| *Nanocladius sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Odontomesa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| Orthocladiinae*** | 645 | 300 | 92 | 1360 | 1100 | 101 | 355 | 339 | 887 | 196 | 56 | 17 | 53 | 8 |
| Orthocladius sp. | 97 | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- |
| *Pagastia sp.* | 194 | 23 | 46 | 65 | 194 | 22 | -- | -- | 81 | -- | -- | -- | 6 | 11 |
| *Paracladopelma sp.* | -- | -- | -- | -- | -- | -- | 65 | -- | -- | -- | -- | -- | -- | -- |
| *Parakiefferiella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parametriocnemus sp.* | -- | -- | -- | 65 | -- | -- | -- | -- | -- | 23 | 10 | 5 | 21 | -- |
| *Paraphaenocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| *Paratanytarsus sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parorthocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pentaneura sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | 5 | -- | -- |
| Pentaneurini**** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Phaenopsectra sp.* | -- | -- | -- | -- | -- | 34 | -- | -- | 81 | -- | 46 | -- | -- | -- |
| *Polypedilum sp.* | -- | -- | 92 | 162 | 65 | 78 | 65 | -- | -- | 461 | 184 | 2 | -- | -- |
| *Potthastia sp.* | 32 | -- | -- | -- | -- | -- | 65 | -- | 162 | -- | -- | -- | -- | -- |
| *Pseudodiamesa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pseudosmittia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 28 | -- | -- | -- |
| *Rheocricotopus sp.* | 65 | -- | 23 | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rheotanytarsus sp.* | -- | -- | -- | 258 | -- | 22 | 97 | -- | -- | 34 | -- | -- | -- | -- |
| *Sergentia sp.* | -- | -- | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- |
| *Stempellinella sp.* | 516 | 2440 | 184 | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Subletta sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Synendotendipes sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Synorthocladius sp.* | -- | -- | -- | 32 | -- | 45 | 162 | 16 | 121 | -- | -- | -- | -- | -- |
| Tanypodinae*** | -- | -- | -- | 32 | -- | -- | -- | 16 | -- | -- | -- | 2 | -- | -- |
| Tanytarsini**** | 290 | 184 | -- | 258 | 65 | -- | -- | 16 | -- | -- | -- | -- | -- | -- |
| *Tanytarsus sp.* | -- | 23 | -- | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thienemanniella sp.* | -- | -- | -- | 32 | -- | 45 | -- | -- | -- | -- | -- | -- | 6 | -- |
| *Thienemannimyia group* | 97 | 23 | 23 | -- | -- | 11 | -- | -- | -- | 34 | 18 | 14 | 1 | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site abbreviations are used in this appendix. See table 1 for full site names. Densities are rounded according to Britton and Greeson, 1987. --, species not collected]

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| *Tribelos sp.* | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tvetenia sp.* | 774 | 92 | 322 | -- | 97 | 67 | 451 | 274 | 2220 | 34 | 19 | -- | 20 | -- |
| Culicidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Deuterophlebiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Deuterophlebia sp.* | 130 | 23 | 46 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dixidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychodidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pericoma / Telmatoscopus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| Simuliidae | 1030 | 671 | 2280 | 516 | 1970 | 11 | 97 | 258 | 40 | 682 | 102 | 5 | 62 | 23 |
| *Prosimulium sp.* | -- | -- | -- | -- | 974 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Simulium sp.* | 227 | 392 | 346 | 65 | 646 | -- | 65 | -- | 40 | 23 | 64 | -- | -- | -- |
| Tanyderidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tipulidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| *Antocha sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dicranota sp.* | 65 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hexatoma sp.* | 3 | 26 | 1 | 32 | -- | 11 | -- | -- | -- | 1 | 19 | 2 | -- | -- |
| *Rhabdomastix sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tipula sp.* | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 11 | -- | -- | -- | -- |
| Brachycera** | -- | -- | -- | -- | 65 | -- | -- | 32 | 40 | -- | -- | -- | 1 | -- |
| Athericidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Atherix pachypus* | 1 | 23 | 93 | 1 | 2 | -- | -- | -- | -- | 2 | -- | -- | -- | -- |
| *Atherix sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Empididae | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Chelifera sp.* | 32 | -- | -- | 97 | -- | 22 | -- | 16 | 40 | 11 | -- | -- | -- | -- |
| *Chelifera / Hemerodromia sp.* | -- | -- | -- | -- | -- | -- | -- | 32 | -- | -- | -- | 5 | 1 | -- |
| *Clinocera sp.* | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hemerodromia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- |
| Ephydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| Muscidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Syrphidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMIPTERA (true bugs, leaf hoppers) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| Corixidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- |
| Gerridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| Veliidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microvelia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| LEPIDOPTERA (butterflies) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEGALOPTERA (dobson-flies/hellgrammites) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Corydalidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Corydalus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ODONATA (damsel/dragonfly) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| Calopterygidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hetaerina sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Coenagrionidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- |
| *Argia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 4 |
| Gomphidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ophiogomphus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| COLLEMBOLA (springtails) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| **CHELICERATA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ACARI (water mites) | 97 | 46 | 69 | 258 | 97 | 56 | -- | 81 | 40 | 46 | 83 | 86 | 14 | 11 |
| **MALACOSTRACA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| AMPHIPODA (scuds, shrimp) | -- | -- | -- | -- | -- | -- | 32 | -- | 40 | -- | -- | -- | -- | -- |
| Gammaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gammarus sp.* | -- | -- | -- | -- | -- | -- | -- | 65 | 122 | -- | -- | -- | -- | -- |
| Hyalellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hyalella azteca* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| ISOPODA (aquatic sow bugs) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Asellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lirceus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| DECAPODA (crayfish, shrimp) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cambaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Orconectes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **OLIGOCHAETA (aquatic worms)** | -- | -- | -- | -- | 1 | -- | -- | 17 | -- | -- | -- | -- | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site abbreviations are used in this appendix. See table 1 for full site names. Densities are rounded according to Britton and Greeson, 1987. --, species not collected]

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| ENCHYTRAEIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Enchytraeidae | 1650 | 878 | 622 | -- | -- | -- | -- | -- | 40 | -- | -- | 7 | 20 | 4 |
| TUBIFICIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Naididae | 258 | 69 | -- | 2060 | 550 | 336 | 226 | 16 | 242 | 278 | 83 | 7 | 74 | -- |
| Tubificidae | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | 10 | -- | -- |
| LUMBRICULIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lumbriculidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Megadrili sp.* | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **HIRUDINEA (leeches)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARHYNCHOBDELLAE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Erpobdellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HYDROZOA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HYDROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydra sp.* | -- | -- | -- | -- | -- | -- | 968 | -- | 1090 | -- | -- | -- | -- | -- |
| **GASTROPODA (snails, limpets)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BASOMMATOPHORA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ancylidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ferrissia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lymnaeidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Fossaria/Stagnicola sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Physidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Physa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Physella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Planorbidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gyraulus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **BIVALVIA (bivalve molluscs)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| VENEROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sphaeriidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| **NEMATODA (roundworms)*** | 97 | -- | 23 | 65 | 162 | 45 | 162 | 242 | -- | 70 | -- | 5 | -- | -- |
| **NEMATOMORPHA (horse-hair worms)*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |

**APPENDIX A**. Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | | | |
| Family | | | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | | | |
| **ENOPLA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HOPLONEMERTEA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tetrastemmatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Prostoma sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **TURBELLARIA (flatworms)** | 32 | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

*Phylum
**Suborder
***Subfamily
****Tribe

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit —Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| **INSECTA (insects)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPHEMEROPTERA (mayflies) | -- | 6 | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- |
| Ameletidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ameletus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Baetidae | 269 | 160 | 504 | 53 | 54 | 1510 | 440 | 40 | 56 | -- | 9 | 11 |
| *Acentrella insignificans* | -- | -- | -- | -- | -- | 30 | 62 | -- | -- | -- | -- | -- |
| *Acentrella turbida* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Acentrella sp.* | -- | -- | -- | -- | -- | 62 | -- | -- | -- | -- | -- | -- |
| *Baetis bicaudatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis flavistriga* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Baetis intercalaris* | -- | -- | -- | -- | -- | 30 | -- | -- | -- | -- | -- | -- |
| *Baetis tricaudatus* | -- | -- | 34 | 10 | -- | 123 | 162 | -- | -- | -- | -- | -- |
| *Baetis sp.* | -- | 130 | 22 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Labiobaetis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paracloeodes minuts* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ephemerellidae | -- | -- | -- | -- | -- | 30 | -- | -- | -- | -- | -- | -- |
| *Attenella margarita* | -- | -- | -- | -- | -- | 30 | 18 | -- | -- | -- | -- | -- |
| *Drunella coloradensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella doddsi* | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- |
| *Drunella grandis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella tuberculata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Drunella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40 | -- | -- |
| *Ephemerella aurivilli* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella inermis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephemerella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- |
| *Serratella micheneri* | -- | -- | -- | -- | -- | -- | 27 | -- | -- | -- | -- | -- |
| *Serratella tibialis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Serratella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Timpanoga hecuba* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Heptageniidae | -- | -- | -- | -- | -- | 586 | 197 | -- | -- | -- | -- | -- |
| *Cinygmula sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Epeorus albertae* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| *Epeorus longimanus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Eperous sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heptagenia solitaria* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heptagenia sp.* | -- | -- | -- | -- | -- | -- | 18 | -- | -- | -- | 26 | -- |
| *Rhithrogena sp.* | -- | -- | -- | -- | -- | 338 | 36 | -- | -- | -- | -- | -- |
| Leptophlebiidae | -- | -- | -- | -- | -- | -- | 90 | -- | -- | -- | -- | -- |
| *Choroterpes sp.* | -- | -- | -- | -- | -- | -- | 45 | -- | -- | -- | -- | -- |
| *Paraleptophlebia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Traverella albertana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 |
| Tricorythidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tricorythodes corpulentus group* | -- | -- | -- | -- | -- | -- | 414 | -- | -- | -- | -- | -- |
| *Tricorythodes minutus* | -- | -- | -- | -- | -- | -- | 808 | -- | 11 | -- | 9 | -- |
| *Tricorythodes sp.* | -- | -- | -- | -- | -- | 646 | -- | 40 | 146 | -- | 17 | 22 |
| PLECOPTERA (stoneflies) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Capniidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chloroperlidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Suwallia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Sweltsa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Leuctridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nemouridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Amphinemura sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Zapada sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perlidae | -- | -- | -- | -- | -- | 30 | -- | -- | -- | -- | -- | -- |
| *Claassenia sabulosa* | -- | -- | -- | -- | -- | 5 | 2 | -- | -- | -- | -- | -- |
| *Hesperoperla pacifica* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perlodidae | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- |
| *Isogenoides zionensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Megarcys signata* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Skwala americana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Skwala sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Pteronarcyidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pteronarcella badia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| *Pteronarcella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Taeniopterygidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRICHOPTERA (caddisflies) | -- | -- | -- | -- | -- | 62 | -- | -- | -- | -- | -- | -- |
| Brachycentridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brachycentrus americanus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brachycentrus occidentalis* | -- | -- | -- | -- | -- | 94 | 18 | -- | -- | 2 | -- | -- |
| *Brachycentrus sp.* | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Micrasema sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Glossosomatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agapetus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Culoptila sp.* | -- | -- | -- | -- | -- | 30 | -- | -- | -- | -- | -- | -- |
| *Glossosoma verdonum* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glossosoma sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydropsychidae | -- | -- | -- | 14 | -- | 740 | 269 | -- | 34 | 1 | 17 | 22 |
| *Arctopsyche grandis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Arctopsyche sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ceratopsyche oslari* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ceratopsyche sp.* | -- | -- | -- | -- | -- | 246 | 9 | -- | -- | -- | -- | -- |
| *Cheumatopsyche sp.* | -- | -- | -- | -- | -- | 154 | 81 | -- | -- | -- | -- | -- |
| *Hydropsyche occidentalis* | -- | 3 | 34 | 5 | -- | 277 | 48 | 82 | -- | 1 | -- | -- |
| *Hydropsyche sp.* | -- | -- | -- | -- | 8 | -- | 45 | -- | -- | -- | -- | 11 |
| Hydroptilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 34 |
| *Hydroptila consimilis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydroptila sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | 22 | -- | 9 | 34 |
| *Mayatrichia ayama* | -- | -- | -- | -- | -- | 1 | 18 | -- | -- | -- | -- | -- |
| *Neotrichia halia* | -- | -- | -- | -- | -- | -- | 18 | -- | -- | -- | -- | -- |
| *Neotrichia sp.* | -- | -- | -- | -- | -- | 153 | 314 | -- | -- | -- | -- | -- |
| *Ochrotrichia logana* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochrotrichia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Oxyethira sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stactobiella brustia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stactobiella delira* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| Lepidostomatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lepidostoma sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Leptoceridae | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| *Oecetis sp.* | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- |
| Limnephilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dicosmoecus atripes* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Onocosmoecus unicolor* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Limnephiloidea | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychomyiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Psychomyia flavida* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Rhyacophilidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila angelita* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila coloradensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rhyacophila sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| Uenoidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neophylax sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Neothremma alicia* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| COLEOPTERA (beetles) | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Curculionidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dryopidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Helichus striatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dytiscidae | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- |
| *Agabus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydroporus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Elmidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | 202 | -- | -- |
| *Cleptelmis sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterlimnius corpulentus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterlimnius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microcylloepus pusillus* | -- | -- | -- | -- | -- | 92 | -- | 40 | -- | 121 | -- | 11 |
| *Microcylloepus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | 45 |
| *Optioservus catanipennis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Optioservus divergens* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| *Optioservus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Zaitzevia parvula* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydraenidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ochthebius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DIPTERA (true flies) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- |
| Blephariceridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Agathon sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ceratopogonidae | -- | 34 | 11 | -- | -- | -- | 9 | -- | -- | -- | 9 | -- |
| *Bezzia / Palpomyia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dasyhelea sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Forcipomyiinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chironomidae | 54 | 6 | -- | 5 | -- | 281 | 18 | 524 | 78 | 822 | 35 | -- |
| *Ablabesmyia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Brillia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cardiocladius sp.* | -- | -- | -- | -- | -- | 123 | -- | -- | -- | -- | -- | -- |
| *Chaetocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Chironominae*** | -- | 11 | -- | -- | -- | -- | 18 | -- | 11 | 1210 | -- | -- |
| Chironomini**** | 54 | -- | -- | -- | -- | -- | 9 | 40 | -- | 40 | 9 | 11 |
| *Chironomus sp.* | -- | 14 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cryptochironomus sp.* | 107 | 11 | 56 | -- | -- | -- | -- | -- | 22 | -- | 9 | -- |
| *Cladotanytarsus sp.* | -- | -- | -- | -- | -- | 30 | 9 | 81 | 56 | 121 | 17 | 45 |
| *Corynoneura sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Cricotopus bicinctus group* | 269 | -- | 146 | 5 | 4 | -- | -- | 565 | 134 | 887 | -- | 22 |
| *Cricotopus trifascia group* | 1770 | -- | 269 | -- | 4 | -- | -- | 968 | 34 | 806 | -- | -- |
| *Cricotopus / Orthocladius sp.* | 538 | 202 | 963 | 29 | 30 | 522 | 134 | 1770 | 101 | 3670 | 67 | 67 |
| Diamesinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Diamesa sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Eukiefferiella sp.* | -- | 11 | 34 | 82 | 15 | 30 | 9 | -- | -- | -- | -- | -- |
| *Eukiefferiella/Tvetenia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Heterotrissocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydrobaenus sp.* | 54 | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Krenosmittia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| *Micropsectra sp.* | -- | -- | 11 | 5 | -- | -- | -- | -- | 11 | -- | -- | -- |
| *Microtendipes sp.* | -- | -- | -- | -- | -- | 30 | 18 | 40 | 45 | -- | -- | -- |
| *Nanocladius sp.* | -- | -- | -- | -- | -- | -- | 9 | -- | 22 | -- | 9 | 11 |
| *Odontomesa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Orthocladiinae*** | 215 | 151 | 78 | 72 | 11 | 154 | 26 | 403 | 56 | 1210 | 67 | 11 |
| *Orthocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pagastia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paracladopelma sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parakiefferiella sp.* | 54 | -- | 22 | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parametriocnemus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paraphaenocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Paratanytarsus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Parorthocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pentaneura sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pentaneurini**** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Phaenopsectra sp.* | -- | -- | -- | -- | -- | -- | -- | 40 | -- | -- | -- | -- |
| *Polypedilum sp.* | -- | -- | 11 | -- | -- | 461 | 162 | 202 | 179 | 80 | 9 | 67 |
| *Potthastia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pseudodiamesa sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pseudosmittia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rheocricotopus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Rheotanytarsus sp.* | -- | -- | -- | 5 | -- | 2400 | 314 | 3190 | 34 | 8470 | 76 | 3680 |
| *Sergentia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Stempellinella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Subletta sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Synendotendipes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Synorthocladius sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tanypodinae*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tanytarsini**** | -- | -- | -- | -- | -- | 30 | 107 | 40 | 11 | 81 | -- | 22 |
| *Tanytarsus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 |
| *Thienemanniella sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 11 | 40 | -- | -- |
| *Thienemannimyia group* | -- | -- | -- | -- | -- | -- | 27 | -- | -- | 40 | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| *Tribelos sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tvetenia sp.* | 54 | 45 | 235 | 115 | -- | 215 | -- | 121 | -- | 121 | 9 | -- |
| Culicidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Deuterophlebiidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Deuterophlebia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dixidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Psychodidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Pericoma / Telmatoscopus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Simuliidae | 54 | 11 | -- | 144 | 85 | 123 | -- | -- | -- | 40 | -- | 34 |
| *Prosimulium sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Simulium sp.* | -- | -- | -- | 43 | 11 | -- | -- | -- | -- | -- | -- | -- |
| Tanyderidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tipulidae | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| *Antocha sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Dicranota sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hexatoma sp.* | -- | -- | -- | -- | -- | 30 | 18 | -- | -- | -- | -- | -- |
| *Rhabdomastix sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tipula sp.* | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Brachycera** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Athericidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Atherix pachypus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Atherix sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Empididae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Chelifera sp.* | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | 11 |
| *Chelifera / Hemerodromia sp.* | -- | 6 | -- | -- | -- | -- | -- | 81 | -- | -- | -- | 34 |
| *Clinocera sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hemerodromia sp.* | -- | -- | -- | -- | 4 | -- | 9 | 40 | -- | 81 | -- | 347 |
| Ephydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Muscidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Syrphidae | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMIPTERA (true bugs, leaf hoppers) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| Corixidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Gerridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Veliidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Microvelia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LEPIDOPTERA (butterflies) | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEGALOPTERA (dobson-flies/hellgrammites) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Corydalidae | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- |
| *Corydalus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| ODONATA (damsel/dragonfly) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Calopterygidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hetaerina sp.* | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| Coenagrionidae | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- |
| *Argia sp.* | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- |
| Gomphidae | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| *Ophiogomphus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| COLLEMBOLA (springtails) | 54 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **CHELICERATA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ACARI (water mites) | -- | -- | 11 | 19 | 11 | 277 | 18 | 1090 | 146 | 524 | 17 | 302 |
| **MALACOSTRACA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| AMPHIPODA (scuds, shrimp) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Gammaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gammarus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hyalellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hyalella azteca* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ISOPODA (aquatic sow bugs) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Asellidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lirceus sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DECAPODA (crayfish, shrimp) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cambaridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| *Orconectes sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| **OLIGOCHAETA (aquatic worms)** | -- | 50 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site abbreviations are used in this appendix. See table 1 for full site names. Densities are rounded according to Britton and Greeson, 1987. --, species not collected]

| | DryCk 08/96 | DryCk 08/97 | DryCk 08/98 | Reed 11/96 | Reed 11/97 | Cameo 08/96 | Cameo 08/97 | GunnGJ 08/96 | GunnGJ 08/97 | State line 08/96 | State line 08/97 | State line 08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| ENCHYTRAEIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Enchytraeidae | 376 | 28 | 45 | 5 | -- | 30 | -- | 40 | 34 | -- | -- | 22 |
| TUBIFICIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Naididae | 10300 | 644 | 1380 | 29 | -- | 215 | 54 | 7700 | 190 | 605 | 34 | 213 |
| Tubificidae | 1290 | 994 | 336 | -- | -- | 30 | -- | 81 | 34 | -- | 42 | -- |
| LUMBRICULIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lumbriculidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Megadrili sp.* | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **HIRUDINEA (leeches)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARHYNCHOBDELLAE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Erpobdellidae | 5 | 3 | 23 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **HYDROZOA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HYDROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Hydridae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Hydra sp.* | -- | -- | -- | -- | -- | -- | -- | 363 | -- | 162 | -- | -- |
| **GASTROPODA (snails, limpets)** | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BASOMMATOPHORA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ancylidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ferrissia sp.* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 90 |
| Lymnaeidae | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Fossaria/Stagnicola sp.* | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Physidae | 376 | 28 | 101 | -- | -- | -- | -- | -- | 22 | -- | -- | -- |
| *Physa sp.* | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Physella sp.* | 485 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Planorbidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Gyraulus sp.* | 54 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **BIVALVIA (bivalve molluscs)** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| VENEROIDA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sphaeriidae | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **NEMATODA (roundworms)*** | 699 | 169 | 190 | 14 | 30 | 31 | 90 | 282 | 134 | 162 | 34 | -- |
| **NEMATOMORPHA (horse-hair worms)*** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX A.** Taxa, densities of macroinvertebrates (organisms per square meter) collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site abbreviations are used in this appendix. See table 1 for full site names. Densities are rounded according to Britton and Greeson, 1987. --, species not collected]

| | DryCk 08/96 | DryCk 08/97 | DryCk 08/98 | Reed 11/96 | Reed 11/97 | Cameo 08/96 | Cameo 08/97 | GunnGJ 08/96 | GunnGJ 08/97 | State line 08/96 | State line 08/97 | State line 08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLASS** | | | | | | | | | | | | |
| ORDER | | | | | | | | | | | | |
| Family | | | | | | | | | | | | |
| *Genus species* | | | | | | | | | | | | |
| **ENOPLA** | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HOPLONEMERTEA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tetrastemmatidae | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Prostoma sp.* | -- | -- | -- | 14 | -- | -- | -- | 40 | -- | -- | -- | -- |
| **TURBELLARIA (flatworms)** | -- | 8 | 22 | -- | 4 | -- | -- | -- | -- | 40 | -- | -- |

*Phylum
**Suborder
***Subfamily
****Tribe

**APPENDIX B.** Taxa, numbers of fish collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit

[Site 2 (French Gulch near Breckenridge) and site 10 (Dry Fork at upper station near De Beque) did not have fish present. --, species not collected]

| Common name[1] | Scientific name[1] | Baker 08/96 | Baker 08/97 | Baker 08/96 | Blue 08/96 | Blue 08/97 | Blue 08/98 | Ridgway 08/96 | Ridgway 08/97 | Ridgway 08/98 | Gore 08/96 | Gore 08/97 | Gore 08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trouts** | **Salmonidae** | | | | | | | | | | | | |
| Brown Trout | *Salmo trutta* | 81 | 59 | 82 | 2 | 2 | 4 | 5 | 6 | 8 | 137 | 88 | 80 |
| Rainbow Trout | *Onchorhynchus mykiss* | -- | -- | -- | -- | -- | -- | 20 | 16 | 30 | 67 | 35 | 33 |
| Brook Trout | *Salvelinus fontinalis* | 19 | 4 | 50 | 36 | 17 | 36 | -- | -- | -- | 5 | -- | 1 |
| Cutthroat Trout | *Onchorhynchus clarki* | 1 | -- | | -- | -- | -- | -- | -- | -- | -- | 2 | 5 |
| Kokanee Salmon | *Onchorhynchus nerka* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Mountain Whitefish | *Prosopium williamsoni* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Sculpins** | **Cottidae** | | | | | | | | | | | | |
| Mottled Sculpin | *Cottus bairdi* | 18 | 25 | 23 | -- | -- | -- | 45 | 33 | 7 | 162 | 159 | 306 |
| **Suckers** | **Catostomidae** | | | | | | | | | | | | |
| Longnose Sucker | *Catostomus catostomus* | 2 | 2 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| White Sucker | *Catostomus commersoni* | -- | -- | -- | -- | -- | -- | 15 | 6 | 5 | -- | -- | -- |
| Bluehead Sucker | *Catostomus discobolus* | -- | -- | -- | -- | -- | -- | 16 | 17 | -- | -- | -- | -- |
| Flannelmouth Sucker | *Catostomus latipinnis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Razorback Sucker | *Xyrauchen texanus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Carps and Minnows** | **Cyprinidae** | | | | | | | | | | | | |
| Roundtail Chub | *Gila robusta* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Common Carp | *Cyprinus carpio* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Speckled Dace | *Rhinichthys osculus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Longnose Dace | *Rhinichthys cataractae* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Fathead Minnow | *Pimephales promelas* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sand Shiner | *Notropis stramineus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Red Shiner | *Cyprinella lutrensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Colorado Pikeminnow | *Ptychocheilus lucius* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Sunfishes** | **Centrarchidae** | | | | | | | | | | | | |
| Green Sunfish | *Lepomis cyanellus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Largemouth Bass | *Micropterus salmoides* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Smallmouth Bass | *Micropterus dolomieu* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Perches** | **Percidae** | | | | | | | | | | | | |
| Yellow Perch | *Perca flavescens* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Catfishes** | **Ictaluridae** | | | | | | | | | | | | |
| Channel Catfish | *Ictalurus punctatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Black Bullhead | *Ameiurus melas* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX B.** Taxa, numbers of fish collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site 2 (French Gulch near Breckenridge) and site 10 (Dry Fork at upper station near De Beque) did not have fish present. --, species not collected]

| Common name | Scientific name | East 08//96 | East 08/97 | East 08/98 | Gunn32 08/96 | Gunn32 08//97 | Gunn32 08/98 | GunnTun 08/96 | GunnTun 08/97 | GunnTun 08/98 | Dotsero 08/96 | Dotsero 08/97 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trouts** | **Salmonidae** | | | | | | | | | | | |
| Brown Trout | *Salmo trutta* | 100 | 83 | 259 | 12 | 19 | 30 | 51 | 129 | 78 | 13 | 34 |
| Rainbow Trout | *Onchorhynchus mykiss* | 3 | 2 | 2 | 16 | 5 | 25 | 65 | 146 | 8 | 4 | 12 |
| Brook Trout | *Salvelinus fontinalis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cutthroat Trout | *Onchorhynchus clarki* | 1 | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- |
| Kokanee Salmon | *Onchorhynchus nerka* | 61 | 2 | 14 | 5 | 5 | 6 | -- | -- | -- | -- | -- |
| Mountain Whitefish | *Prosopium williamsoni* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 18 | 36 |
| **Sculpins** | ***Cottidae*** | | | | | | | | | | | |
| Mottled Sculpin | *Cottus bairdi* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 |
| **Suckers** | **Catostomidae** | | | | | | | | | | | |
| Longnose Sucker | *Catostomus catostomus* | 1 | -- | -- | 107 | 71 | 58 | -- | -- | -- | 7 | -- |
| White Sucker | *Catostomus commersoni* | -- | -- | -- | 7 | 9 | 10 | -- | -- | -- | 72 | 108 |
| Bluehead Sucker | *Catostomus discobolus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | 32 |
| Flannelmouth Sucker | *Catostomus latipinnis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 31 | 86 |
| Razorback Sucker | *Xyrauchen texanus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Carps and Minnows** | **Cyprinidae** | | | | | | | | | | | |
| Roundtail Chub | *Gila robusta* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Common Carp | *Cyprinus carpio* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Speckled Dace | *Rhinichthys osculus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 |
| Longnose Dace | *Rhinichthys cataractae* | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- |
| Fathead Minnow | *Pimephales promelas* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sand Shiner | *Notropis stramineus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Red Shiner | *Cyprinella lutrensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Colorado Pikeminnow | *Ptychocheilus lucius* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Sunfishes** | **Centrarchidae** | | | | | | | | | | | |
| Green Sunfish | *Lepomis cyanellus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Largemouth Bass | *Micropterus salmoides* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Smallmouth Bass | *Micropterus dolomieu* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Perches** | **Percidae** | | | | | | | | | | | |
| Yellow Perch | *Perca flavescens* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Catfishes** | **Ictaluridae** | | | | | | | | | | | |
| Channel Catfish | *Ictalurus punctatus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Black Bullhead | *Ameiurus melas* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

**APPENDIX B.** Taxa, numbers of fish collected, and sampling date at fixed sites in the Upper Colorado River Basin study unit—Continued

[Site 2 (French Gulch near Breckenridge) and site 10 (Dry Fork at upper station near De Beque) did not have fish present; --, species not collected]

| Common name | Scientific name | DryCr 08/96 | DryCr 08/97 | DryCr 08/98 | Reed 11/96 | Reed 01/97 | Cameo 08/96 | Cameo 08/97 | GunnGJ 08/96 | GunnGJ 08/97 | State line 08/96 | State line 08/97 | State line 08/98 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trouts** | **Salmonidae** | | | | | | | | | | | | |
| Brown Trout | *Salmo trutta* | 1 | 3 | 6 | -- | -- | 6 | 7 | 3 | 4 | -- | -- | -- |
| Rainbow Trout | *Onchorhynchus mykiss* | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Brook Trout | *Salvelinus fontinalis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cutthroat Trout | *Onchorhynchus clarki* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Kokanee Salmon | *Onchorhynchus nerka* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Mountain Whitefish | *Prosopium williamsoni* | -- | -- | -- | -- | -- | 29 | 2 | -- | -- | -- | -- | -- |
| **Sculpins** | **Cottidae** | | | | | | | | | | | | |
| Mottled Sculpin | *Cottus bairdi* | 3 | 10 | 28 | -- | -- | 3 | -- | -- | -- | -- | -- | -- |
| **Suckers** | **Catostomidae** | | | | | | | | | | | | |
| Longnose Sucker | *Catostomus catostomus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| White Sucker | *Catostomus commersoni* | 17 | 18 | 22 | 2 | -- | 31 | 25 | 6 | 9 | 2 | 4 | -- |
| Bluehead Sucker | *Catostomus discobolus* | 22 | 9 | 21 | -- | 1 | 48 | 81 | 68 | 85 | 173 | 109 | 85 |
| Flannelmouth Sucker | *Catostomus latipinnis* | 18 | 11 | 9 | 21 | 45 | 100 | 193 | 39 | 51 | 99 | 87 | 98 |
| Razorback Sucker | *Xyrauchen texanus* | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| **Carps and Minnows** | **Cyprinidae** | | | | | | | | | | | | |
| Roundtail Chub | *Gila robusta* | 5 | 1 | 2 | 5 | 2 | 65 | 80 | 39 | 52 | 45 | 42 | 20 |
| Common Carp | *Cyprinus carpio* | -- | -- | -- | 13 | 3 | 18 | 5 | 2 | 9 | 19 | 13 | 20 |
| Speckled Dace | *Rhinichthys osculus* | 46 | 38 | 44 | -- | -- | 2 | -- | 5 | 1 | 21 | 1 | 11 |
| Longnose Dace | *Rhinichthys cataractae* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Fathead Minnow | *Pimephales promelas* | 17 | 10 | 9 | 3 | 1 | -- | -- | 2 | -- | -- | 3 | |
| Sand Shiner | *Notropis stramineus* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | 3 | 1 |
| Red Shiner | *Cyprinella lutrensis* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | 2 |
| Colorado Pikeminnow | *Ptychocheilus lucius* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| **Sunfishes** | **Centrarchidae** | | | | | | | | | | | | |
| Green Sunfish | *Lepomis cyanellus* | 6 | 1 | 4 | -- | 6 | 1 | -- | -- | 1 | 6 | 13 | 3 |
| Largemouth Bass | *Micropterus salmoides* | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 3 | 1 | 1 |
| Smallmouth Bass | *Micropterus dolomieu* | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 3 | -- |
| **Perches** | ***Percidae*** | | | | | | | | | | | | |
| Yellow Perch | *Perca flavescens* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| **Catfishes** | **Ictaluridae** | | | | | | | | | | | | |
| Channel Catfish | *Ictalurus punctatus* | -- | -- | -- | -- | -- | -- | -- | -- | | 18 | 12 | 10 |
| Black Bullhead | *Ameiurus melas* | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | 1 | -- |

[1] Common and scientific names are from Robins and others, 1991.

[2] Site name abbreviations are used in this appendix. See table 1 for full site names.

**APPENDIX C.** Selected sites from the Rio Grande Valley, the South Platte River, and the Upper Snake River Basins used for comparison to the Upper Colorado River Basin fixed sites

[$mi^2$, square miles; ft, feet]

| Site name | Site identification | Study unit | Drainage ($mi^2$) | Elevation (ft) | Predominant land use | Nutrients | Trace elements | Pesticides | Habitat | Fish | Macroinvertebrates |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rio Grande near Del Norte, CO | 08220000 | RIOG | 1,311 | 7,980 | Mixed | x | | | x | x | |
| Saguache Creek near Saguache, CO | 08227000 | RIOG | 513 | 8,030 | Forest | x | x | x | x | x | x |
| Rio Grande near Lasauses, CO | 08240000 | RIOG | 2,749 | 7,500 | Mixed | x | | | | | |
| Conejos River near Lasauses, CO | 08249000 | RIOG | 789 | 7,495 | Mixed | x | | | x | x | |
| Rio Grande near Lobatos, CO | 08251500 | RIOG | 4,585 | 7,428 | Mixed | x | | | | | |
| Rio Pueblo de Taos below Los Cordovas, NM | 08276300 | RIOG | 384 | 6,650 | Forest | | | x | | | |
| Rio Grande near Taos, NM | 08276500 | RIOG | 6,527 | 6,050 | Mixed | x | x | | x | x | x |
| Rio Chama near Chamita, NM | 08290000 | RIOG | 3,073 | 5,653 | Mixed | x | x | | x | x | x |
| Rio Grande at Otowi Bridge, NM | 08313000 | RIOG | 10,958 | 5,488 | Mixed | x | | | | | |
| Rito de los Frijoles in Bandelier National Monument | 08313350 | RIOG | 18 | 6,140 | Forest | x | | | x | | x |
| Santa Fe River above Cochiti Lake, NM | 08317200 | RIOG | 228 | 5,505 | Forest | x | x | | x | | x |
| Rio Guadalupe at Box Canyon near Jemez, NM | 08323000 | RIOG | 235 | 6,015 | Forest | | x | x | | | |
| Jemez River near Jemez, NM | 08324000 | RIOG | 466 | 5,622 | Forest | | x | | | | x |
| Rio Grande at Isleta, NM | 08331000 | RIOG | 14,669 | 4,896 | Mixed | | x | x | x | x | x |
| Rio Puerco near Bernardo, NM | 08353000 | RIOG | 6,071 | 4,722 | Mixed | x | x | | | | |
| Rio Grande Floodway at San Marcial, NM | 08358400 | RIOG | 27,700 | 4,455 | Mixed | x | | | | | |
| Rio Grande at Leasburg Dam near Las Cruces, NM | 08363500 | RIOG | 28,858 | 3,950 | Mixed | x | | | | | |
| Rio Grande at El Paso, TX | 08364000 | RIOG | 29,943 | 3,722 | Mixed | x | | | x | x | x |
| Rio Grande near Bernalillo, NM | 351921106332710 | RIOG | 13,963 | 5,055 | Mixed | | x | | | | |
| Rito de los Frijoles below Frijoles Falls, NM | 354511106151010 | RIOG | 19 | 6,140 | Forest | | x | x | | | |
| La Jara Creek at Alamosa county line, CO | 372124105510601 | RIOG | 268 | 7,540 | Mixed | | x | x | | | |
| Rio Grande at Alamosa Refuge, CO | 372334105470001 | RIOG | 2,116 | 7,510 | Mixed | | x | x | | | |
| Medano Creek near Mosca, CO | 374752105300801 | RIOG | 15 | 8,450 | Forest | | x | | x | | x |
| Rio Grande near Creede, CO | 374922106542901 | RIOG | 640 | 8,580 | Forest | | x | x | | | |
| Big Thompson near Estes Park, CO | 402114105350101 | SPLT | 39 | 7,998 | Forest | | x | x | x | x | x |
| Clear Creek at Lawson, CO | 06716500 | SPLT | 147 | 8,080 | Forest | | x | | | | |
| Clear Creek at Golden, CO | 06719505 | SPLT | 400 | 5,696 | Forest | x | x | | x | x | x |
| N. St. Vrain near Allenspark, CO | 06721500 | SPLT | 33 | 8,280 | Forest | | x | x | | | |
| St. Vrain at mouth, CO | 06731000 | SPLT | 976 | 4,741 | Mixed | x | x | x | x | x | x |
| Cache La Poudre near Fort Collins, CO | 06752000 | SPLT | 1,056 | 5,220 | Forest | x | x | x | x | x | x |
| Cache La Poudre near Greeley, CO | 06752500 | SPLT | 1,902 | 4,610 | Mixed | | x | x | | | |
| Lonetree Creek near Greeley, CO | 06753990 | SPLT | 567 | 4,629 | Agricultural | x | x | | x | | x |

**APPENDIX C.** Selected sites from the Rio Grande Valley, the South Platte River, and the Upper Snake River Basins used for comparison to the Upper Colorado River Basin fixed sites

[$mi^2$, square miles; ft, feet]

| Site name | Site identification | Study unit | Drainage ($mi^2$) | Elevation (ft) | Predominant land use | Nutrients | Trace elements | Pesticides | Habitat | Fish | Macroinvertebrates |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South Platte near Kersey, CO | 06754000 | SPLT | 9,598 | 4,577 | Mixed | x | x | x | x | x | x |
| South Platte at Weldona, CO | 06758500 | SPLT | 13,313 | 4,308 | Agricultural | | x | x | | | |
| South Platte near Balzac, CO | 06759910 | SPLT | 16,852 | 4,091 | Agricultural | x | x | x | x | x | x |
| South Platte at Julesburg, CO | 06764000 | SPLT | 22,815 | 3,447 | Agricultural | | x | x | | | |
| South Platte River at North Platte, NE | 06765500 | SPLT | 24,300 | 2,789 | Agricultural | x | x | x | x | x | x |
| Snake River at Flagg Ranch, WY | 13010065 | USNK | 511 | 6,802 | Forest | x | x | x | x | x | x |
| Salt River near Smoot, WY | 13023700 | USNK | 20 | 7,040 | Forest | | x | x | | | x |
| Salt River near Etna, WY | 13027500 | USNK | 852 | 5,676 | Agricultural | x | x | x | x | x | x |
| Bitch Creek near Lamont, ID | 13054300 | USNK | 83 | 5,820 | Forest | | x | x | | | x |
| Teton River near St. Anthony, ID | 13055000 | USNK | 886 | 4,972 | Agricultural | x | x | x | | | x |
| Henrys Fork near Rexburg, ID | 13056500 | USNK | 3,218 | 4,807 | Mixed | x | x | x | | x | x |
| Blackfoot River near Henry, ID | 13063000 | USNK | 341 | 6,260 | Forest | | x | x | | | |
| Snake River near Blackfoot, ID | 13069500 | USNK | 12,184 | 4,401 | Mixed | x | x | x | | x | x |
| Portneuf River at Topaz, ID | 13073000 | USNK | 588 | 4,918 | Agricultural | x | x | x | x | x | x |
| Portneuf River at Pocatello, ID | 13075500 | USNK | 1,295 | 5,850 | Mixed | | x | x | | | |
| Snake River near Minidoka Dam, ID | 13081500 | USNK | 18,853 | 4,132 | Mixed | x | x | x | | x | x |
| Snake River near Kimberly, ID | 13090000 | USNK | 22,645 | 3,363 | Mixed | | x | x | | | |
| Rock Creek near Rock Creek, ID | 13091995 | USNK | 52 | 4,700 | Forest | | x | x | | | x |
| Rock Creek at Twin Falls, ID | 13092747 | USNK | 241 | 3,625 | Agricultural | x | x | x | x | x | x |
| Snake River near Buhl, ID | 13094000 | USNK | 29,384 | 2,952 | Mixed | x | x | x | | x | x |
| Big Wood River below Boulder Creek, ID | 13135350 | USNK | 125 | 6,540 | Forest | | x | x | | | x |
| Malad River near Gooding, ID | 13152500 | USNK | 3,323 | 3,345 | Agricultural | x | x | x | | x | x |
| Snake River at King Hill, ID | 13154500 | USNK | 35,885 | 2,492 | Mixed | x | x | x | | x | x |