Section 8.0
Wildlife, Fish, and Aquatic Invertebrates

Summary

Within the South Arkansas River watershed, most of the land above the project corridor is managed by federal agencies and wildlife habitat is generally good. Within the project corridor, most of the land adjacent to the river is privately owned and habitat conditions exhibit marked differences in quality. In-stream and streamside habitat are in generally good condition in the upper portion of the project corridor. In-stream habitat in the lower portion is degraded by reduced stream flows, lack of in-stream habitat diversity, barriers to fish movement, and channel encroachment (straightening, bank hardening). Similarly, streamside habitat in many areas has been degraded or eliminated by development and intensive grazing. These changes also negatively affect in-stream habitat through excessive erosion and deposition of fine sediments. Some in-stream habitat solutions are difficult and expensive, such as replacing culverts that block fish movement. On the other hand, restoration of streamside habitat may only involve small changes in the timing and intensity of grazing.

This section discusses the wildlife, fish, and aquatic invertebrates common to the South Arkansas River watershed. Species that depend on the river and streamside habitat, such as beaver and trout, are examined in more detail. The section concludes with recommendations to address existing and potential adverse conditions.

Background

The South Arkansas River watershed is located in the Southern Rockies Ecoregion 21 (Chapman et al. 2006[1]) and encompasses three distinct vegetation zones—alpine (above timberline or about 11,500 feet), subalpine (9,000 feet to timberline), and montane (7,000 to 9,000 feet). Some animals are specific to the plant communities in these zones, but many range between them. Except where indicated, information in this section was drawn from Whitney et al. (1985), Benedict (1991), Mutel and Emerick (1984), and CNHP (2009).

Mammals

Mule deer (*Odocoileus hemionus*), elk (*Cervus elephus*), and beaver (*Castor canadensis*) were observed during the field work. Other mammals common in the watershed include squirrels (*Sciurus* sp., *Tamiasciurus* sp.*),* coyote (*Canis latrans*), and

[1] Ecoregion 21 corresponds to the NRCS Major Land Resource Area 48A, Southern Rocky Mountains (NRCS 2006) and to the USFS Section M331F, Southern Parks and Rocky Mountain Range (USFS 2013b).

mice (*Zapus* sp., *Peromyscus* sp.). Species common at higher elevations include yellow-bellied marmot (*Marmota flaviventris*) and snowshoe hare (*Lepus americanus*).

Reptiles and Amphibians

Reptiles and amphibians are not common in Chaffee County. Amphibians in the South Arkansas River watershed include the barred tiger salamander (*Ambystoma mavortium*) and the boreal chorus frog (*Pseudacris maculata*) in small scattered populations mostly at lower elevations. The western terrestrial garter snake (*Thamnophis elegans*) can be found throughout the county up to approximately 11,000 feet (CNHP 2009).

Birds

The South Arkansas River watershed provides mid- to high-elevation habitat important to migratory birds. The watershed is located in Bird Conservation Region (BCR) 16, and is situated between three designated bird habitat conservation areas (BHCA) in the Southern Rocky Mountains—South Park to the north (BHCA 10), the San Luis Valley to the south (BHCAs 1, 2) , and Gunnison to the west (BHCA 4) (Figure 8-1) (NABCI 2013). Priority bird habitats in the South Arkansas River watershed are as follows: Priority A (high threat)—high-elevation riparian, aspen, and wetlands; Priority B (moderate threat)—mountain shrublands, mixed conifer forest, and spruce-fir forest; and Priority C (low threat)—alpine tundra (PIF 2000, IWJV 2005). Bird names are according to Sibley (2000).

Birds common in riparian areas include: tree swallows (*Tachycineta* sp.), warblers (*Dendroica* spp., *Oporornis* spp.), and sparrows (*Melospiza* spp.). Of the IWJV priority bird species, Virginia's Warbler (*Vermivora virginiae*) is specifically mentioned for the Arkansas River basin (PIF 2000). Other priority species that may be found in the watershed include Sora (*Porzana carolina*), Red-Naped Sapsucker (*Sphyrapicus nuchalis*), Lewis's Woodpecker (*Melanerpes lewis*), Flammulated Owl (*Otus flammeolus*), Pinyon Jay (*Gymnorhinus cyanocephalus*), and Swainson's Hawk (*Buteo swainsoni*) (Mackie 2013).

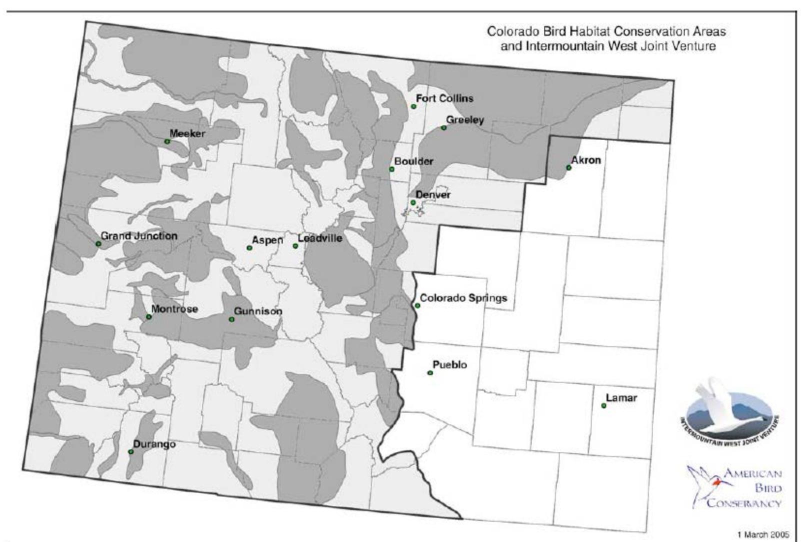

Figure 8-1. BCR 16 (left) **and Colorado BHCAs** (IWJV 2013)

Birds observed during field visits in the South Arkansas River project corridor included American Dipper (*Cinclus mexicanus*), Magpie (*Pica pica*), Red-tailed Hawk (*Buteo jamaicensis*), Wild Turkey (*Meleagris gallopavo*), and Great Blue Heron (*Ardea herodias*). Colorado Parks and Wildlife has designated critical habitat in the watershed for Peregrine Falcon (*Falco peregrinus*), Bald Eagle (*Haliaeetus leucocephalus*), and Wild Turkey. Most of that habitat is on lands managed by the U.S. Forest Service and Bureau of Land Management. For the Bald Eagle, however, a significant amount of habitat is located on private land adjacent to the South Arkansas River.

Wildlife Species of Special Concern in the South Arkansas River Watershed

The northern leopard frog (*Lithobates pipiens*) is the only vertebrate species of special concern in the South Arkansas River watershed (Wertsbaugh 2013). It is state listed as a species of concern (CNHP 2014a). Two other vertebrates are found in the county, but not in the South Arkansas River watershed—the state-endangered western toad (*Anaxyrus boreas*), previously known as the boreal toad (*Bufo boreas*) (CNHP 2014a); and the greenback cutthroat trout (*Oncorhynchus clarki somias*) is listed as a threatened species at the federal and state levels (Policky 2012, CNHP 2014b).

Wildlife Habitat in the South Arkansas River Watershed

In the South Arkansas River watershed, Colorado Parks and Wildlife (formerly Colorado Division of Wildlife) has designated critical habitat for elk, deer, bighorn sheep, black bear, mountain lions, and bobcat (Figure 8-2). Most of the habitat is managed by the U.S. Forest Service and Bureau of Land Management. For elk and deer, however, a significant amount is located on private land adjacent to the South Arkansas River. Significant wildlife habitat as designated by Colorado Parks and Wildlife is provided in Appendix B.

Beavers and Stream Ecology

Trappers arrived in the Upper Arkansas Valley in 1811 and continued trapping beaver for the next 30 to 40 years (Chaffee County 2013). No information was located that compares current and historic beaver populations in the South Arkansas watershed. Like most areas of the Intermountain West, most beaver were presumably removed from the watershed in the 1800s. In general, current beaver populations in North America (6-12 million) represent a small fraction of those prior to major settlement (60-400 million) (Naiman et al. 1988, Outwater 1996). Beaver are currently active throughout the watershed.

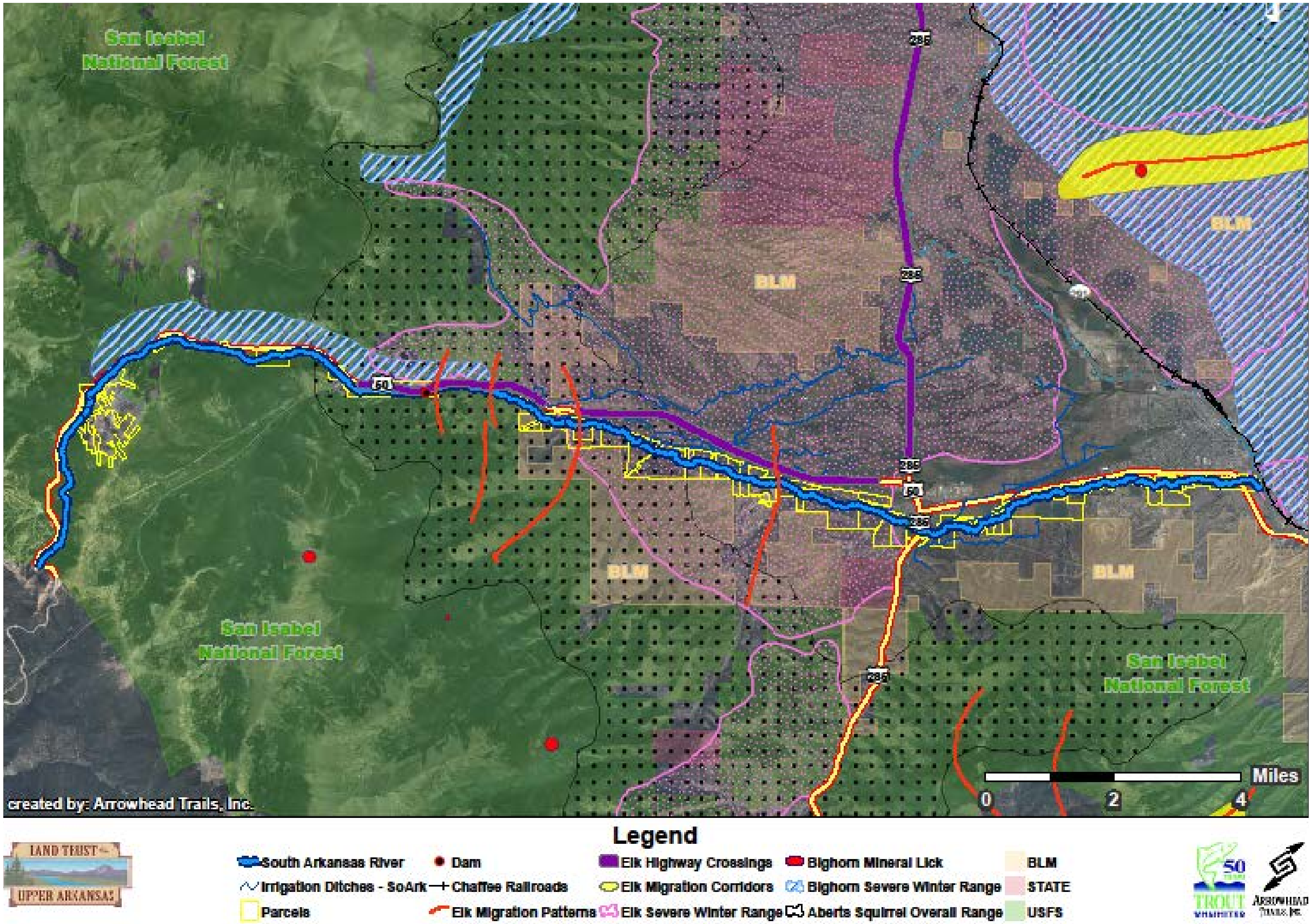

Figure 8-2. Important mammal habitat in the South Arkansas River watershed

Beavers dam smaller streams (usually first- to-fourth order) to impound water. This increases the size of their habitat and food supply, and offers protection from predators. Locally, this changes a moving-water ("lotic") system to a standing-water ("lentic") system. Consequences of beaver dams for the stream include:

- altering the normal discharge patterns, such as slowing of flow velocity and increasing the elevation of the local water table;
- increasing retention of sediment and organic matter and, through that, modifying downstream water quality and material flows; and
- modifying the riparian zone—and often the stream channel—by felling trees and shrubs (e.g., aspens, willows) (Naiman et al. 1988, Butler and Malanson 2005).

These changes may substantially influence habitat availability for other plants and animals, for good and ill. For instance, wetlands usually increase and conifers may begin to replace deciduous species around beaver ponds. Trout may be adversely affected by the silting-in of existing spawning beds, and the creation of too many dams may slow or prevent the movement of fish to other sections of stream (Butler 2006, USFS 1990). Beaver dams that fail may scour downstream areas and release large amounts of sediment that may bury downstream spawning beds. However, some researchers note that the amount of sediment delivered downstream "appears to be small" and that revegetation of exposed sediment remaining behind the dam was "extremely rapid" (Butler and Malanson 2005).

On the other hand, water levels during spring runoff may lessen barriers to fish movement. Also, beaver ponds in the Rocky Mountain west "tend to support greater production of aquatic invertebrates, as well as more and larger trout than undammed sections of the same stream" (Butler 2006, USFS 1990). Beaver ponds may also provide refuge for fish and amphibians during drought (Lewis and Tricot 2003). Medin and Clary (1990) found greater bird density and diversity associated with beaver ponds compared to adjacent riparian habitat. Livestock are also attracted to areas influenced by beaver because of water, shade, and vegetation that remains green after upland forage has dried out (McKinstry and Anderson 2002).

Habitat changes as a result of beaver activity may remain until the next spring runoff, or for years or centuries (Naiman et al. 1988, Butler 2006). Because of the impact that beaver have on their surroundings, the terms "keystone species" (Power et al. 1996) and "ecosystem engineer" (Wright et al. 2002) have been applied to them. For instance, a sinuous, single channel is often presumed to be the natural state of streams in the Rocky Mountains. However, historically, under the influence of beaver activity and riparian vegetation, a more likely form was multiple, smaller channels separated by vegetated islands that are large relative to the individual channels (referred to as "anabranching") (Polvi and Wohl 2013). These differences in channel form have implications for the impact of a stream on local ecosystems, what is considered "natural" for a given stream and, therefore, the type of restoration pursued.

Removal of beaver results in: (1) a lowering of the local water table; (2) less diverse habitat for fish, aquatic insects, and streamside vegetation; (3) a more uniform stream gradient; and (4) increased stream power, such as faster spring flows. Changes in flow regime may alter channel configuration through increased erosion and deposition, including increased channel entrenchment and incision downstream (Wohl 2006, Butler and Malanson 2005).

Trout Habitat Requirements

Stream channel physical features—gradient, water depth, water velocity, substrate, and cover—are the primary determinants of the types and quality of fish habitat. In general, trout require:

- clear, cold water, silt-free rocky substrate in riffle-run areas;
- an approximately 1:1 pool-to-riffle ratio, with areas of slow, deep water;
- well-vegetated stream banks;
- relatively stable water flow, temperature regimes, and stream banks; and
- abundant in-stream cover.

Important water quality characteristics for trout waters include the amount of suspended sediment, temperature, pH, nutrients, and potentially toxic chemicals (USFS 1990).

Cover is any bank or channel feature "that allows trout to avoid the impact of the elements or enemies" (Binns and Eiserman [1979], in USFS 1990). Cover can be provided by water depths greater than 6 inches; areas of water surface turbulence; rocky substrate greater than 3 inches in diameter; overhead bank cover—undercut banks, overhanging vegetation, logs, or debris piles—at least 3.5 inches wide and associated with water at least 6 inches deep; submerged vegetation; in-stream objects such as stumps, logs, roots, and large rocks, and pools deeper than 18 inches. Mid-day shade should cover 50 to 75% of small trout streams (USFS 1990; USFWS 1982b, 1984, 1986).

How and when stream channel physical features are used depends on the fish life stage, that is, eggs, fry, juveniles, and breeding adults (Schlosser 1991). Comparisons of habitat suitability indices for rainbow trout (USFWS 1984), brook trout (USFWS 1982b), and brown trout (USFWS 1986) indicate the following general requirements for each life stage.

- **Eggs**—Successful incubation requires a combination of low temperature, high dissolved oxygen, moderate water velocity (1.0 to 2.3 feet per second; high water velocities can wash out nests, known as "redds"), gravel permeability, and lack of fine sediments.
- **Fry**—This life stage requires shallower water and slower velocities (less than 0.3 feet/second) than other life stages of stream trout. Other important characteristics include pool habitat that is 40 to 60% of total stream area, and

cover, whether in the form of aquatic vegetation, debris piles, or the spaces between stream substrate that are 4 to 16 inches in diameter.

In addition to protection from predation, the spaces between stream substrate are important for eggs and fry because they facilitate the movement of oxygen and nutrients from the overlying water column. Reduction in the permeability due to increased fine sediments also decreases the survival of fish embryo and reduces fry emergence and fry size (Chapman 1988, Sylte and Fischenich 2002). The lack of space between substrate is referred to as embeddedness, i.e., the extent to which larger substrate (gravel, cobble, and boulders) is covered by smaller particles (mud, silt, and sand)[2] (USEPA 1999). Embeddedness also adversely affects aquatic invertebrates (discussed below) and is also used as a measure of water quality (see Section 9.0).

- **Juveniles**—The juvenile stage requires water velocities between 0.3 and 0.4 feet per second cover habitat comprising about 10 to 15% of stream area. Examples include logs, upturned roots, piles of woody debris, overhanging banks, riffles, and small boulders.
- **Breeding adults**—Adult brook trout tend to occupy headwater stream areas, especially when adult rainbow and brown trout are present in the same river system. In terms of nesting, substrate should be 0.4 to 3.0 inches in diameter. Areas of groundwater welling up into stream substrate are preferred by brook and rainbow trout. Spawning periods are as follows: rainbow trout – summer, brown trout – fall, and brook trout – all-early winter.

Trout also occupy different habitats during the winter. Overwintering areas are usually structurally complex and have greater water volumes and lower water velocities. These aspects reduce the likelihood of exposure to extreme changes in temperature (Schlosser 1991). Large substrate (4 to 16 inches in diameter) provides winter cover for fry and smaller juveniles (USFWS 1986). Deposition of fine sediment can restrict winter cover for adult fish by filling in low-velocity habitats such as pools and undercut banks (USFS 1990). The presence of adequate overwintering habitat can be more limiting to trout populations in some streams than the adequacy of summer rearing habitat (USFWS 1982b). Last, the presence of barriers to migration may adversely affect the ability of trout to escape predation and to move to more suitable habitat within a stream during both summer and winter (USFS 1990).

Importance of Stream Dynamics for Trout Habitat

According to Poff et al. (1997), "streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems." The quantity and timing of water—a river's "natural flow regime"—create and continually modify the

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[2] Gravel, cobble, and boulders range in size from 0.1 to 10.1 inches (2 mm to > 256 mm); mud, silt, and sand range in size from < 0.00008 to 0.08 inches (< 0.002 mm to 2 mm).

nature and location of in-stream and streamside habitats, streambed substrate size and distribution, available sediment, and woody debris (Figure 8-3). These authors also emphasized the importance of high- and low-flow conditions because “they often serve as ecological ‘bottlenecks’ that present critical stresses and opportunities for a wide array of riverine species.” This “predictable diversity” is required by species such as trout for completion of each stage of their life cycle. Changes in a river’s natural flow regime, such as by dams and water diversions, alters normal disturbance patterns and habitat dynamics created by the natural flow regime and creates conditions to which native species may be poorly adapted.

Impacts of Land Use on Trout Habitat

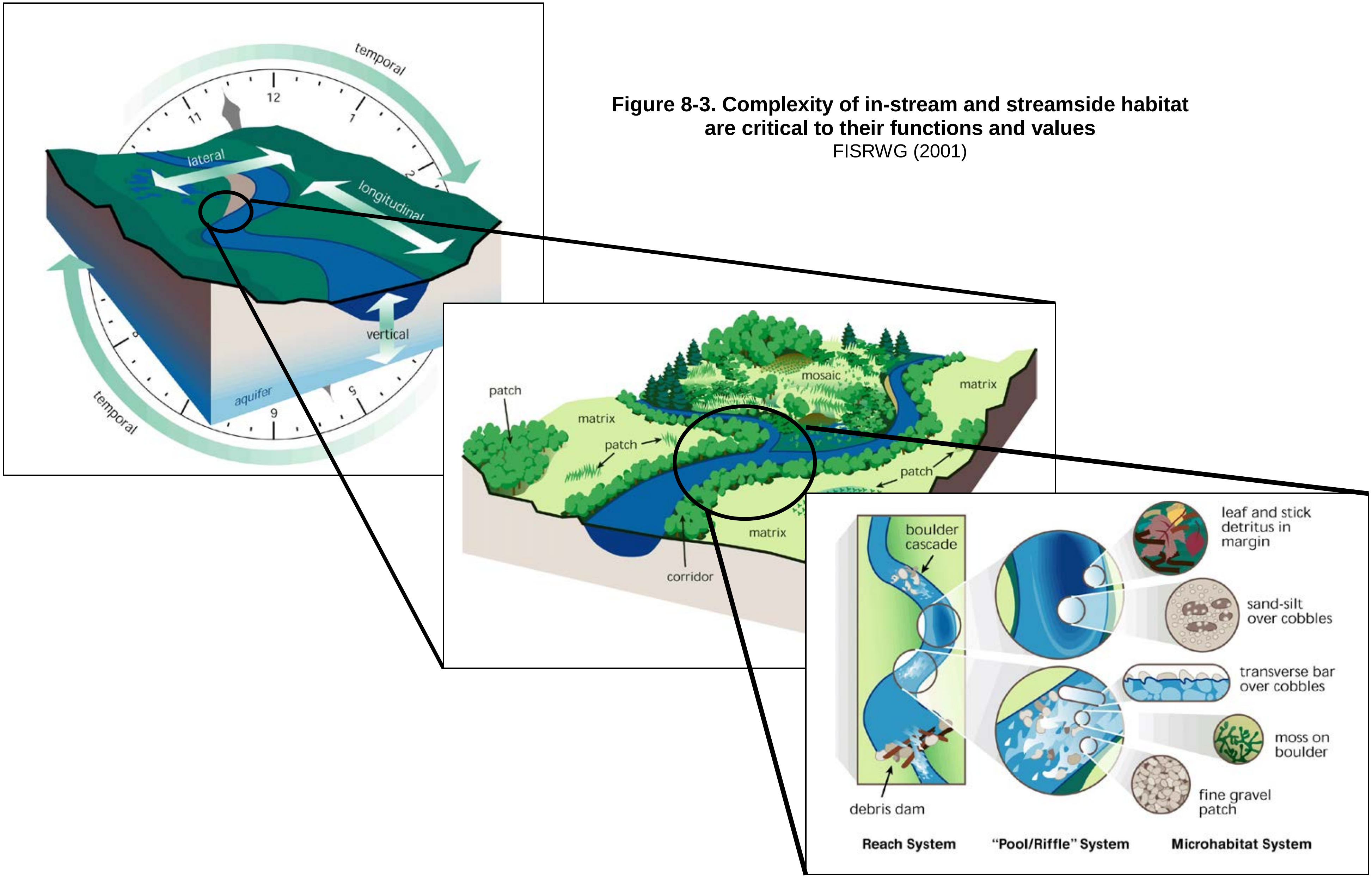
According to Schlosser (1991), land use is the primary factor causing the decline of fish and fish habitat in streams, often by creating “stream channels consisting of large expanses of structurally simple, shallow habitats.” These habitat changes usually reduce the diversity and age structure of fish populations (i.e., fewer adults, more juveniles), reduce the spatial separation of age classes, and limit reproductive success. Other changes are described below.

- **Streamside vegetation**—Loss of streamside vegetation can lead to higher water temperatures, increased streambank erosion, and declines in the amount of organic materials entering the stream. Such organic matter forms the base of the food chain in most headwater streams. Loss of vegetation may arise from mechanical removal or from inappropriate livestock use of streamside habitats.
- **Habitat complexity**—In-stream habitat complexity is reduced by the removal of woody debris, or through physical changes in the stream channel such as straightening (“channelization”). Loss of stream complexity may also arise from loss of the normal variability of stream flows from water diversions or dams.
- **Development**—Intensive land use, such as from urbanization, usually increases the amount of water reaching a stream, the speed with which it arrives, and the amount of fine sediments carried with it. These changes aggravate stream conditions during high and low flows and often bury existing stream substrate (Schlosser 1991).

Barriers to Fish Migration

Fish migrate within a river channel to: escape unfavorable conditions (e.g., excess heat or cold); find appropriate spawning habitat; find food; and escape predation. Barriers to such movements may lead to declines in or elimination of fish populations. Physical barriers to fish migration include: water diversion structures; road crossings and culverts; and dams, weirs, and other impoundments. Related conditions that may impede or prevent migration include: high water velocities; a change in elevation that is too great for the fish’s jumping ability; lack of a resting pool below an obstruction; or the

Figure 8-3. Complexity of in-stream and streamside habitat are critical to their functions and values
FISRWG (2001)



water within an obstruction, such as a road culvert, may be too shallow to allow passage (CDFG 2003). Last, barriers may be seasonal, such as occurs during low flows, or they may be permanent (USFS 1990, Warren and Pardew 1998).

The impact of barriers to fish migration can be reduced or eliminated by:

- creating a resting pool immediately below the barrier that allows fish to conserve energy and obtain a good start to overcome the obstacle;
- limiting jumps to less than one foot for a single jump or less than one-half foot if a series of jumps is required;
- providing resting pools if the swimming distance through culverts is greater than 50 to100 feet;
- providing a second rest area upstream of the barrier; and
- placing culverts as close to zero gradient as possible and limiting sudden increases in water velocities below, within, and above culverts (Yee and Roelofs 1980).

Fish in the South Arkansas River

Fish in the South Arkansas River include brook trout, rainbow trout, brown trout, white sucker, and longnose sucker. Brook trout (*Salvelinus fontinalis*) are native to the eastern U.S. and Canada (USFWS 1982b), rainbow trout (*Oncorhynchus mykiss*) are native to the west coast of the U.S. (USFWS 1984), and brown trout (*Salmo trutta*) are native to Eurasia (USFWS 1986). These species were introduced to Colorado in the late 1800s. The white sucker (*Catostomus commersonii*) and longnose sucker (*C. catostomus*) are native to rivers and lakes on the eastern slope of Colorado (Woodling 1985). No information exists as to whether or what other native fish species, such as greenback cutthroat trout (*Oncorhynchus clarki somias*), may have existed in the South Arkansas River prior to major settlement (Policky 2012).

The most recent fish surveys of the South Arkansas River were conducted in 2000 and 2004. The 2000 survey was conducted in Salida at Chaffee County Road 107. Brown trout, rainbow trout, white sucker, and longnose sucker were captured. The 2004 survey was conducted at five sites between the Xcel hydropower site west of Maysville and Chaffee County Road 220 in the upper portion of the project corridor. Brook trout, brown trout, and rainbow trout were captured. At survey sites within the project corridor, brown trout were most abundant, followed by rainbow trout (CDOW 2004; Table 8-1). The 2004 survey is considered stronger statistically. The 2000 survey was a single-pass survey conducted with the help of volunteers; it is considered qualitative (Policky 2012).

Table 8-1
Comparison of 2004 Trout Surveys in the South Arkansas River

	Brown Trout	Rainbow Trout
Number per mile	1,275.5	89.9
Number per acre	717.8	50.4
Pounds per acre	127.9	10.9

Water quality in the South Arkansas River is considered sufficient to support healthy trout populations (Brinkman 2013). See Section 9.0, Water Quality, for more details.

Aquatic Invertebrates

Aquatic invertebrates (organisms without backbones) include micro-invertebrates like rotifers, midge larvae (e.g., chironomids), and water fleas (*Daphnia* sp.), and larger macro-invertebrates like aquatic insects, insect larvae, crustaceans (e.g., amphipods), snails, and annelid worms. Many of these organisms feed on the aquatic fungi, bacteria, protozoans, and algae ("periphyton") that colonize the leaves and other organic matter that fall into the stream. These creatures are fed upon by predatory adult insects and insect larvae that then become food for fish and other wildlife (Allan 1995). A variety of stream substrate sizes is important to maintain a diverse invertebrate community. Cobble-size material seems to predominate (2.5 to 10.0 inches) and the presence of too much fine material (less than 0.1 inch) seems to limit their numbers.

Invertebrates are usually more abundant and diverse in riffle areas rather than pools (USFWS 1986). Abundance also varies seasonally, with peaks in late spring and summer, declines through summer, and another increase in late fall (Schlosser 1991). Given the association of invertebrates with stream substrate, the exchange of water between the stream and groundwater ("hyporheic zone") is also important (Allan 1995, Meyer et al. 2007).

Whether in urban or rural areas, fine sediments (i.e., sand, silt, and clay-sized particles) affect the stream environment by: (1) altering substrate composition and its suitability for various organisms; (2) reducing the food value of periphyton; (3) reducing prey density; (4) adversely affecting respiration by clinging to gills; (5) decreasing the oxygen available in the stream bed; (6) smothering and burial; and (7) changing the distribution and composition of invertebrate species (Wood and Armitage 1997; USEPA 2003b). Similar to the effects on fish, physical barriers along the length of a stream can inhibit restoration of a stream for aquatic invertebrates (Blakely et al. 2006). However, the response of aquatic macro-invertebrates to in-stream restoration structures was "highly variable" (Roni et al. 2008). Given the importance of aquatic invertebrates in the stream food chain, attention to the impact of larger restoration efforts on aquatic insects can be important to overall success.

Aquatic Invertebrates and Stream Bioassessment

Biological assessment ("bioassessment") is "an evaluation of the condition of a waterbody using biological surveys and other direct measurements of the resident biota in surface waters" (USEPA 1999). Aquatic macro-invertebrates are used in the bioassessment of streams because: (1) they are found in almost all freshwater environments; (2) are easy to sample and identify; and (3) different groups ("taxa") of aquatic macro-invertebrates show different sensitivities to pollution and other stream impacts (USEPA 1999). Specifically, three groups of aquatic insect larvae—mayflies (Family: Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera)—are an important food source for trout, but are sensitive to degraded habitat and water quality conditions. Other invertebrates, such as midge larvae (chironomids) and annelid worms (oligochaetes), use fine sediments for feeding and burrowing. Therefore, increasing amounts of fine sediments can cause a shift in the composition of the invertebrate community (Harrison et al. 2007).

Colorado's Multi-Metric Index (MMI) is used for bioassessment purposes (CDPHE 2010). Use of the MMI begins with determination of ecoregion, elevation, and stream slope at the aquatic invertebrate sampling sites. For the South Arkansas River, the ecoregion is Southern Rockies[3]; from west to east, elevation at sampling sites range from 10,400 to 7,040 feet; and stream slope range from 3.5 to 1.8. Thereafter, MMI specifies protocols for sampling of the invertebrates collected and identification of most specimens to species. The results are analyzed according to relative pollution tolerance, functional feeding groups, and habit types.[4] A final MMI index score is then generated.

Aquatic Invertebrates in the South Arkansas River

Sampling of aquatic invertebrates in the South Arkansas River was conducted in August, 2013. Single-site sampling protocols are detailed in USEPA (1999) and CDPHE (2010). Five sampling locations were selected to correspond with those for water quality evaluation. These locations were chosen in an attempt to identify whether development and changes in land use above and within the project corridor significantly alters the aquatic invertebrate community. Samples were preserved in a 70% solution of isopropyl alcohol. All aquatic invertebrates collected were counted. Cost considerations limited identification of aquatic invertebrates to family, or genus, if possible. Insects were identified using Ward and Kondratieff (1992). Table 8-2 summarizes sampling results.

[3] Crystalline Subalpine Forests (21b) – 8,500 to 12,000 feet; and Crystalline Mid-Elevation Forests (21c) – 7,000 to 9,000 feet.
[4] Functional feeding groups include parasite, predator, omnivore, scraper, gatherer/collector, filter/collector, shredder, and piercer. Habit types include clinger, climber, sprawler, burrower, swimmer, diver, and skater.

Table 8-2
Results of Aquatic Invertebrate Sampling in the South Arkansas River

Taxa	Site 1	Site 2	Site 3	Site 4	Site 5
Ephemeroptera (mayflies)	84	12	51	81	17
Plecoptera (stoneflies)	128	147	16	28	5
Tricoptera (caddisflies)	50	22	130	54	29
EPT Subtotal	262	181	197	163	51
Diptera (true flies)					
Other Dipterans 1/	67	4	65	13	15
Chironomidae (midges)	1	1	0	0	2
Coleoptera (beetles)	18	30	47	41	35
Molluscs	7	0	12	8	6
Other Invertebrates 2/	15	5	11	11	64 3/
Total	370	221	332	236	173

1/ For example, Dixidae and Simuliidae
2/ For example, Amphipoda, Lepidoptera, Hemiptera, and *Planaria*
3/ 70% amphipods

Wildlife, Fish, and Aquatic Invertebrates—
Impacts and Issues in the South Arkansas River and Watershed

Existing Fish Habitat

In the upper portion of the project corridor, in-stream habitat is good based on the following observations.

- There are few barriers to fish movement, such as culverts, water diversion structures, and areas of shallow water.
- In-stream habitat is more diverse, both from more frequent occurrence of large woody debris in the channel and larger and more diverse channel substrate.
- Lack of significant impacts from fine sediment deposition (embeddedness), generally less than 25% based on visual observations. Materials were mostly sand-sized (< 0.04 inches [< 1.0 mm]).
- Streamside plant communities are largely intact and provide shading, organic matter, and bank stability.

By comparison, in-stream habitat in the lower portion of the project corridor declines progressively in a downstream direction based on the following observations.

- In-stream habitat diversity decreases due to channel straightening, lack of large woody debris in the channel, few areas of velocity protection, and limited overwintering habitat.

- Areas of sediment deposition are more frequent, larger, and the materials smaller (silt and mud, < 0.002 inches [< 0.05 mm]). These areas are most often associated with water diversions, that is, embeddedness is greater (50-75%) below many such diversions than above (≤ 25%). Areas with existing and remnant beaver dams display the opposite pattern.
- Streamside plant communities are more degraded (e.g., greater percentage of upland and non-native species) or are absent. This limits their ability to provide shade, organic matter, and bank stability.
- The number of individual EPT specimens declined from 262 at Site 1 to 51 at Site 5. The percentage of EPT individuals among all invertebrate collected declined from a high of 82% at Site 2 to 22% at Site 1. These patterns are consistent with the general downstream decline in water quality and stream substrate conditions.
- Potential barriers to fish movement in the project corridor are more frequent. These barriers were identified during field surveys in 2012 and 2013. Photographs and general locations are provided in Appendix D. Preliminary measurements were taken of barrier components, such as pool volume below and jump heights, but each site should be analyzed further, such as for water velocities, to determine if a barrier actually exists or whether passage may be seasonal, such as only during high flows.
- The impact of reduced water volume in the channel because of water diversions is more evident, especially in the frequency of shallow water in overly wide sections of the river.

Some of the adverse conditions noted above can be easily addressed, while others are more difficult. For instance, changing grazing practices[5] and helping landowners restore riparian vegetation are fairly inexpensive, fairly simple to implement, and can lead to dramatic improvements. On the other hand, removing structural barriers and reconfiguring channelized or overly wide sections of the river are more difficult and expensive. However, several government programs are available to help fund both land management and in-stream projects, including the federal Natural Resources Conservation Service (NRCS 2013b), Partners for Fish and Wildlife (USFWS 2013b), the Colorado Water Conservation Board (CWCB 2013a), and the Private Land Program at Colorado Parks and Wildlife (CPW 2013b).

While many studies reported positive responses by salmon and trout to in-stream habitat improvement, other studies produced conflicting results, and few studies were long enough (5 years) to detect statistically significant changes (Roni et al. 2008). Last, degraded in-stream areas that remain may present barriers to fish movement and limit the success of areas that are restored.

[5] More detail on grazing impacts in riparian areas is provided in Section 3.0, History, Land Use, and Development.

Beavers in the South Arkansas River

Most areas along the length of the South Arkansas River show evidence of past and current beaver activity. The changes created by beaver have many of the desired features in riparian restoration and don’t require maintenance. Damage from damming and flooding caused by beaver can be significant, but breaching or destruction of existing dams is not necessary to control flooding in the vicinity of beaver dams (Figure 8-4). Other techniques are available to prevent beavers from blocking culverts (Figure 8-5) and felling trees (Figure 8-6).

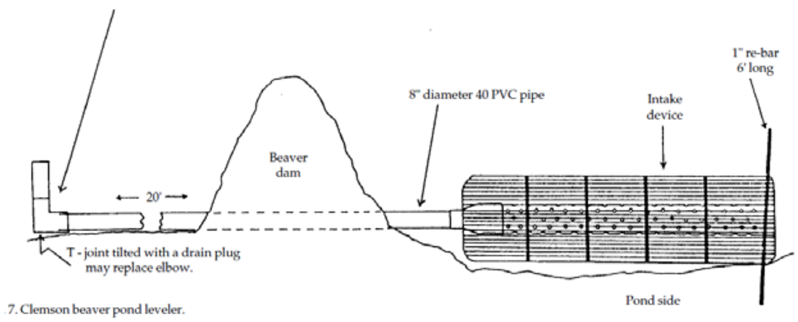


Figure 8-4. Pond leveler to control water elevation
(Miller and Yarrow 1994)

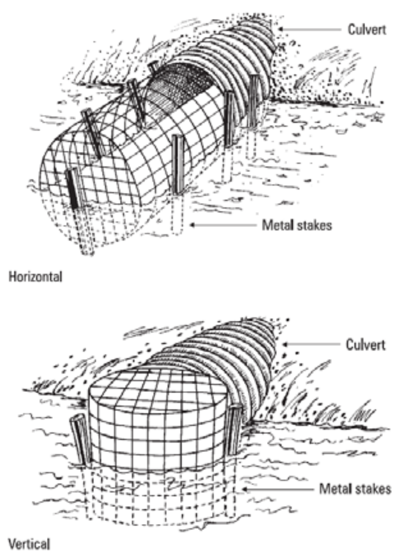


Figure 8-5. Wire mesh to prevent blockage of culvert by beaver (USFS no date)

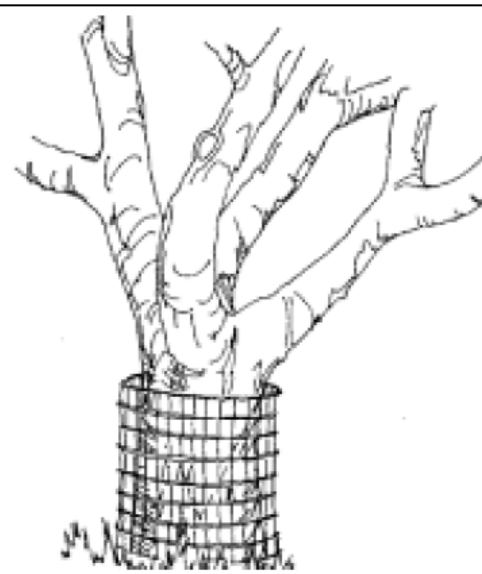


Figure 8-6. Wire mesh to protect existing trees from beaver damage (WDFW 2004)

Other aspects of wildlife, fish, and aquatic invertebrates are discussed in the following sections.

- Section 2.0, Watershed Assessment and Stream Ecology
- Section 6.0, Hydrology and Flow Regime
- Section 7.0, Vegetation
- Section 9.0, Water Quality
- Section10.0, Channel and Floodplain Processes

Restoration goals and recommendations for the South Arkansas River and watershed are discussed in Section 11.0, Establishing Watershed and Riparian Restoration Goals.

I never drink water because of the disgusting things fish do in it.

W.C. Fields