

The Upper Yampa River Watershed Group

2014

State of the Watershed Report



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Yampa River, photo Courtesy of Western Rivers Conservancy



Flat Tops Wilderness Area Courtesy United States Forest Service

Preface

The Upper Yampa River Watershed Group (UYRWG) represents a collaboration to protect and enhance the health of the Upper Yampa River Watershed (UYRW) from the headwaters of the Yampa River to the confluence of, and including, Elkhead Creek (Figure 1). The UYRWG is committed to the physical, chemical, and biological health of the upper Yampa River and its tributaries. By creating a non-regulatory watershed plan, the UYRWG hopes to increase local partnerships and their capacity to protect and enhance water quality, promote water conservation, and sustain and improve the present health of the watershed. This 2014 State of the Watershed Report (SOTWR) is the first step in that process and serves to document existing conditions. Next, stakeholders will work together both to define objectives for watershed health and to prioritize projects aimed at meeting those objectives. All efforts will culminate in a dynamic watershed action plan outlining those objectives and projects cited above.

The SOTWR builds upon the work of many stakeholder efforts, studies, and reports within the past two decades, such as the 1996 and updated 2002 [208 Water Quality Management Plan for the Yampa River Basin](#) and the more recent U.S. Geologic Survey (USGS) [Water-Quality Assessment and Macroinvertebrate Data for the Upper Yampa River Watershed, Colorado, 1975-2009](#). The UYRWG will utilize and contribute to the [Upper Yampa Water Quality Monitoring Program](#), which was spearheaded in 2010, by many of the same partners that funded the USGS Assessment: Routt County, Colorado Water Conservation Board, the City of Steamboat Springs, the Yampa-White-Green Basin Roundtable and the Upper Yampa Water Conservancy, Mt. Werner and Morrison Creek Water & Sanitation Districts. The water quality monitoring program is contracted through the USGS which monitors long-term water quality at six sites in the UYRW (Figure 1). The intent of the program is to create baseline references that will be analyzed after five years of data collection. Detailed information can be found at the [USGS Colorado Water site](#).

The UYRWG anticipates this watershed planning process will provide 1) information and context regarding the upper Yampa River system and the essential components that it needs to function properly for both the community and the environment and 2) vetted suggestions of how those needs may be met.

This report contains introductory information on watershed characteristics, water quality parameters (see Explanations of Terms), and natural and human influences on water quality. The subbasin sections provide area-specific overviews of water quality and watershed characteristics.

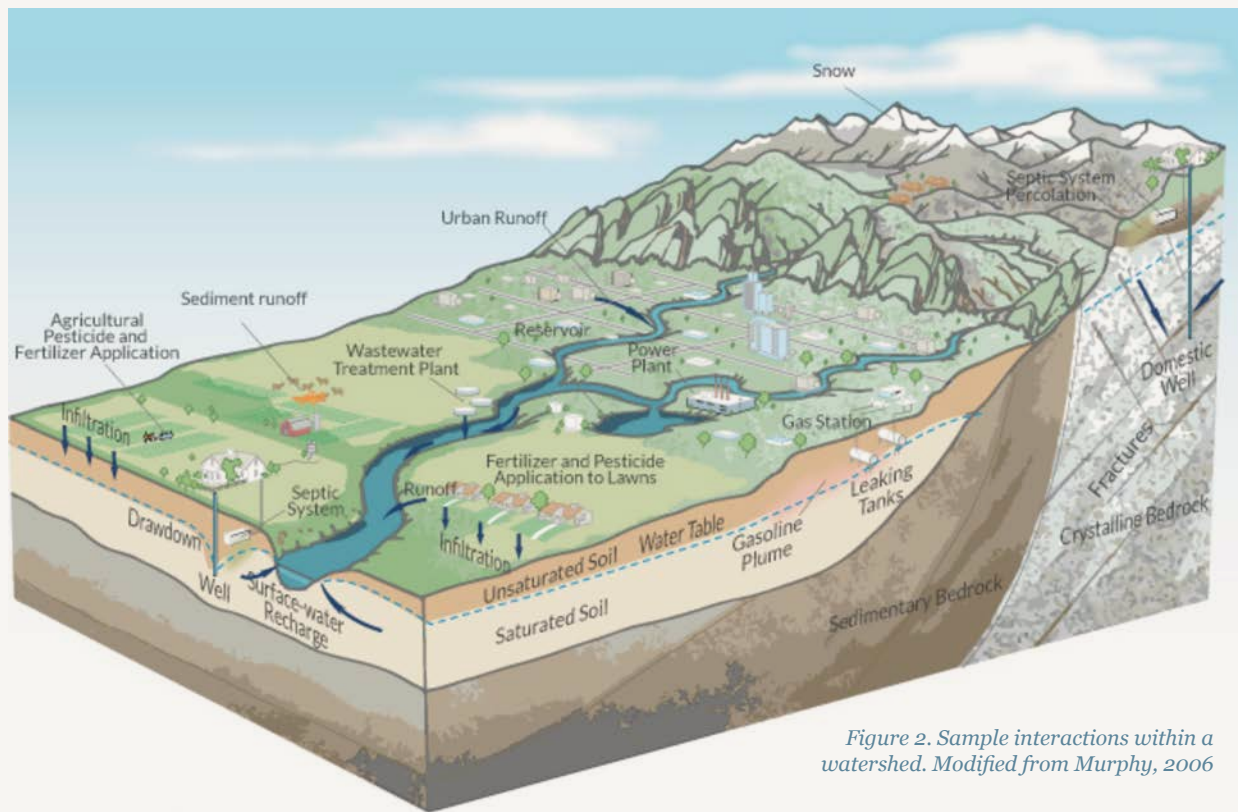


Figure 2. Sample interactions within a watershed. Modified from Murphy, 2006

What is a Watershed?

A watershed is an area of land from which all water drains to a common point (Figure 2). Smaller subbasins make up a larger watershed and, in most cases, water eventually flows to the ocean. John Wesley Powell, scientist and geographer, said that a watershed is “that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community.” Water on earth moves continuously through the hydrologic cycle: falling in the form of precipitation, running off or infiltrating the ground, and evaporating into the atmosphere where the cycle begins again. Surface water, such as streams and lakes, as well as groundwater, which is water stored underground are closely interconnected.

Watershed health is influenced by both natural processes and human activities and is important for drinking water, agriculture, recreation, and ecological integrity. As water moves through a watershed the surface and sub-surface conditions affect the quality of water.

When human interaction is located within a watershed, a balanced system-based approach becomes necessary to achieve proper functioning conditions that can support the demand from humans and nature alike. The following considerations which are discussed throughout this report are important to understanding the dynamics of watershed health:

- Water quality (non-point and point sources of contamination)
- Water quantity and seasonal flow variations
- Surface water/groundwater interface
- Management of human development and the environment (such as land use, forests, wildlife & fisheries)
- Habitat & riparian health, including native biodiversity
- Water storage reservoirs for municipal, agriculture, and industrial use
- Non-consumptive uses such as recreation and environment

Upper Yampa River Watershed

The UYRW is approximately 1,800 square miles in area and is located in northwestern Colorado, west of the Continental Divide. It is almost entirely contained within Routt County (Figure 1). The headwaters of the Yampa River are located in the Flat Tops Mountains in the southwest part of the watershed and in the Park Range on the eastern side of the watershed. Eleven reservoirs within the UYRW, nine of which are on tributary streams, have either locally significant storage or a capacity greater than 4,000 acre-feet. The combined storage capacity of these reservoirs is 147,603 acre-feet. (Table 1). The UYRW has the smallest storage capacity of any major river basin in Colorado. Reservoirs in the UYRW are managed to store a portion of spring runoff, which is later released to meet a variety of needs and which affects water quality in a variety of ways. It is commonly stated that the Yampa River is the last free flowing western river because of its relatively natural flow regime and because it is undammed for 126 miles, from the Catamount Dam to the confluence with the Green River.

General Characteristics:

Drainage Area: 1,800 sq. mi.

Mean Daily Streamflow: At different locations along the Yampa River, the peak and baseline flows vary (Figure 3).

Average Annual Precipitation: 27 inches at Crosho lake in the Flat Tops Mountains at elev. 9,100 feet (SNOTEL, Crosho Site 1987-2013, 2014), 58 inches at Buffalo Pass in the Park Range at elev. 10,500 feet (SNOTEL, Tower Site 1980-2013, 2014), 17 inches at Hayden in West Routt at elev. 6,337 feet (Sundberg, 2014).

Population in 2010: 23,509 (United States Census Bureau, 2014)

Elevation: 12,000 feet (Flattops) to 6,400 feet (confluence of Yampa River & Elkhead River)

State Threatened & Endangered Species Occurring or Potentially Occurring in the UYRW:

Yellow-billed cuckoo, wolverine (U.S. Fish and Wildlife Service [USFWS] proposed threatened), Greater sage-grouse (USFWS Candidate species), Columbian sharp-tailed grouse, Bald eagle, greater sandhill crane, American peregrine falcon, river otter, boreal toad, northern leopard frog, striped chorus frog, tiger salamander, mountain sucker, bluehead sucker, flannelmouth sucker, roundtail chub, and Colorado River cutthroat trout (Colorado Parks and Wildlife [CPW] state threatened).

The Yampa River System:

The Yampa River is a snow-melt dominated river system, which is typical of high-elevation drainage basins where a majority of annual precipitation occurs as snow in winter months and then melts and runs off over a relatively short time period in spring and early summer. The Bear River and Chimney Creek receive water from mountain tributaries in the Bear River subbasin and merge to form the Yampa River in the town of Yampa. As it continues west, the Yampa River widens and warms, and collects water from hundreds of tributaries. Flows in tributary streams and mainstem free-flowing rivers vary considerably across seasons. This river carries tons of sediment over its sand, gravel and cobble beds before its confluence with the Green River in Dinosaur National Monument. Typically, most transport of sediment and contaminants from non-point sources occurs during peak flow. The Yampa River supports consumptive (municipal, agricultural, industrial) and non-consumptive (environmental, recreational) uses. The continued tradition of agricultural flood irrigation augments groundwater aquifers and creates wetlands which can assist with late season return flows to the river. For community members and water users to fully comprehend the Yampa River system and the aquatic ecosystem, water quality and quantity must be considered holistically.

Reservoir Storage Capacity

Reservoir Name	Storage capacity (acre-ft.)	Purpose	Stream impounded	Drainage Area (mi ²)	Total upstream storage capacity (ft ³) relative to drainage area (ft ²)
Upper Yampa River - Bear River Subbasin					
Stillwater Reservoir No. 1	6,392	Irrigation	Bear River	8.5	136.21%
Yamcolo Reservoir	9,096	Irrigation	Bear River	28.2	108.23%
Stagecoach Reservoir & Hydroelectric generation facility	36,460	Irrigation Hydroelectric, Water Supply, Recreation	Yampa River	227	36.64%
Lake Catamount	7,422	Fishery & recreation	Yampa River	390	27.68%
Upper Yampa River - Walton Creek - Fish Creek Subbasin					
Long Lake	595	Water Supply	South Fork Fish Creek	1.09	85.29%
Fish Creek Reservoir	5,359	Water Supply	Middle Fork Fish Creek	4.85	191.82%
Elk River Subbasin					
Steamboat Lake	36,900	Fishery & recreation	Willow Creek tributary to Elk Creek	35.53	162.27%
Pearl Lake	6,739	Fishery & recreation	Lester Creek tributary to Willow Creek tributary to Elk Creek	4	263.24%
Middle Yampa River - Trout and Dry Creeks Subbasin					
Sheriff Reservoir	1,450	Irrigation, Water Supply	Trout Creek	12.2	18.57%
Elkhead Creek Subbasin					
Elkhead Reservoir	37,190	Water Supply, Fish & Wildlife Pond	Elkhead Creek	212	27.41%
TOTAL CAPACITY	147,603				

Table 1. Eight reservoirs with an active storage capacity greater than 4,000 acre-ft. and two that are large relative to their watershed size (U.S. Army Corps of Engineers National Inventory of Dams; Colorado Water Conservation Board, 2009). The total upstream storage capacity relative to drainage area expresses the potential of the reservoir to influence natural flow conditions and downstream water quality.

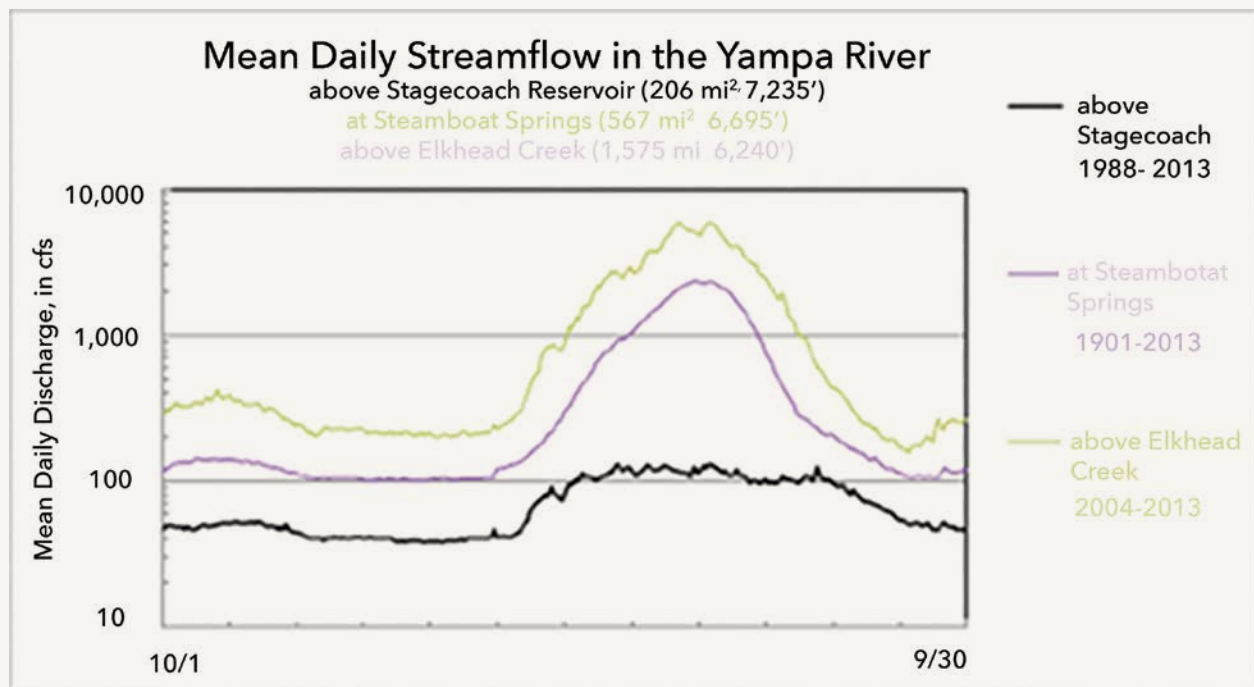


Figure 3. Mean daily stream flow in the Yampa River above Stagecoach Reservoir, at Steamboat Springs, and above Elkhead Creek. Baseline flows occur from late August through March before the peak snow melt driven run-off increases. Note the natural pattern of peak flows in the Yampa River above Stagecoach Reservoir is noticeably decreased by upstream storage of water in Stillwater Reservoir #1 and Yamcolo Reservoir. U.S. Geological Survey, 2014, National Water Information System data available on the World Wide Web (USGS Water Data for the Nation), accessed June, 2014, at URL <http://waterdata.usgs.gov/nwis/>.

Factors that Influence Water Quality in the UYRW

Understanding the natural as well as the human factors that influence water quality within the UYRW is essential to best allocate limited resources and to implement action plans. These protect existing water quality and minimize its future degradation in the watershed (Table 2). When diagnosing the health of a river system, there are several categories to be considered: water quality, ecosystem function, surrounding land use, and consequently, the ability of the river system to support the demand of the local communities.

Water quality refers to the chemical, physical, and biological characteristics of water. Water quality is a measure of the condition of water relative to aquatic and human needs. Needs include consumptive uses such as municipal, industrial, and agricultural as well as non-consumptive uses such as environmental and recreational.

Although beyond the scope of this report, changes in water quantity and the method and rates at which water flows have a direct influence on water quality. The amount and timing of water availability as it moves through the watershed is influenced by flood, drought, over pumping of ground water, withdrawals from streams, interbasin transfers, construction and management of reservoirs, and climate change.

Factors Affecting Water Quality

Natural Factors	Geology	Rock outcrops and soils have varying amounts and solubility of major ions, trace elements, and salt that can dissolve or be transported by water. Iron in surface water during spring runoff is an example of a chemical element that can exceed health-based standards primarily due to underlying geology.
	Climate	Mountains in the UYRW tend to have cooler air and stream temperatures and receive more total precipitation, much of which falls as snow in the winter and runs off in the spring and early summer. Semi-arid valleys are warmer and receive less precipitation. Temperature, water availability and contact time all influence water quality.
	Vegetation	Vegetation type, maturity, and density influence water uptake, recharge, and runoff rates, which influence erosion and deposition of sediment.
	Wildlife	Wildlife are a source of fecal bacteria and may degrade riparian vegetation which can increase stream bank erosion.
	Wildfires	Wildfires can result in loss of upland vegetation and riparian habitat, increased erosion, and sedimentation, higher stream temperatures, and flooding from burned areas.
Human-Related Factors	Point source	Point sources of pollution include industrial and municipal wastewater discharge, stormwater runoff through a pipe, and chemical spills. Point source pollutants can include nutrients, trace elements, pharmaceuticals, hormones, and industrial chemicals.
	Nonpoint source	Nonpoint sources of pollution come from diffuse sources such as runoff from impervious surfaces, agricultural fields, grazed areas, septic systems, construction sites, recreational areas (e.g., parks and ski areas), and stormwater runoff (un-piped). Nonpoint source pollutants can include nutrients, sediment, trace elements, and pesticides. Trace elements, petroleum products, and hazardous material spills on roadways near water bodies can also influence water quality.
	Structural changes	Structural changes tend to impact the area, timing, and volume of water transported, which can affect water quality. Examples include modified stream channels, reservoirs and other impoundments such as storm water basins and stock ponds, diversion of water from streams for consumptive and non-consumptive water use within the watershed and interbasin transfers out of watershed, and drainage of wetlands.

Table 2. Natural and human factors that affect water quality in the UYRW. Modified from Colorado Foundation For Water Education Citizen's Guide To Water Quality 2nd Ed. (Frohardt, 2013)

The UYWG will continue to address the following natural and human factors throughout the watershed planning process.

Land Use

Land use can impact water quality as described below.

Mining, Oil and Gas Development: Drainage from mined areas can impact water quality, create structural changes to natural hydrography and groundwater flow paths, and increase surface area for water contact with unconsolidated material. Historic hard-rock mining occurred at Hahns Peak in the northern Elk River subbasin in the late 1800's and into the early 1900's, but the majority of mining activity in the UYRW has occurred at the Yampa Coal Fields near Oak Creek and Hayden. The construction of the railroad through the Yampa Valley in 1909, provided a market for the large-scale coal mines. Today, electricity generation provides the markets for coal. The low sulfur-content of the coal from this region has limited the potential for acid coal mine drainage into the watershed (Nancy J. Bauch, 2012).

In 1977, the Surface Mining Control and Reclamation Act (SMCRA) was enacted to address environmental and reclamation issues, inclusive of erosion and vegetation loss, as well as to protect water quality and natural resources for operating mines. The Abandoned Mine Lands group from the Division of Mining & Safety (DRMS) was formed to address mines that were abandoned prior to the SMCRA operations and were never properly remediated.

Oil and gas development has occurred on a small scale throughout the Yampa Valley since the early 1900's, though drilling has been relatively limited compared to neighboring regions. A recent increase in oil and gas exploration has triggered concerns among stakeholders that the construction of roads and well pads, transportation of hazardous materials, and hydraulic fracturing could impair water quality in the UYRW. The dominate method used in hydraulic fracturing requires chemicals and large volumes of water to be injected deep below the land surface to increase oil and gas recovery.

Developed Areas: Infrastructure development can introduce sediment, nutrients, and other pollutants into the waterways. Road cuts and fills, erosion of unstable slopes adjacent to roads, unpaved roads and parking surfaces, runoff from impervious surfaces, and road de-icing operations are all examples of pollutant sources. Additionally, roads, railroads, and bridges confine the channel and prevent the river from dissipating energy, often changing the physical condition of the river downstream. Runoff from impervious surfaces absent of a riparian buffer can introduce nonpoint source pollutants (Table 2). Another form of pollution is increased water temperatures from the warmed runoff caused by the transfer of heat off impervious surfaces in summer.

Agriculture and Grazing: Livestock operations have traditionally relied on natural waterways as water sources for their herds. Thus, the potential exists for water pollution and degraded or eroded streambanks. By creating specific points of entry, bringing water off channel, or fencing riparian areas, landowners can improve water quality and land value. The loss of healthy land, fish habitat, and aesthetic features are examples of negative impacts to land value.

Degraded range and pasture health influence not only water quality but quantity as well. Stronger, healthier soil structure and resulting plant matter will retain more water while land that has been grazed too low, tilled consistently or left bare will increase water run-off (Natural Resource Conservation Service). Many landowners have achieved long-term economic success through resource stewardship by creating management plans that consider natural resource preservation and watershed protection.

Public Land Management: Public lands managed by the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the Colorado Board of State Land Commissioners (State Land Board) make up 51% of the UYRW and provide for a diversity of uses including mineral extraction, livestock grazing, timber harvesting, and recreation. The same natural and human-related impacts that occur on private land also challenge public land use managers, who must navigate more complex management relationships in addition to implementing on-the-ground projects.



Figure 4. Before Restoration, Chuck Lewis State wildlife area spring 1999. Photo courtesy of BC Riverkeeper.



Figure 4. Restored riparian area, Chuck Lewis State wildlife area, spring 2003. Photo courtesy of BC Riverkeeper.

Physical Conditions

Rivers and streams develop a natural channel shape and capacity that most efficiently transport the water, sediment, and bedload (particles transported on the river bottom) supplied by the watershed. Following spring runoff, rivers maintain a healthy ecology through baseflows. River channels need to be large enough to accommodate average annual peak flows, but not so large that baseflows are too shallow to support aquatic life and adjacent riparian vegetation. Increases in water yield, physical alteration of the stream channel, and/or channel encroachment by riparian vegetation can alter the natural channel geometry. Alteration of the natural channel geometry upsets efficient water and sediment transport as well as sufficient low flows which support aquatic and riparian ecosystems. The following physical parameters are metrics of stream health.

Width-depth ratios: The width to depth ratio is key to understanding the distribution of available energy within a channel and the ability of various discharges occurring within the channel to move sediment (Rosgen, 1996). Many of the river channels within the UYRW are wider than what is proportionate to their natural water and sediment yield for a given slope and depth. Therefore, the water within these channels has reduced velocities, which reduces the transport of suspended sediments and bedload. The alteration of width to depth ratios can be both natural and human caused. See figures 4 and 5 for a restoration example that corrected poor width to depth ratios, improved bedload and sediment transport, and enhanced low flows to support aquatic ecosystems.



Confluence of Sarvis Creek with the Yampa River, photo Courtesy of Western Rivers Conservancy

Pool riffle ratios: A sequence of deep slow water sections (pools) and shallower faster moving water sections (riffles) develop at alternating, regularly spaced intervals. If a channel becomes overly wide, riffles will increase in length and alter the regular pool to riffle ratio. Riffles provide habitat for the macroinvertebrates that compose the basis of the food chain. Pools are important for dissipating energy and create habitat for aquatic organisms. Pools can be very important to survival of fishes in streams with seasonally high temperatures and low-flows (Figure 6).

Channel meanders: A meander is created by friction from a river experiencing turbulent water that begins to erode the streambanks, widening into the valley floor. Erosion occurs on the outside bank where velocity is high and deposition occurs on the inside bank where velocity is reduced. This exchange produces sinuosity which is defined as the actual channel length divided by the straight-line valley length. Sinuosity is a natural energy dissipater.

If sinuosity becomes too great, processes such as sediment deposition and flood events can cause channel instability. Instability may result in flood flows cutting across a meander thus straightening its channel – a process called avulsion. Smooth meander transitions, or relative sinuosity, are necessary for the Yampa River to move bedload and diffuse energy. Aerial photography from 1962 to 2013, shows that areas of the UYRW have experienced large deposits of bedload at meander bends. Resulting processes have eroded streambanks and several meanders have been lost to avulsion, causing new, straighter channel sections in the UYRW. Straighter channels have higher water velocities which increase erosion of streambanks, causing streambank instability and increased sediment to the system.

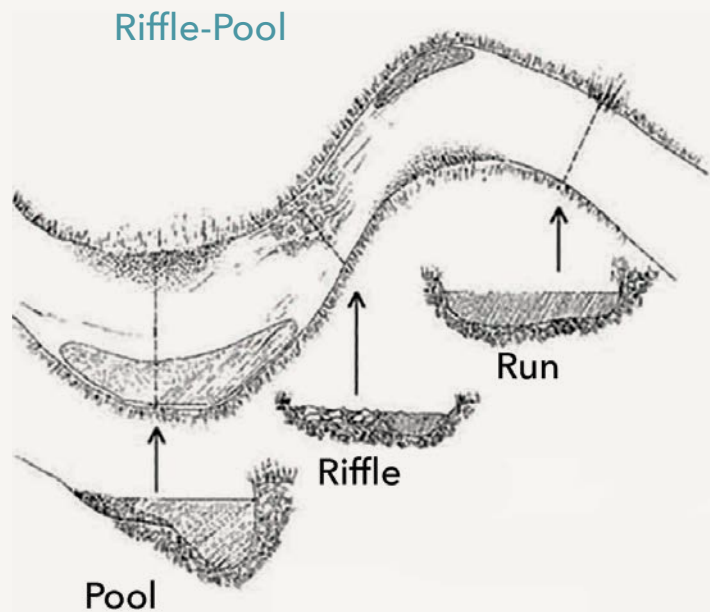


Figure 6. Riffle-pool system. Courtesy of the EPA.

Riparian Zones & Wetlands

Riparian zones are the transitional areas between uplands and streams, rivers, and lakes. These zones are inclusive of wetlands which are areas that undergo frequent flooding and support a range of vegetation adapted for life in saturated soils (Figures 7 and 8).

Land use is one of the biggest challenges that humans present to riparian ecosystems. Human-introduced invasive as well as non-native plants and aquatic species are particularly challenging issue. When managed properly, riparian zones and wetlands act as filters for non-point source pollutants that would otherwise reach our waterways. For example, nutrients and fertilizers can be absorbed by riparian plants through a process called [denitrification](#). Riparian zones dissipate annual spring floods by increasing infiltration and reduce flow velocities by trapping water, thereby, reducing the flooding of meadows and valley floors. Additionally, hydric (poorly draining) soils retain water in natural reservoirs that slowly release and can increase low summer and fall stream flows in snowmelt-dominated systems.

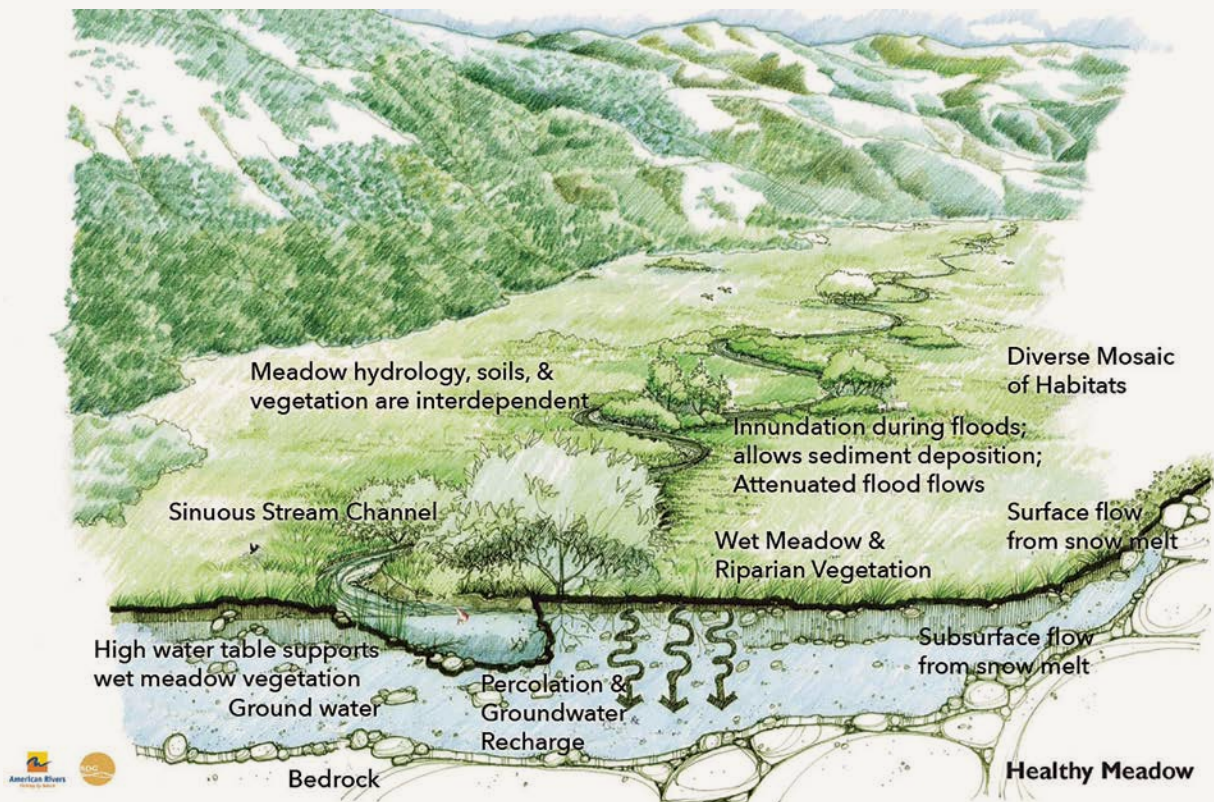


Figure 7. A healthy riparian zone. Courtesy of American Rivers.

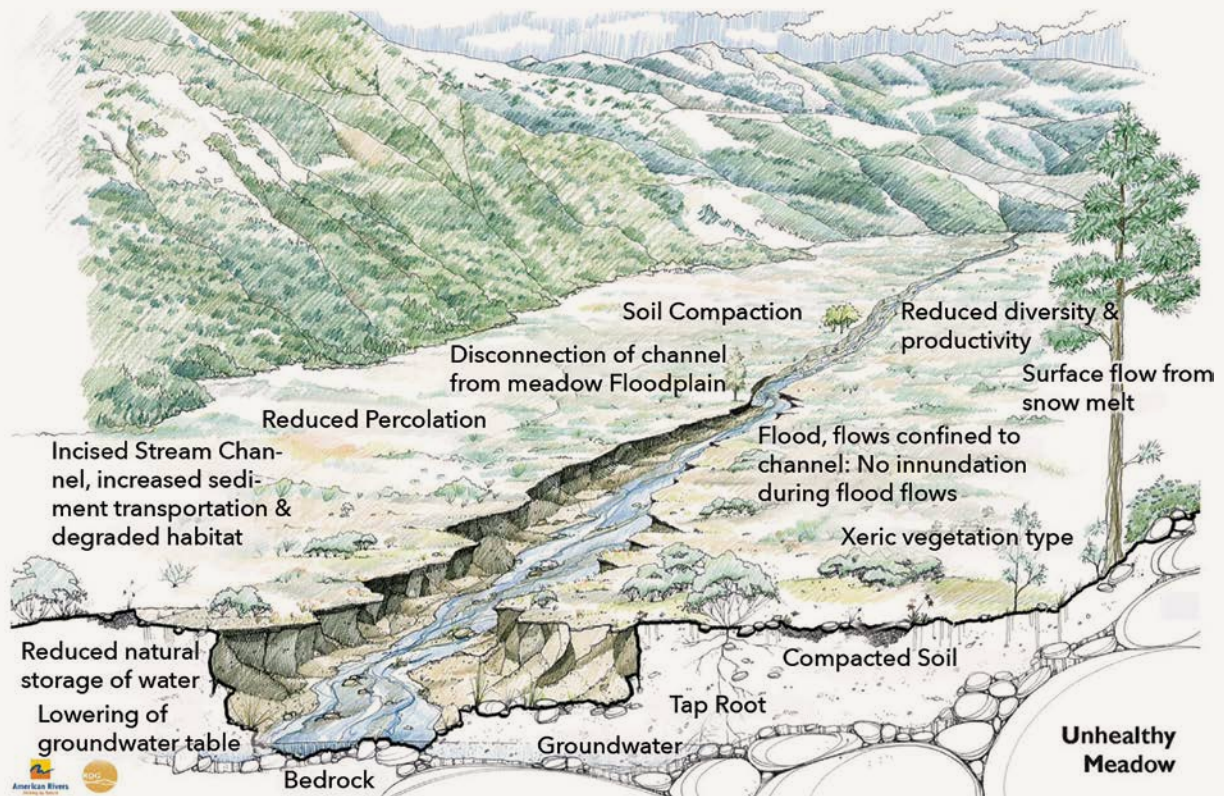


Figure 8. An unhealthy riparian zone. Courtesy of American Rivers.

Fisheries & Aquatic Life



Figure 9. Colorado River cutthroat trout. Courtesy of Trout Unlimited (TU)



Figure 10. Flannelmouth Sucker. Courtesy of Colorado Parks and Wildlife (CPW).



Figure 11. Bluehead Sucker. Courtesy of CPW.



Figure 12. Roundtail Chub. Courtesy of CPW.

The UYRW is occupied by a variety of aquatic and semi-aquatic organisms. Native fishes include, among others, Colorado River cutthroat trout, mountain whitefish, mountain sucker, flannelmouth sucker, bluehead sucker, and roundtail chub (Figures 9-12). Native amphibian species include boreal toad, chorus frog, and northern leopard frog. Native macroinvertebrates (i.e., bugs) include stoneflies, caddis flies, and mayflies. Non-native fishes include popular sportfish like rainbow trout, brown trout and brook trout. Non-native fishes also include northern pike, smallmouth bass, and white sucker.

Water quality influences the health, distribution, and abundance of aquatic organisms. Accordingly, aquatic organisms can serve as indicators of water quality and watershed health. Following are brief descriptions of relationships between water quality parameters and aquatic organisms with an emphasis on relationships between water quality and fish. Each of these water quality parameters is influenced by water quantity (i.e., flow).

Water temperature influences biological and chemical processes in aquatic environments. Temperature requirements differ among aquatic species in the basin. For example, trout, whitefish, and mountain sucker are cold-water obligates (they occupy cool to cold waters), whereas, flannelmouth sucker, bluehead sucker, roundtail chub, northern pike, and white sucker are “transitional” fishes that occupy warm to cool waters.

Dissolved oxygen can influence the distribution and the health of aquatic organisms. Fish species like trout generally require high levels of dissolved oxygen, whereas, suckers require only moderate levels. Restricted concentrations of dissolved oxygen can alter the performance and the function of fishes while extremely low concentrations can cause mortality. As water temperature increases, the concentration of dissolved oxygen in streams decreases.

Suspended sediment occurs naturally in stream systems and some of the native fishes in the Yampa River basin are adapted to seasonally high turbidity. Unnaturally high levels of suspended or fine sediment can, however, have direct and indirect effects on aquatic creatures. For example, excess fine sediment can reduce the abundance and composition of aquatic bugs (i.e., fish food) and inundate fish nesting sites which reduces the survival of young embryos.

Other water quality parameters of potential interest include nutrients (e.g., nitrogen and phosphorous), trace elements (e.g., manganese, selenium), major ions (e.g., calcium, chloride), and pH.

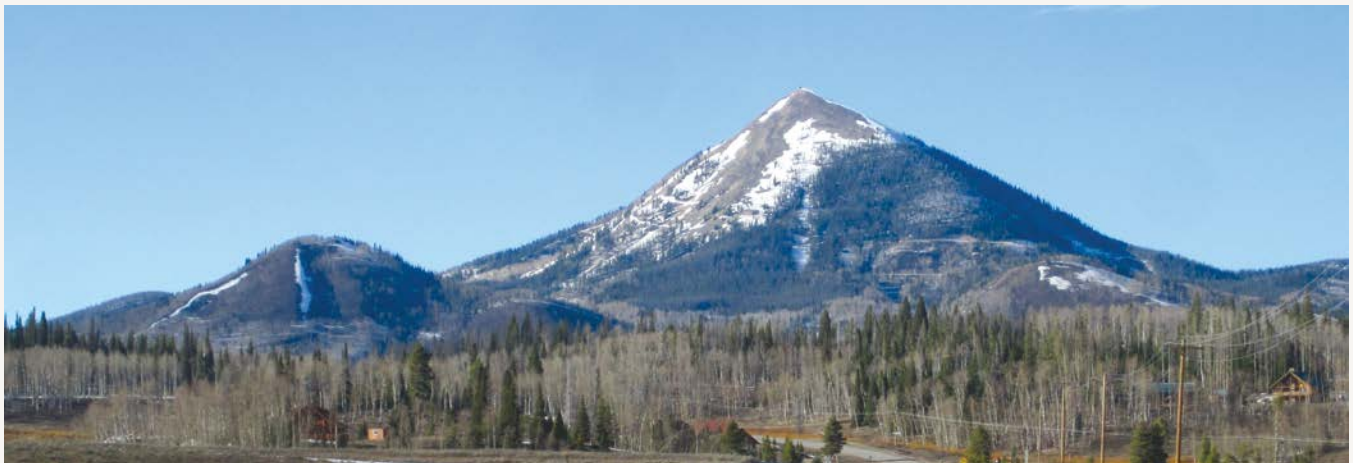
Like fish, amphibians, macroinvertebrates, and other aquatic organisms are influenced by water quality. For example, amphibians are particularly sensitive to changes in pH. Macroinvertebrate abundance and community composition differ with, among other factors, water temperature, dissolved oxygen, and suspended sediment.

General Geology

The UYRW is predominantly underlain by: 1) Precambrian metamorphic and intrusive igneous rocks in the eastern one-third of the watershed (Gore and Park Ranges), 2) sedimentary rocks of the Cretaceous age and sedimentary, intrusive, and volcanic igneous rocks of the Tertiary age including the Yampa Coal field, and 3) unconsolidated surface deposits in the valley floors derived from river alluvium, landslides, and glacial drift which primarily occurred on the toe slopes of the highest southern and western mountains (Figure 13) (Nancy J. Bauch, 2012).

Major coal deposits in the Yampa coal field occur in the Upper Cretaceous Williams Fork and the Iles formations located in the northwestern part of the UYRW. These formations plus other sedimentary rock formations such as the Mancos shale contain soluble major ions and trace elements. These have caused elevated concentrations and, in isolated settings, exceedances of water-quality standards due to natural causes (Nancy J. Bauch, 2012).

More than 150 geo-thermal mineral springs are located at or near the intersection of regional 12,000-15,000 foot deep, high-angle faults cross cut by local faults through the Dakota Sandstone. These warm springs may have slightly elevated concentrations of a few minerals but have not triggered any recorded exceedances to date.



Hahns Peak, photo courtesy Tom Delancey

Generalized Geologic Map

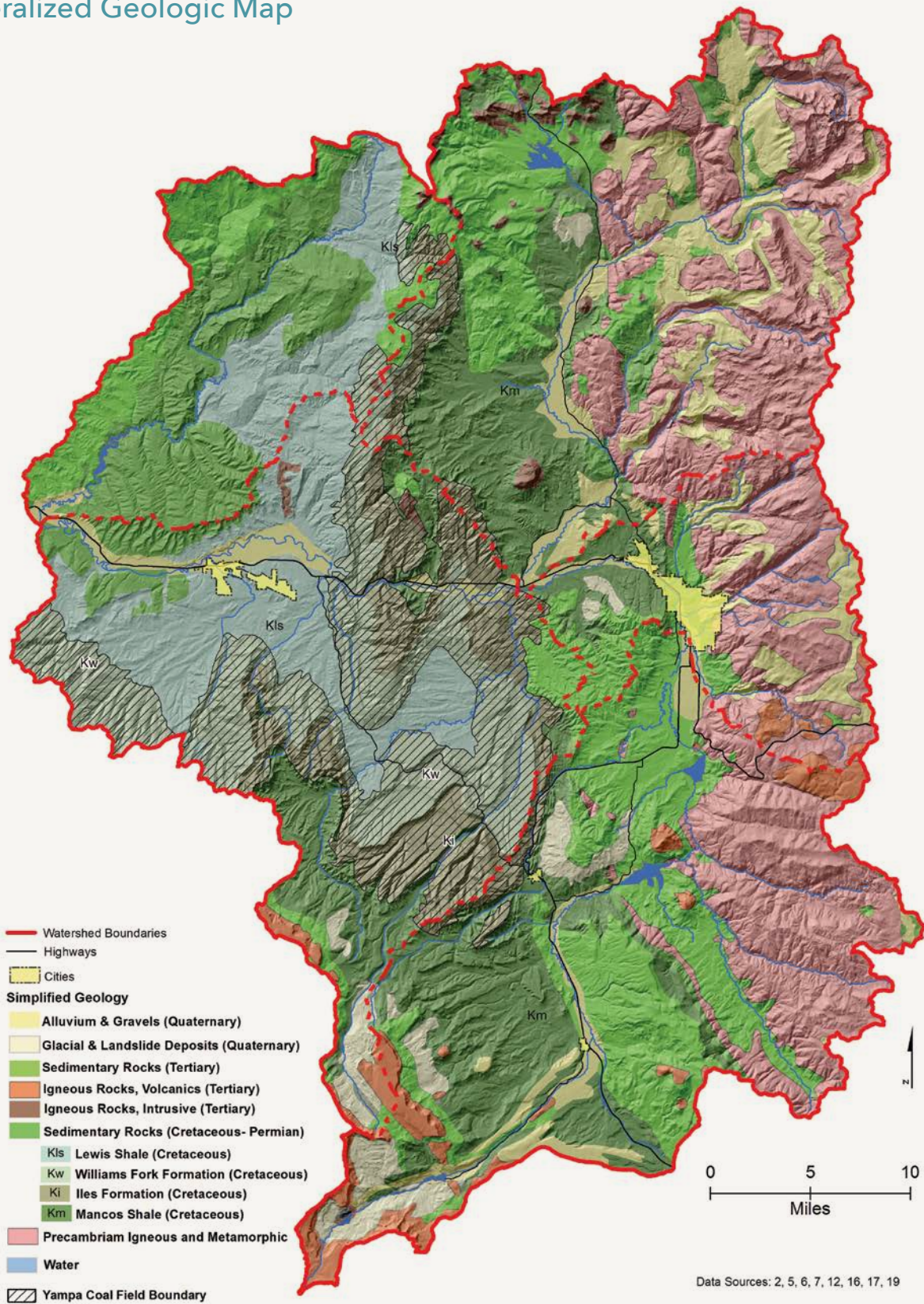


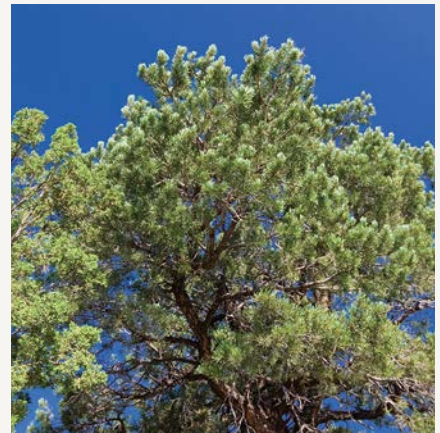
Figure 13. Generalized geologic map of the UYRW (legend shows geology in descending order from youngest to oldest geologic formations).

Land Cover

Land cover has a significant impact on water quality. Above 7,000 feet, plant communities in the UYRW are dominated by spruce, fir, ponderosa pine, lodgepole pine, Colorado blue spruce, Engelmann's spruce, aspen, piñon pines, juniper, sagebrush and mixed grasslands.



At elevations of less than 7,000 feet, plant communities include mountain sagebrush with patches of Douglas fir, Gambel's oak, service berry, chokecherry, piñon juniper, and grasslands.



Above and below 7,000 feet, wetlands occur on floodplains and oxbow lakes, and in beaver ponds. These wetlands are dominated by sedges, willows, narrowleaf cottonwood, thinleaf alder, and box elder (Figure 14).



Land Cover Map

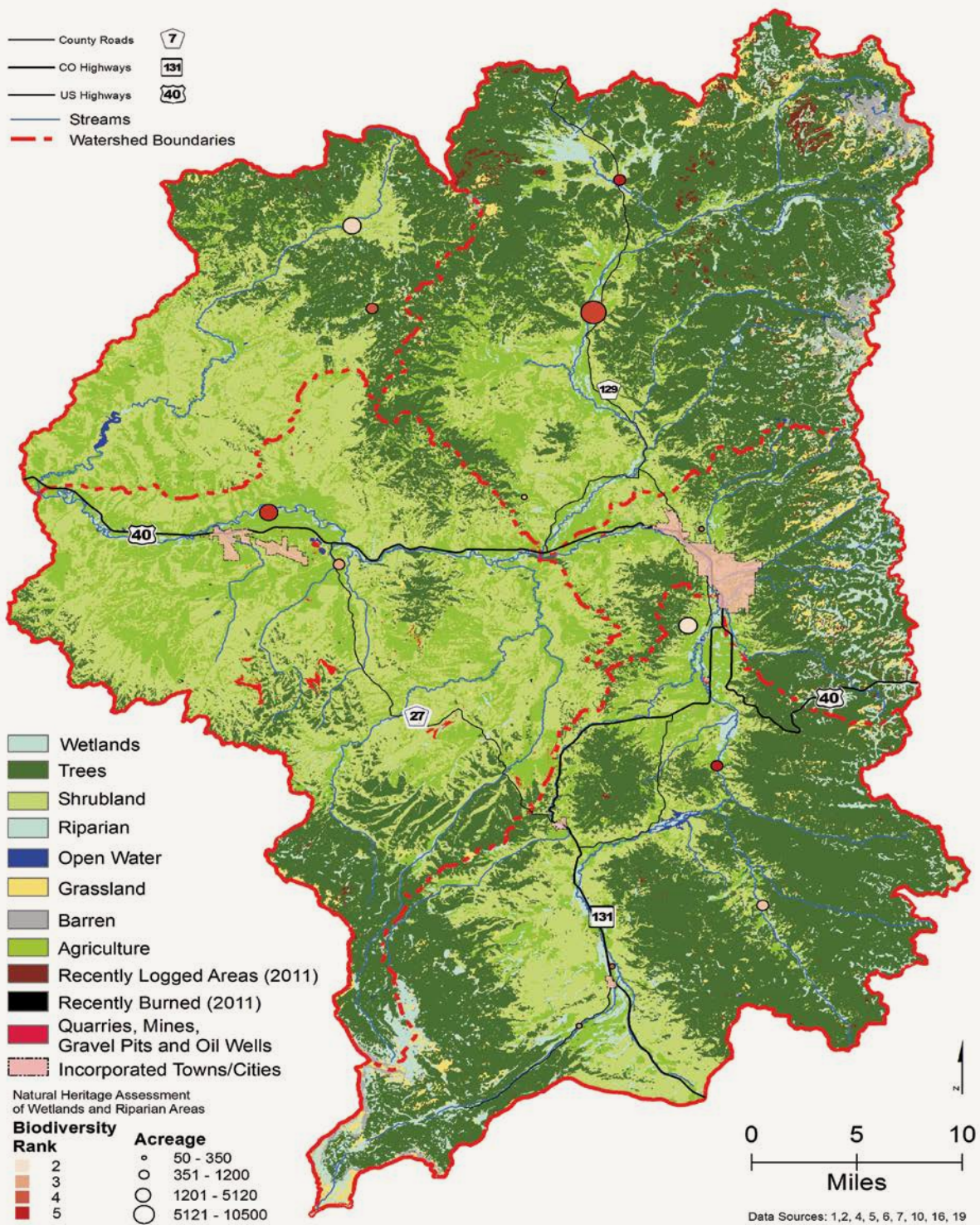


Figure 14. Land Cover map of the UYRW, 2014.

Water Quality Criteria and Classifications in Colorado

The [Colorado Water Quality Control Commission](#) regulates water quality in the state through the Colorado Department of Public Health and Environment (CDPHE). Each major river basin within the state has its own water quality standards based on the State's methodologies, classifications, standards (Figure 15) as well as additional guidelines.

Aquatic Use Classifications:

- Class I - Cold Water Aquatic Life: Waters capable of sustaining a wide variety of cold water (<20 °C) biota (e.g., trout).
- Class 1 - Warm Water Aquatic Life: Waters capable of sustaining a wide variety of warm water (>20° C) biota (e.g., smallmouth bass).
- Class 2 - Cold and Class 2 - Warm Water Aquatic Life: These are waters that are not capable of sustaining a wide variety of cold or warm water biota due to physical habitat, water flows or levels, or uncorrectable water quality conditions

Five Use Classifications: (based on the highest water quality attainable)

- recreation
- aquatic life
- agriculture
- water supply
- wetlands

Anti-degradation guidelines: are adopted to protect current water quality

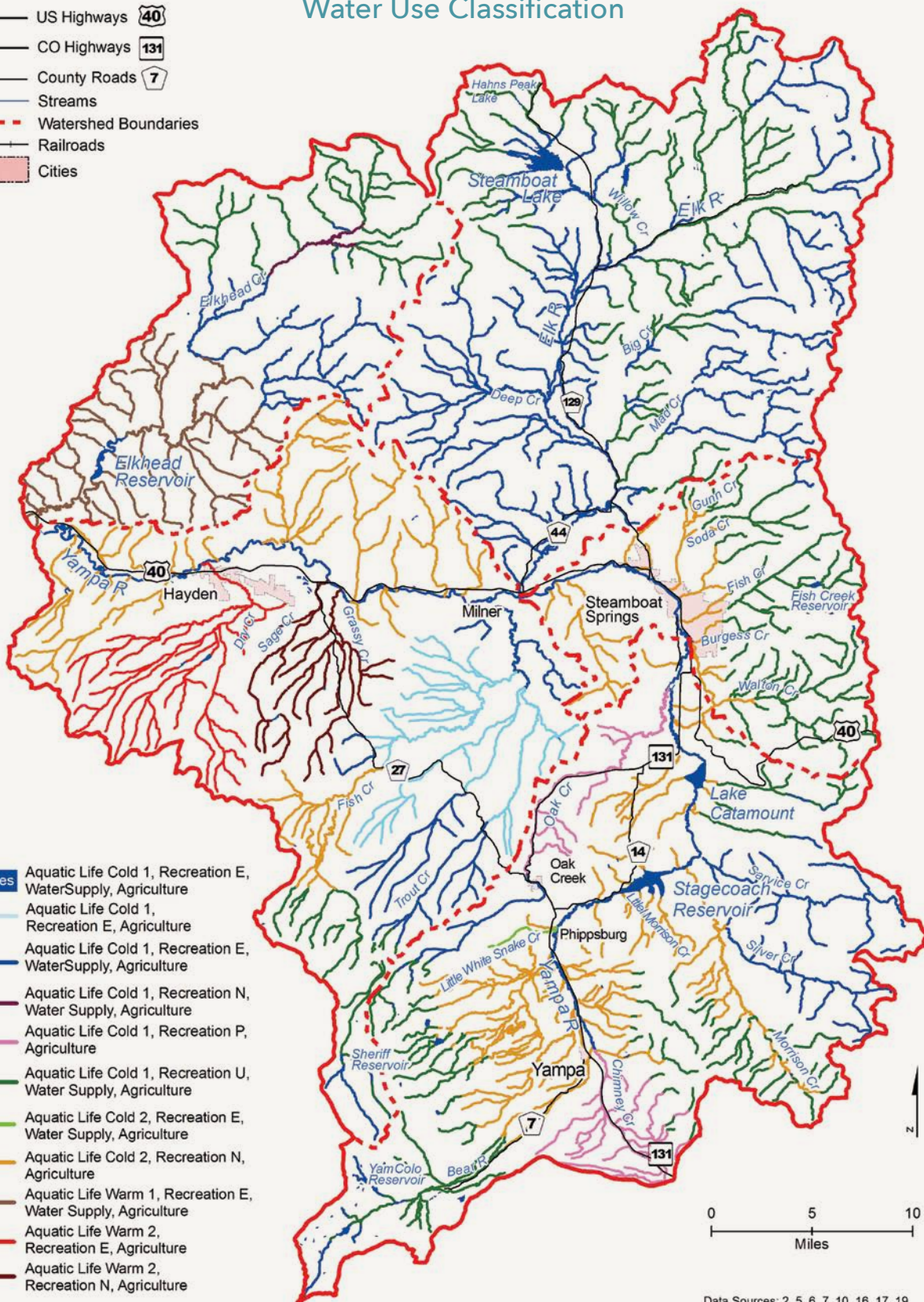
- Outstanding Waters designation – no degradation is allowed
- Use-protected Waters – degradation is allowed but water quality standards must be met
- Reviewable Waters – based on whether reasonable alternatives are available, degradation may or may not be allowed.

Additionally, narrative standards describe goals and numeric standards set maximum acceptable concentrations of specific pollutants. Many issues of concern for aquatic life, human health, or suitability of water for various uses include those on the (1) CDPHE 2012 303(d) list of impaired waters or (2) the Monitoring & Evaluation list. Impaired waters remain listed until sufficient monitoring shows the stream is no longer impaired.

Water Use Classification

- US Highways
- CO Highways
- County Roads
- Streams
- Watershed Boundaries
- Railroads
- Cities

- Lakes**
- Aquatic Life Cold 1, Recreation E, WaterSupply, Agriculture
 - Aquatic Life Cold 1, Recreation E, Agriculture
 - Aquatic Life Cold 1, Recreation E, WaterSupply, Agriculture
 - Aquatic Life Cold 1, Recreation N, Water Supply, Agriculture
 - Aquatic Life Cold 1, Recreation P, Agriculture
 - Aquatic Life Cold 1, Recreation U, Water Supply, Agriculture
 - Aquatic Life Cold 2, Recreation E, Water Supply, Agriculture
 - Aquatic Life Cold 2, Recreation N, Agriculture
 - Aquatic Life Warm 1, Recreation E, Water Supply, Agriculture
 - Aquatic Life Warm 2, Recreation E, Agriculture
 - Aquatic Life Warm 2, Recreation N, Agriculture



Data Sources: 2, 5, 6, 7, 10, 16, 17, 19

Upper Yampa River - Bear River Subbasin

Background

This high mountain valley (elevation range 7,200-11,085 feet) is home to the scenic Flat Tops mountain range and to an active agriculture and recreation community (Figure 16). A population of approximately 4,000 people is spread among Yampa, Phippsburg, Oak Creek, Stagecoach, and rural areas.

Water Supply

The Yampa River system begins in the Bear River subbasin. Four of the eight reservoirs with an active storage capacity over 4,000 acre feet (AF) are located in this subbasin (see Table 1). Stagecoach State Park leases recreational facilities from the [Upper Yampa Water Conservancy District](#) (UYWCD) which manages both the Stagecoach and the Yamcolo Reservoirs (Figure 17). Residents of Oak Creek consume surface water that flows from the Sheriff's Reservoir via Trout Creek and the Rich Ditch into a pipeline going to the municipal treatment facility. Potential wildfire impacts to the water supply are a concern and may be alleviated by prioritizing fuels reduction in the Routt National Forest. Yampa, Phippsburg, the Stagecoach community, and outlying rural residences use groundwater as their primary source of drinking water. Each community has a wastewater treatment facility whereas rural residences use septic tanks and drain fields. Several tributaries in the Flat Tops and the Sarvis Creek Wilderness areas have Outstanding Waters designation which prevents any degradation to the water quality (Colorado Dept. Public Health and Environment, 2012).

Geology

Geology, stream flow, and land-use have the greatest influence on water quality in the Bear River subbasin. Erosion-resistant Tertiary basalts and intrusive volcanic rocks form the Flat Tops range and landslide deposits are more common here than in other areas of the watershed. The Cretaceous Mancos shale and the Tertiary Browns Park formations create the valley floors and are more susceptible to erosion, create harder water, and can buffer acid well. Cretaceous and Tertiary sedimentary rocks contain soluble materials and trace elements such as arsenic, barium, boron, iron, manganese, nickel, selenium and strontium. Streams flowing in areas underlain by these formations are characterized by higher amounts of suspended solids during spring run-off. The formations south of Rabbit Ears in the Sarvis Wilderness area are primarily Precambrian granite—igneous and metamorphic rocks which are resistant to weathering, create soft water, and cannot buffer acid (Nancy J. Bauch, 2012)

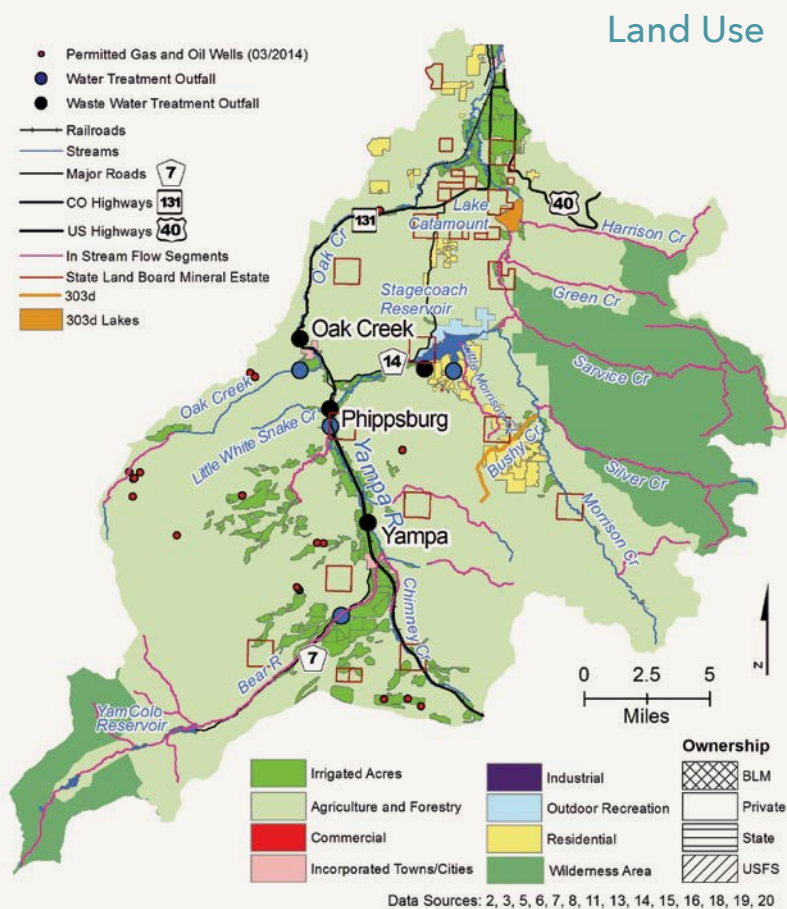


Figure 16. Land use, cover and ownership characteristics of the Bear River Subbasin.

Water Quality

Water quality in the Bear River subbasin is generally good. Samples from the Yampa River below Stagecoach Reservoir have shown slightly elevated concentrations of selenium and manganese. Samples from Little Morrison Creek have shown elevated levels of zinc and dissolved iron. In both cases, geology is considered to be the contributing factor for the presence of these minerals. Water temperatures for the main-stem Yampa River are normally low for the Bear subbasin due to the inflow of streams that drain from cold high altitude areas. In 2003 and 2004, drought conditions and/or upstream changes in the river channel increased water temperatures. Because of this, the Yampa River was placed on the 2012 State Monitoring and Evaluation list (Nancy J. Bauch, 2012). The drought events illustrated the importance of assuring minimum flows in small headwater tributaries for the added benefit to the main-stem Yampa River.



Figure 17. John Fetcher Hydroelectric Plant at Stagecoach Reservoir. Photo courtesy of Richard Stenzel

Observations & Developments

On-site observations have contributed to a understanding of watershed health in the Bear River sub-basin. Algae blooms have been observed in Stagecoach Reservoir and are directly related to high nutrient levels. This may be an indicator of accelerated eutrophication (excess nutrients in a lake causing dense growth of plant life and death of animal life from lack of oxygen). Eutrophic characteristics from high nutrient levels have also been observed in Lake Catamount. In both cases, additional sampling is needed to determine sources and treatment. Additionally, the CDPHE has established [fish consumption advisories](#) for mercury in Lake Catamount and Stagecoach Reservoir.

The United States Forest Service (USFS) has observed that increased sediment has the largest impact on water quality and native fish species in the subbasin. The USFS has decommissioned some roads to reduce erosion and contributions to sediment loading and continues to look for opportunities to implement other Best Management Practices (BMPs). Bushy Creek, a tributary to Morrison Creek, is currently listed on the 2012 CDPHE 303(d) list for excess sediment.

Observations of the Yampa River between Lake Catamount and Chuck Lewis State Wildlife Area suggest that the Yampa River is deprived of normal seasonal bedload because Catamount dam traps large particles. Also due to loss of meanders in this section of river, the Yampa is less efficient at dissipating energy. Streambank erosion can also contribute sediment into the river channel. To reduce streambank erosion, BMPs have been implemented, including temporary riparian fencing, changes in the timing and intensity of livestock grazing, and riparian restoration. These steps will continue to be important to restoring stream health within this subbasin.

CPW and other partners are in the process of completing two large restoration and fish habitat improvement projects at the Chuck Lewis State Wildlife Recreation Area and at the Yampa River tailwaters below the Stagecoach dam. Extensive non-native fish species control has taken place in the subbasin to protect natives and eliminate the occurrence of fish-tissue mercury found in the Northern Pike fish population in Catamount Reservoir. Together, CPW, USFS, and Trout Unlimited have installed several fish barriers to protect Colorado River cutthroat trout populations.

Upper Yampa River – Walton Creek – Fish Creek Subbasin

Background

The Walton Creek and Fish Creek subbasin has the smallest area and the largest population center within the UYRW (Figure 19). Steamboat Springs is known for its thriving recreation- and tourism-based economy. According to the 2012 update of the 2010 US Census, 12,029 people live within the 10.1 square mile city limits.

Land Use

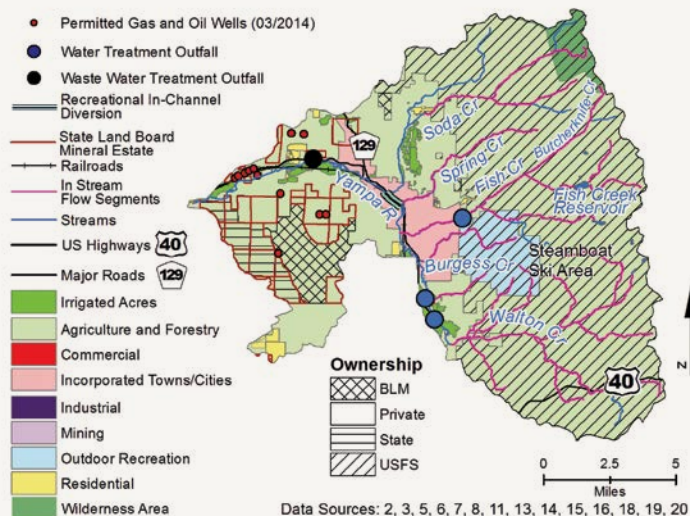


Figure 19. Land use, cover and ownership characteristics of the Walton Cr. & Fish Cr. Subbasin.

Water Supply

The city of Steamboat Springs and the Mt. Werner Water and Sanitation District divert most of their municipal water supply directly from Fish Creek east of Steamboat Springs (Figure 19). When natural flow in Fish Creek is insufficient to meet water demand, water is released from the Fish Creek Reservoir (Table 1). Municipal supplies are augmented as needed by three alluvial wells and storage water in the Stagecoach and the Yamcolo Reservoirs. Threat of wildfire to the city's water supply, in the Fish Creek drainage, is of high concern.

In 2007, Steamboat Springs adopted a Water Supply Protection ordinance to help mitigate risks to water quality. A [Water Conservation Plan](#) was approved by the Colorado Water Conservation Board and jointly adopted by the city and the Mount Werner Water District in 2011.

In October 2013, the Steamboat Springs City Council adopted the Stormwater Master Plan, a culmination of work prepared by the Stormwater Task Force. This report recognized the importance of continued city efforts to actively manage a stormwater program aimed at compliance with the State issued Municipal Separate Stormsewer System permit (MS4). This permit includes continued water quality testing and the need to create an outreach and education plan that communicates to businesses, government entities and the public the characteristics, benefits and threats posed by stormwater runoff.

Steamboat Springs has robust local and tourism-based recreation which largely depends on non-consumptive water uses including trout fishing, seasonal boating, and summer tubing. In 2005, the city was granted a Recreational In-Channel Diversion (RICD) from April 15 through August 15, which appropriated a minimum stream flow necessary for a reasonable recreational experience in and on the water (Figure 20).

The Steamboat Ski and Resort Corporation leases 2,965 acres of land for both winter and summer recreation from the USFS. The ski area diverts an average of 275 AF for snow making, typically from October through January (Boyle Engineering, 2004).

Geology

Geology, stream flow, and land-use have the greatest influence on water quality in the Walton Creek and the Fish Creek subbasin. Cretaceous Mancos shale and the Tertiary Browns Park formation create the valley floors—these formations are relatively susceptible to erosion, create harder water, and can buffer acid well. Cretaceous and Tertiary sedimentary rocks contain soluble materials and trace elements such as arsenic, barium, boron, iron, manganese, nickel, selenium, and strontium. These formations are also characteristic of having higher amounts of suspended solids during spring run-off. The Park Range, west of the continental divide, is primarily Precambrian igneous and metamorphic rocks which are resistant to weathering, create soft water, and cannot buffer acid (Nancy J. Bauch, 2012)

Water Quality

Water quality in the Walton Creek and the Fish Creek subbasin is generally good. Stream flow data for the Yampa River at Steamboat Springs begins in 1904, prior to any dam construction. In 1934 and 1944, drought caused stream flows through downtown Steamboat Springs to decrease below 10 cubic feet per second (cfs) in. Then, as well as now, consequences of extremely low flows include life threatening high temperatures and low dissolved oxygen levels. Also, problems related to treated sewage effluent discharges arise at those low flows because of so little water available to assimilate wastes.

Exceedances of the cold-water aquatic life standards from mid-July through August in 2002, 2003, and 2005, caused the Yampa River to be placed on the 2012 CDPHE Monitoring and Evaluation list (Bauch, 2012). After experiencing low drought-related flows again in 2012 and 2013, the UYWCD and the Colorado Water Trust recognized that elevated water temperatures posed a threat to fish. Together, the entities utilized Colorado's never-before-used 2003 short-term water leasing statute (§37-83-105

Colorado Revised Statute) to lease 4,000 AF of water from Stagecoach Reservoir. Strategic releases benefitted stream flows, aquatic habitat, hydropower generation, and recreation (Colorado Water Trust, 2013).

Limited samples taken from the subbasin have shown elevated levels of manganese and highlight the need for additional baseline monitoring to determine the cause and extent of this occurrence.



Figure 20. Yampa River in Steamboat Springs. Courtesy of Kent Vertrees.

Observations & Developments

On-site observations contribute to an understanding of watershed health. Excess sediment is present in the subbasin and is, in part, a continuation of the upstream sediment loading from the lower Bear River subbasin. Below the confluence of Walton Creek, the Yampa's gradient and velocity are enough to move a majority of sediment through Steamboat Springs where it is deposited west of the city as evidenced by large gravel bars. The sediment contribution from road sanding and scoria application and its impact on the system from US Highway 40 over Rabbit Ears Pass are of potential concern to the Colorado Department of Transportation (CDOT) and USFS. As funding becomes available, the finalization and future implementation of a draft sediment management plan with CDOT and USFS will reduce sediment loading and address magnesium chloride and sanding operations.

The Steamboat Ski Area has taken measures to reduce erosion and sedimentation, such as minimizing soil disturbance near stream crossings when improving roads and trails. Helicopter logging has been utilized to minimize ground disturbance from timber harvesting. The ski area is currently performing a hydrological assessment with the USFS to improve water quality management strategies.

The Yampa River and its tributaries have been disconnected from their historic floodplains by streamside development and the resulting loss of riparian zones and wetlands. This loss has hindered the river's natural ability to filter sediment and adapt to seasonal flow variations. Consequently, a need for stream bank modification was recognized and will enhance smaller floodplains, habitat and riparian areas that may compensate for the loss of natural systems. The Steamboat Springs' 2008 [Yampa River Structures Master Plan](#), a combined effort between the city and the general public, provides "a framework for 6.4 miles of instream and riparian area improvements that will optimize the recreational benefits of the river while protecting its ecological integrity." The non-profit [Friends of the Yampa](#) is helping to implement the Yampa River Structures Project.

Elk River Subbasin

Background

The Elk River is the largest tributary to the UYRW, draining 448 square miles at USGS gage number [09242500](#). Historically, mining activities were conducted in the Elk River Drainage. Extensive gold mining occurred in the late 1800's, when Hahns Peak was the county seat. Mining operations occurred in the Slavonia mining district along the North Fork of the Elk River drainage as well as just outside of Clark at the Greenville Mine. Today, there are several rural communities in the area: Clark, located along the Elk River, Willow Creek Pass Village, just north of Clark, and Hahns Peak further north. There are also several residential subdivisions near Steamboat Lake, along the Elk River on Seedhouse Road (RCR 64) and along the lower Elk River along RCR 44 (Figure 21).

Water Supply

The primary sources of water in the Elk River subbasin are streams and rivers. Agriculture is currently the largest consumptive user of water in the Elk River Valley. Flood irrigation is a common practice for hay and pasture production (Figure 22). Several reservoirs exist in this subbasin (Table 1).

Excluding the Willow Creek Pass Village, which is serviced by a small-scale community water supply and waste water treatment plant, individual wells and septic systems predominate the Elk River subbasin.

Segments of the Elk River attract kayak and raft recreation but public access is very limited. Several tributaries in the Mt. Zirkel Wilderness area have Outstanding Waters designation, which prevents any degradation to the water quality (Colorado Dept. Public Health and Environment, 2012).

Land Use

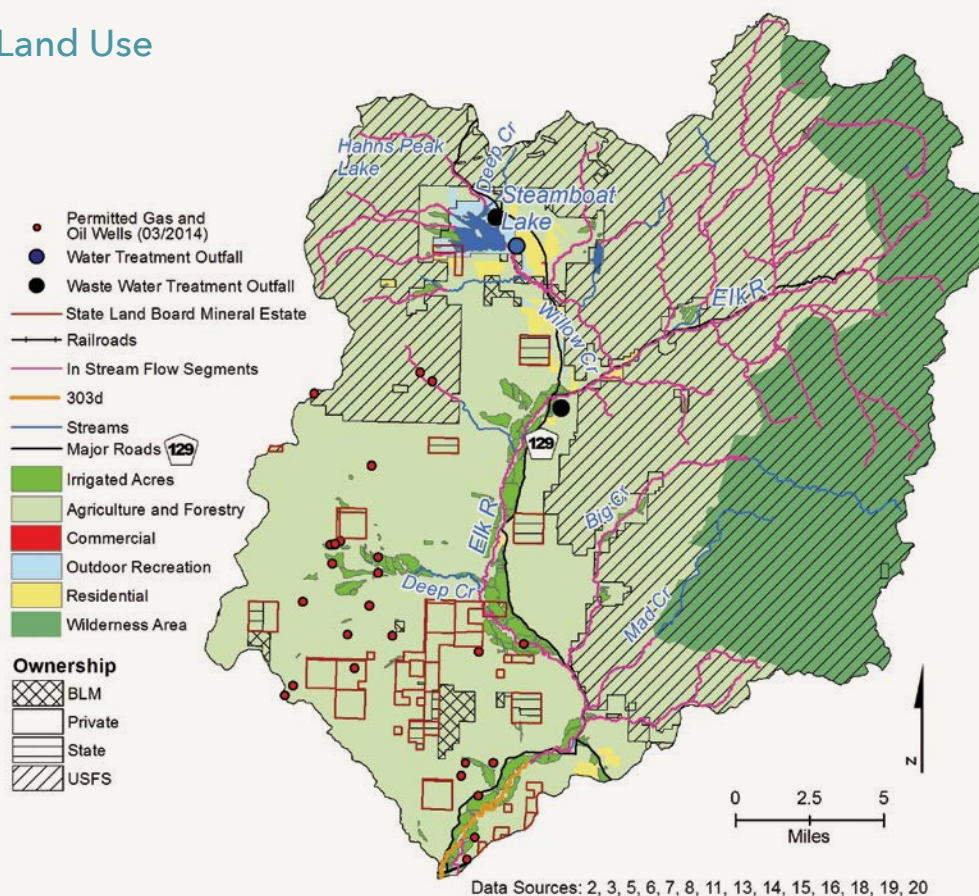


Figure 21. Land use cover and ownership characteristics of the Elk River Subbasin.

Geology

Geology, stream flow and land-use have the greatest influence on water quality in the Elk River subbasin. North of Steamboat Lake and on the eastern side of the subbasin, Precambrian formations of granite and metamorphic rock with dispersed glacial drifts dominate the Zirkels—these formations are resistant to weathering. More erodible Cretaceous Mancos shale and a Tertiary Browns Park formation create the valleys and western side of the subbasin. These rocks create harder water and can buffer acid well. Cretaceous and Tertiary sedimentary rocks also contain soluble materials and trace elements such as arsenic, barium, boron, iron, manganese, nickel, selenium, and strontium. These formations are also characteristic of having higher amounts of suspended solids during spring run-off. (Nancy J. Bauch, 2012).

Water Quality

The Colorado Water Quality Control Commission found that 6 of 13 samples collected at an Elk River site below Routt County Road 46 in 2001-2002, exceeded the Colorado's standard for *E. coli* (bacteria in human and animal excrement). The USGS found no exceedances in 25 samples collected at a site on the Elk River near Milner between 2001 and 2007 (Bauch, 2012). Lost Dog Creek, located on the Routt National Forest, was sampled ten times between 1999 to 2007, and was placed on the 2012 CDPHE 303(d) list because the stream exceeded the aquatic life standard for mercury. The USFS believes the source of the mercury is past wildfires in the area.

Observations & Developments

Landowners in the Elk River subbasin have observed a number of changes to the watershed. The USFS observed that wildfire activity in 2002 led to increased runoff and sediment in parts of the Elk River subbasin. This problem has declined with the re-establishment of vegetation.

Willow Creek, downstream of Steamboat Lake, was turbid as a result of sediment loading from a landslide in Willow Creek Canyon (Riverkeeper, 2013). Over the years, several local landowners have observed discharges having foul odors and green color occurring below the Steamboat Lake dam in Willow Creek during water releases (Elk River Water Users, 2014). Water quality monitoring of Willow Creek is needed.

Many avulsions have been observed on the Elk River between Clark and the confluence with the Yampa River. Local hydrologists surmise that these avulsions take place because the original channel begins to fill with excessive sediment. Gravel push-up dams are commonly constructed by river users to get water into their headgates. Other channel modifications to create fish habitat and to stabilize stream banks occur as well. Concerns are mounting that frequent river entry with heavy equipment, streambank modification, and lack of coordination between design teams and property owners have and will continue to lead to more avulsions and added bedload into the system.



Figure 22. Elk River valley at flood stage in 2011. Courtesy of Andy Rossi.

Middle Yampa River- Trout Creek & Dry Creek Subbasins

Background

Hayden is the largest population center in the Middle Yampa River subbasin (Figure 23). Some residents of the subbasin live in the small community of Milner and on rural ranches. The 2011 update to the 2010 U.S. Census estimates that 2,463 people live in the subbasin.

The Yampa Coalfield underlays 200,000 acres west of and including Milner. [The Peabody Twentymile Mine](#) will be relocating to a new longwall location, called the Sage Creek Mine. It is near Grassy Creek, about ten miles from the current locale and is slated to begin production in the next several years. The Twentymile Mine opened in 1983 and still has 34 million tons of recoverable coal reserves (Peabody Energy, 2013).

The Hayden Generating Station is a coal-fired, steam-electric generating station with two operating units. Coal is delivered from Peabody Coal's local Twentymile Mine. Operational responsibilities are held by Xcel Energy (Xcel Energy). There are also a number of independently operated and active oil wells in this subbasin.

Water Supply

Water in the Middle Yampa River subbasin has many uses: livestock, agriculture, power generation, coal and gravel mining, municipal supply and recreation (Figure 24). Wells and springs are used for rural residential water supplies, while community water and wastewater facilities exist in some rural home owners associations. Modern on-site wastewater treatment is used to treat sewage where wastewater facilities do not exist. The Town of Hayden pumps water out of the Yampa River for its municipal water supply. The town's wastewater facility discharges into the Yampa River. Milner, a community east of Hayden, uses on-site wells for municipal water but has a community wastewater treatment system which discharges into the Yampa River.

Peabody has proposed an 11,000 AF in-channel reservoir on Trout Creek. The Preliminary Application Development Plan was submitted to the Federal Energy Regulatory Commission in 2012 and a study plan has been developed. The reservoir build-out is at least five years from completion. All surface mines have ceased coal production and currently Seneca and Yost mines are in the SMCRA regulated reclamation phase. Grassy, Sage, and Dry Creeks have current National Pollutant Discharge Elimination System (NPDES) discharge permits related to the Seneca mine.

Land Use

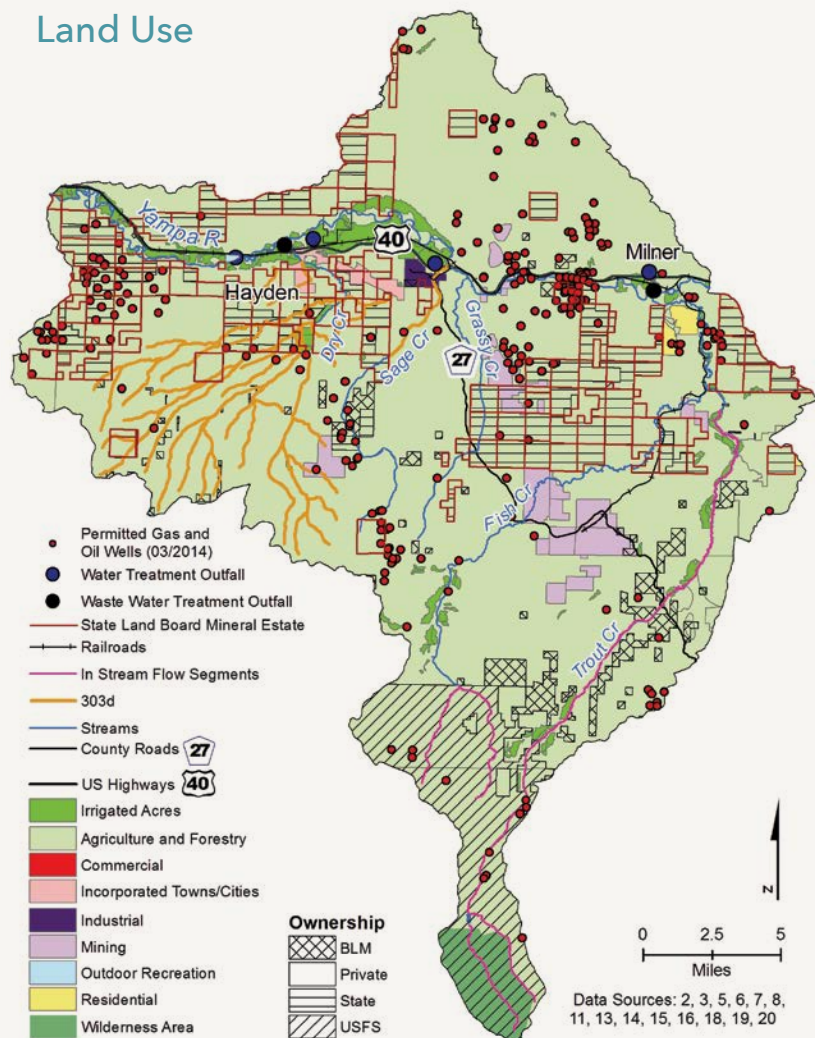


Figure 23. Land use, cover and ownership characteristics of the Middle Yampa River subbasin.



Figure 24. The Middle Yampa River valley at floodstage. Courtesy of Andy Rossi

The oldest water rights on the Yampa River, dating back to the early 1880's, are held in this subbasin and are still used to irrigate hay meadows and water livestock. The Yampa River State Park is located along its namesake, as are the Yampa River Preserve and the Carpenter Ranch - The Nature Conservancy's collaboration and education facility. In this subbasin the Yampa River supports a diverse wildlife population and one of the world's largest remaining examples of a rare riparian forest comprised of narrowleaf cottonwood, box elder and red-osier dogwood (Figure 25).

Geology

Geology, stream flow and land-use have the greatest influence on water quality in the Middle Yampa River - Trout Creek & Dry Creek subbasins. Lewis and Mancos Shale overlay part of the coal fields. Low sulfur coal is currently mined only from the Wadge coal seam, the middle coal group between the lower Wolf Creek group and the upper Lennox group within the Williams Fork formation. Like all Cretaceous and Tertiary sedimentary rocks, each of these formations are susceptible to the weathering action of water, which can result in a large amount of dissolved constituents in surface and ground water. The formations contain soluble materials and trace elements including arsenic, barium, boron, iron, manganese, nickel, selenium and strontium. These formations also have low sulfur content and high acid neutralizing capacity, which likely is why pH values are more alkaline than acidic (Nancy J. Bauch).



Figure 25. The Nature Conservancy Yampa River Preserve, Hayden, Colorado. Photo credit: © Alan W. Eckert, Alan Eckert Photography.

Water Quality

Water quality in the Middle Yampa River subbasin is relatively good. Median concentrations of phosphorus are elevated in this subbasin though still below the standards for all uses. Phosphorus is naturally occurring in the geology, but monitoring should continue. Suspended sediment is high in this subbasin during spring run-off, likely due to silt from its sandstone and shale make-up (Nancy J. Bauch, 2012).

One segment on Dry Creek below the inactive Seneca coal mine is on the CDPHE 303(d) list for exceeding Colorado's aquatic life and agricultural use standards. This segment is also listed for exceeding the aquatic life standard for iron. Additionally, Sage Creek is listed for having exceeded the aquatic life standard for iron. Peabody Energy is conducting extensive water quality and biomonitoring studies and will propose a Site Specific Standard (SSS) for the listed segments through Colorado's rulemaking process. The rationale behind the proposal is that increased selenium could be due in part or in whole from the geology of the area as mentioned above.

Observations & Developments

On-site observations contribute to an understanding of watershed health. The USFS has observed excess sediment in the Routt National Forest within the Middle Yampa River subbasin. Erosion caused by the spread of noxious weeds and overgrazing, resulting in less groundcover and more surface erosion, may contribute increased sediment to the river system. A fish barrier has been installed above Sheriff's Reservoir (Table 1) to protect the Colorado River cutthroat trout population from the invasion of whirling disease.

Downstream of the Routt National Forest boundary, private grazing land dominates the landscape. Sections of Trout Creek have been restored for riparian and aquatic habitat though many areas display evidence of large sediment contributions and a lack of riparian vegetation. These unhealthy river features contribute to high water temperatures.

The main stem of the Yampa River below the confluence with the Elk River and east of Hayden is referred to as Morgan Bottom. It is an area of concern for many of the area's landowners as well as consumptive and non-consumptive users alike. The river channel impairments include mid-channel islands and large point-bars (depositions of sediment and gravel along the inside bends of the river). Degraded stream banks and eroding channels have dominated the system as the river moves laterally away from major irrigation headgates in the Morgan Bottom area.

The Elkhead Creek Subbasin

Background

The upper portion of the Elkhead Creek subbasin is located in the Routt National Forest (Figure 26). This USFS area, referred to as California Park, has a long history of land use impacts. Because of its high biodiversity the area is now a USFS-designated Special Interest Area. Downstream of the Routt National Forest, ranching and farming are the two dominate land uses. There are no large population centers in the subbasin.

Water Supply

Rural water supplies are spring and well fed. Modern day on-site wastewater treatment (septic tanks and drain fields) is used to treat sewage. Elkhead Reservoir was constructed in 1974 by the Colorado Division of Wildlife for recreation (Table 1). The Yampa Project Participants (the operating consortium for the Craig Station power plant) funded part of the construction in return for rights to a portion of the water storage. In 2006, the reservoir was raised 25 feet and the storage capacity increased to 25,550 AF. The Upper Colorado River Recovery Program invested in the enlargement in exchange for water storage to assist with flow management on the Yampa River for endangered fish. Maintenance and operation is shared between the city of Craig and the Colorado River Water Conservation District. The recreation facilities are managed by Colorado Parks & Wildlife (CPW). Water storage is multi-use: municipal, industrial, recreational, and endangered fish flow management.

Land Use

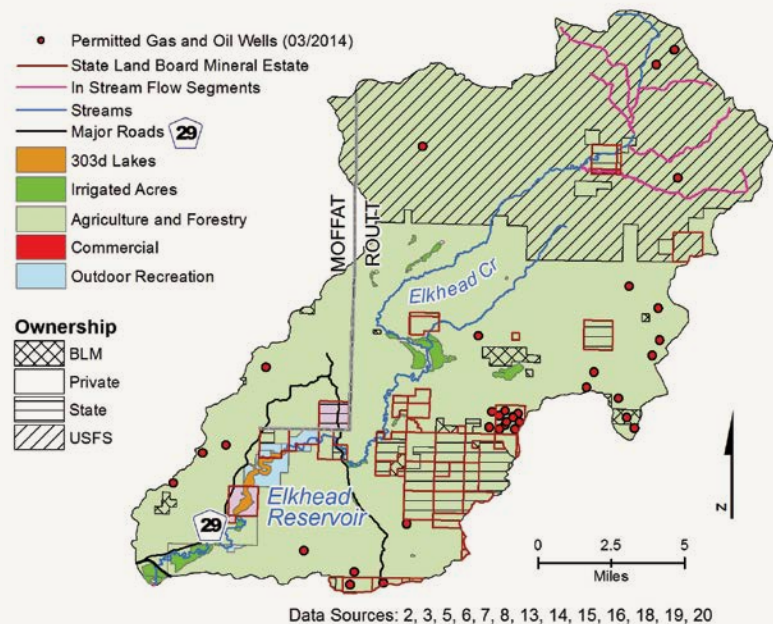


Figure 26. Land use, cover and ownership characteristics of the Elkhead Creek subbasin.

Geology

Geology, stream flow fluctuations and non-point source contributions from land-use have the biggest impact on quality of water in the Elkhead subbasin. The valleys are made up of highly erodible Lewis and Mancos Shale and to the northwest there are Tertiary Fort Union and the Wasatch formations. Like all Cretaceous and Tertiary sedimentary rocks, each of these formations is susceptible to the weathering action of water, which can result in a large amount of dissolved constituents in surface and ground water. The formations contain soluble materials and trace elements including arsenic, barium, boron, iron, manganese, nickel, and selenium, and strontium. Additionally, the formations create hard water and can buffer acid well (Nancy J. Bauch, 2012).

Water Quality

Elkhead Reservoir is currently on the CDPHE 303(d) list for exceeding the State aquatic life standard for fish tissue mercury. [Fish consumption advisories](#) have been in place since 2007. CPW, CDPHE and Colorado State University are currently investigating mercury contamination in the reservoir.



Figure 27. Incised channel in Armstrong Creek.
Courtesy of the U.S. Forest Service.

Observations

Water quality in the Elkhead Creek subbasin is relatively good. However, it has been observed that high sediment loads in the upper basin impact the Elkhead Creek system, including Elkhead Reservoir and various agricultural diversions. Lack of riparian vegetation and incised channels in the upper basin have resulted in excessive streambank erosion (Figure 27). Poor upland conditions, including extensive bare ground and noxious weeds, create minimal effective groundcover and contribute to increased erosion. This results in wide, shallow, and exposed channels which are more susceptible to heating (Figure 28). High temperatures make streams less favorable to cold water aquatic life including Colorado River cutthroat trout.



Figure 28. Elkhead Creek viewing Sand Mountain.
Courtesy of the U.S. Forest Service.

There is a multi-phased conceptual restoration plan for upper Elkhead Creek and its tributaries. The project team includes USFS, CPW, Trout Unlimited, and the Routt County Conservation District. Additional partners—Yampa/White/Green Basin Roundtable, Colorado Water Conservation Board, Colorado River Water Conservancy District, Tri-State Energy, and the city of Craig—have contributed to implementation phases of the project. Restoration activities on Armstrong Creek are being implemented to improve riparian conditions, reduce sediment, reduce stream temperature, and improve habitat for Colorado River cutthroat trout. Additional implementation on other streams, including Elkhead Creek, will be carried out as funding becomes available.

Conclusion and Next Steps

Summary

The Upper Yampa River Watershed generally has good water quality and biodiversity. Water quality is greatly influenced by the geology of the watershed and the deposition of excess sediment in specific areas. Exceedances of water-quality constituents such as *E. coli*, dissolved oxygen, and temperature can be the result of human activities and management practices related to stream-flow modifications, livestock grazing, waste disposal, and alteration of riparian habitats. Observations and data indicate areas where monitoring and implementation of restorative action are needed to improve general water quality and watershed health.

Next steps

The 2014 State of the Watershed Report is the first of four steps in the current watershed planning process. The three remaining steps are described below:

- **Establish Watershed Objectives:** Through outreach with the public stakeholders and partnering organizations, specific watershed objectives will be identified. Prioritize a list of project implementation concepts. Using the watershed objectives, a matrix will be created to help prioritize projects for funding opportunities. Potential projects will be solicited from all private, local, state and federal partners.
- **Develop a watershed plan for the Upper Yampa River Watershed.** The Plan will characterize existing conditions as referred to in this report. Wherever possible, objectives and strategies will be established to address these issues. During Plan development, stakeholders and partners will be engaged to increase coordination and awareness of watershed and water quality health protection measures. Additionally, the Upper Yampa River Water Quality Monitoring Program will provide analysis of the quarterly water-quality sampling at six surface water sites in the basin.

In order to execute the above actions, the UYRWG will concentrate on:

- Landowner and partner outreach and coordination.
- Project specifications to meet watershed objectives.
- Writing grant proposals and leading collaborative funding efforts to secure project implementation funds.

Conclusion

Collaborative water resource management will be necessary as rural areas continue to grow and water shortages continue to rise. Public education and stakeholder engagement will be important to the watershed's planning process and ultimately to watershed health. Perhaps most important is the need for a holistic approach to addressing the Upper Yampa River Watershed's distinctive watershed threats. A watershed plan is the first step in that direction.



Sarvis Creek, photo Courtesy of Western Rivers Conservancy

Explanation of Terms Used

Alkalinity: Is the measure of water's capability to neutralize an acid. Acid can come from the breakdown of carbonate rocks and the presence of carbon dioxide in the air as well as other naturally occurring components such as borate, hydroxide, phosphate, silicate, nitrate.

Avulsion: Is the rapid abandonment of a river channel and the formation of a new river channel.

Flow Volume: Flows in the UYRW can vary significantly; seasonally, following runoff events, as well as during drought periods. Flow is an important consideration when assessing water quality data. Erosion and dilution are two factors that can affect water quality results.

Dissolved Oxygen: Commonly referred to as DO, except in this report. Dissolved oxygen is the measure of the amount of oxygen available to fish and aquatic life is dissolved oxygen. It varies with climate, altitude, water depth, temperature, and flow velocity and is affected by point and non-point sources.

Eutrophication: The natural aging process that normally takes hundreds or thousands of years and results in filling in of the water body is eutrophication. It can be rapidly accelerated, especially in man-enhanced lakes and ponds, by activities within the watershed. Increased nutrients (nitrates and phosphates) from runoff entering the lake often cause excessive algae blooms an/or aquatic plant growth. Decaying algae and plant growth uses oxygen and results in added material to the lakes bottom which disrupts the ecological balance of the system.

Fecal Coliform: The most common source or pathway of fecal coliform bacteria in water systems is waste from humans, wildlife and livestock.

Hardness: Measures salinity dissolved in water, and can be caused by calcium, magnesium and other metals. It is often affected by the materials (e.g., geologic formations) through which water flows. Water that drains through sedimentary formations containing carbonate has hard water. Lower hardness can increase metal toxicity to aquatic life. Tolerance limits for aquatic life vary.

Nutrients: Nitrite, nitrate, ammonia, phosphorus, and orthophosphate are essential nutrients to animal and plant life. They occur naturally in streams and lakes, from human sources such as wastewater treatment plant discharges, and through nonpoint source runoff from urban and agricultural areas.

pH: pH measures the relative acidity of water, generally between 6.5 and 8.5 standard units. Lower than 7 is acidic; and greater is alkaline. Fluctuations of pH in the UYRW can be affected by surrounding geology; biologic and human activities; acid rock drainage; and the atmosphere (precipitation).

Sediment: Particles like silt and clay resulting from soil erosion can enter a water body and cause a variety of concerns. Excessive sediment can negatively impact aquatic life, aid in the transport of unwanted nutrients, degrade drinking water, may alter stream channels and riparian habitats and accelerate lake and reservoir eutrophication.

Temperature: Temperature effects water chemistry in its entirety and can significantly impact the life cycles of aquatic organisms. Dissolved oxygen levels are also affected since cold water holds more dissolved oxygen than warm water.

Total Dissolved Solids (TDS): TDS provide a general measure of salinity or matter dissolved in water. It may be used as an indicator of the extent of mineralization or erosional releases in a basin and is often a general indicator of water quality.

Trace Elements: Metal and non-metal elements, usually in small concentrations, are able to adhere to sediment that is washed off the land surface. Many trace elements are needed by biota but substantial concentrations can be toxic and bio-accumulation can occur in the food chain. Examples of trace metals: iron, manganese, selenium, mercury, strontium, cadmium, copper, lead and chromium. Sources include soils, geology, thermal springs, and human and industrial activities.

Width-Depth Ratio: Ratio of bankfull surface to the mean depth of the bankfull channel.

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