



Landowner Guide and Practitioner Handbook

AUTHORS

Roddy Beall, Zenobia Consultants
Ben Beall, Zenobia Consultants
Kim Lennberg, Alba Watershed Consulting

CONTRIBUTORS

Ellie Miller, Trout Unlimited
Emily Spencer, National Park Service
Mark Monger, HT Erosion
Kaitlin Flick, KMF Consulting
Shannon Wadas, Strategic by Nature
Jennifer Peers, Copy Editor

ADVISING COMMITTEE

Emily Burke, Friends of the Yampa
Patrick Stanko, Community Agriculture Alliance
Amber Pougiales, Community Agriculture Alliance
Jayla Poppleton, Western Resilience Center
Ryan Messinger, Western Resilience Center
Sara Rathburn, Colorado State University
Brian Murphy, River Network
Jennifer Wellman, The Nature Conservancy
Lindsey Marlow, Friends of the Yampa
Jenny Frithsen, Friends of the Yampa

PARTNERS AND FUNDERS

Colorado Water Conservation Board
Walton Family Foundation

Executive Summary

Yampa River Stewardship Program: Landowner Guide and Practitioner Handbook

The Yampa River is one of the last largely free-flowing rivers in the Colorado River Basin, supporting a rich mosaic of ecosystems, agricultural operations, and rural communities. Its health depends on active, informed stewardship by landowners, land managers, and restoration practitioners working along the river and its tributaries. This Handbook provides practical, science-based guidance for addressing common land management challenges while maintaining and enhancing river function, wildlife habitat, and long-term landscape resilience.

The guide equips landowners with tools to:

- Diagnose issues such as erosion, flooding, invasive species, degraded fisheries, livestock impacts, and infrastructure challenges
- Understand the natural processes driving river behavior
- Understand the suite of restoration and management actions that support the ecological integrity of the Yampa River and its tributaries, improve agricultural productivity, and protect infrastructure, and select suitable actions
- Identify funding pathways and connect with the Yampa River Stewardship Program and partner organizations for technical support

Core Principles of River Stewardship

1. Rivers Are Dynamic, Not Static

Natural processes like erosion, deposition, flooding, meandering, and sediment movement are essential to a healthy river system. Efforts to overly constrain the river often create unintended consequences, including accelerated erosion, channel incision, habitat loss, water quality decline, and maintenance burdens.

2. Healthy Riparian Forests Are Foundational

Riparian vegetation stabilizes banks, shades and cools water, filters runoff, provides wildlife habitat, and increases groundwater retention.

3. Beaver Activity Provides Major Ecological Benefits

Beavers slow and spread water, raise water tables, create wetlands, improve water quality, and expand habitat. Coexistence strategies allow landowners to manage risks while retaining these benefits.

4. Complex Physical Habitat Supports Fish and Wildlife

Healthy ecosystems require diverse physical habitat—riffles, pools, undercut banks, large wood, side channels, backwaters, wetlands, and floodplain access.

5. Floodplains Are Part of the Riverscape

The river channel and its floodplain together make up the riverscape. Flooding builds soil, distributes nutrients, supports riparian forest regeneration, recharges groundwater, and reduces downstream flood risk. Restoring floodplain connection strengthens watershed resilience.

6. Land Management Impacts Water Quality and Quantity

Runoff, livestock access, septic systems, accelerated erosion, and vegetation removal can degrade water quality and quantity. Conversely, riparian buffers, infiltration practices, wetland restoration, beaver activity, and efficient irrigation improve it.



Photo Credit Peter Williams, Yampa River Leafy Spurge Project

Summary of Recommended Actions by Common Concern

Bank Erosion	Promote natural stabilization of streambanks through riparian buffers, willow plantings, natural/bioengineered structures, and process-based approaches.
Beaver Coexistence	Use tree wrapping, pond levelers, culvert protection, and starter analog structures to manage conflicts while benefiting from beaver-driven hydrology.
Fisheries	Enhance habitat complexity, improve flow conditions, retrofit barriers, install fish screens, and protect and improve riparian shading.
Flooding and Floodplains	Reconnect side channels, modify berms, create floodplain benches, add floodplain roughness, restore gravel pits, and use setback infrastructure to balance asset protection and river function.
Invasive Plants	Use integrated weed management (manual, mechanical, cultural, chemical, biological) and coordinate with local resources to manage invasive plant species.
Irrigation Infrastructure	Modernize diversions, replace push-up dams, incorporate fish and sediment passage, consider boater safety, install debris racks, automate headgates, and evaluate relocation options.
Riparian Forest & Buffer	Use site-specific plant communities, learn proper planting methods, manage grazing during establishment, and consider a conservation easement.
Stream Crossings	Design crossings so that floods, sediment, and wood may pass, and reduce the overall number of crossings.
Streamside Landscaping	Encourage natural vegetation, retain large wood, and design selective view corridors without removing buffers.
Streamside Livestock Grazing	Implement rotational grazing, protect riparian areas with fencing, develop off-channel watering, and install hardened access points.
Water Quality	Restore riparian buffers, manage runoff and septic systems, enhance infiltration, restore wetlands, and support beaver activity.
Water Quantity	Increase water availability via floodplain reconnection, wetland expansion, beaver structures, and temporary water leasing.
Wildlife Habitat	Enhance riparian forests, support movement corridors, maintain habitat complexity, reconnect secondary channels, and design wildlife-friendly fencing.

Funding and Support

The Handbook outlines numerous funding opportunities including the Yampa River Fund, CWCB grants, NRCS EQIP, USFWS Partners for Fish and Wildlife, RESTORE Colorado, and others. The Stewardship Program assists landowners in designing multi-benefit projects and navigating grant processes.

Overall Vision

The Yampa River Stewardship Program envisions a future where the Yampa River:

- Maintains intact ecological function
- Supports a vibrant agricultural economy
- Meets municipal and industrial needs
- Sustains thriving communities and wildlife

This Handbook serves as a roadmap for landowners to protect their land, increase resilience, and contribute to watershed-wide river health. To get started, a site visit from the Yampa River Stewardship Program can help identify opportunities to address concerns and simultaneously improve river health. There may be opportunities to take on larger projects by designing a multi-benefit project and getting funding from the programs described in this Handbook. Building a strong team with the help of conservation districts and partner organizations can make projects more effective and extend the benefits to the whole watershed.

**Note: This Handbook should be only used to inform landowners about design and construction techniques, and is not a substitute for design consultation with a Professionally Licensed Engineer.*

Executive Summary	3
Welcome	8
Bank Erosion	10
Beaver Coexistence	19
Fisheries	25
Flooding & Floodplains	33
Invasive Plants	40
Irrigation Infrastructure	46
Riparian Forest & Buffer	52
Stream Crossings	58
Streamside Landscaping	65
Streamside Livestock Grazing	69
Water Quality	75
Water Quantity	81
Wildlife Habitat	86
Funding	93
Closing Summary—A Shared Vision	101
Appendices	103
Appendix 1: Yampa Valley Riparian Forest Guide	103
Coniferous Riparian Forest	106
Upper Valley Willow Shrubland	107
Narrowleaf Cottonwood / Thinleaf Alder Woodland	108
Narrowleaf Cottonwood / Red Osier Dogwood Woodland	109
Sandbar Willow Shrubland	111
Fremont Cottowood / Skunkbush Sumac Woodland	113
Appendix 2: Yampa River Scorecard Project	115
Appendix 3: Yampa River Desired Future Conditions	117

Welcome

The Yampa River is one of the last wild rivers in the Colorado River system, flowing free for most of its 250-mile run from the Flat Top Mountains to its confluence with the Green River in Dinosaur National Monument. Many species of animals and plants co-evolved with the river over millennia and continue to thrive in the Yampa's natural, snowmelt-driven flow regime. Today, the Yampa and its tributaries remain a model of a healthy and functional river system.

Stewardship is not a new concept in the Yampa Valley. Indigenous peoples have been caretakers of the land since time immemorial, and local producers and landowners continue to care deeply about the land and river, spearheading efforts to innovate, conserve, and protect the landscape. New challenges are constantly emerging, and the people of the Yampa River Basin rise to meet them, balancing agricultural productivity and rural/urban development with protection of ecosystem services and river health.

The Yampa River Stewardship Program Landowner Guide and Practitioner Handbook is intended to assist landowners, land managers, and restoration practitioners working along the Yampa River and its tributaries in identifying strategies to solve common concerns while simultaneously supporting river health. It provides guidance for how to work with the land and water in ways that support natural processes and create lasting solutions. Techniques are available to design multi-benefit projects to upgrade infrastructure, support sustainable agriculture and outdoor recreation, and improve the integrity and health of the Yampa River watershed. Many of those methods are outlined in this Handbook.

The Handbook is divided into sections that address common concerns of Yampa Valley landowners and land managers. For each concern, the Handbook provides important questions to consider to further understand what activities or conditions might be causing a particular problem. It also introduces a few pertinent principles of river health, which is important for considering the ecological system as a whole. And finally, it provides several recommended practices or actions that may be taken to address concerns while still supporting river health and ecological function. Note that some actions are repeated in different sections because they address multiple concerns. Following these sections, there is information on potential sources of funding for implementing such actions.

The Yampa River Stewardship Program is here to help!

The Yampa River Stewardship Program is a collaborative effort of Yampa Valley agricultural and environmental community organizations, convened under the umbrella of the Yampa River Collaborative and led by Friends of the Yampa. In addition to Friends of the Yampa, members of the Yampa River Collaborative include the Western Resilience Center, Community Agriculture Alliance, The Nature Conservancy, Trout Unlimited, and River Network. The Yampa River Stewardship Program is working to achieve a Yampa River that maintains intact ecological function, an agricultural economy, municipal and industrial needs, and thriving communities that rely on the river for recreation and quality of life. Its goal is to identify opportunities for multi-benefit projects, provide initial assessments, and connect project advocates with partners to successfully fund, design, and implement projects.

To schedule an initial meeting and site assessment, email Emily Burke, Friends of the Yampa environmental program director, at emily@friendsoftheyampa.com, or call (970) 896-5947

Dedication to river health is a testament to community spirit. Stewardship of each segment of the river improves conditions up and down the watershed. Living on a wild river is special, but it demands collaboration, partnership, and hard work.

Bank Erosion

Common Issues

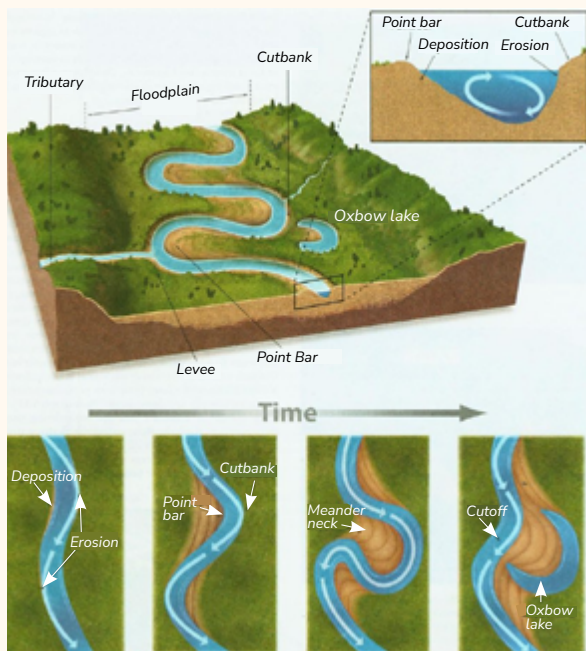
Bank erosion typically occurs on the outside bends of a river channel. Erosion can be concerning if infrastructure like roads, ditches, or buildings are close to where this process occurs. A particular concern is an avulsion, which is when the river establishes a new river channel, shortcutting a longer bend. Erosion may also impact the channel bed in some places, causing downcutting, or deepening, of the whole channel.

Questions to Consider

- Do the banks lack streamside vegetation? Is there evidence of past removal of riparian vegetation where the stream channel has migrated?
- Are livestock accessing banks at the outside bend of the river channel?
- Has bank stabilization or armoring (fortifying the river banks with materials) already been implemented? Has stabilization been implemented on an upstream or downstream property? If so, what types of materials were used?
- Is there a secondary channel that was cut off in the past but could be re-opened to reduce the velocity of water during high flows?
- Does the channel lack natural features that add complexity such as boulders, point bars, sand bars, cobble bars, instream woody material, or vegetation?
- Is the riverbed downcutting? Is the riverbed aggrading?
- While erosion may be problematic in one area, would it be acceptable in other locations?

Principles of River Health

Erosion and Deposition of Sediment are Natural Processes



Meander migration, erosion, and deposition
Diagram courtesy of Paul Bierman and David Montgomery, *Key Concepts in Geomorphology*, 2020

Erosion and deposition are processes that occur as rivers channels move across the valley floor over time. Naturally functioning and healthy rivers are not static; rather, they migrate throughout the landscape, creating fresh surfaces and removing older ones. As shown in the diagram below, the river channel's energy erodes streambanks on outside bends, and those sediments are deposited on opposite inside bends to create sand and gravel point bars. These newly formed areas promote riparian vegetation regeneration, leading to healthier river habitats. This circuit of events—erosion and deposition—is essential for the health of the ecosystems along the river. Cottonwood and willow, for example, require newly created land in the form of fresh sandbars to successfully reproduce. If rivers cannot move because they are locked in place by human impact, then this dynamic sequence is stopped and riparian vegetation may age out and fail to regenerate.

Erosion Increases with Lack of Riparian Buffer

While erosion and deposition are natural processes, rapid or excessive erosion can become a problem both for the health of the river and for adjacent land uses. As river channels interact with areas that have been cleared of riparian forest, bank erosion becomes accelerated and exacerbated due to the absence of deep vegetation roots holding the soil together. This can lead to a loss of productive land and the undermining of existing infrastructure. The photo below shows a current example of these conditions in the Yampa Valley.

The intact riparian forest on the right side of the photo is undergoing healthy, natural erosion, creating gravel bars and undercutting cottonwood trees that then fall into the river and contribute to healthy habitat. Juxtaposed on the left side of the photo is a hayfield with no riparian buffer, where the bank erosion is much more pronounced and accelerated due to the lack of root structure holding the bank together. The field is losing productive agricultural land and a fence is falling into the river.



Streambanks erode more rapidly where they lack riparian vegetation
Photo by Kim Lennberg, Alba Watershed Consulting

Adverse Impacts of Historic Efforts to Reduce Bank Erosion

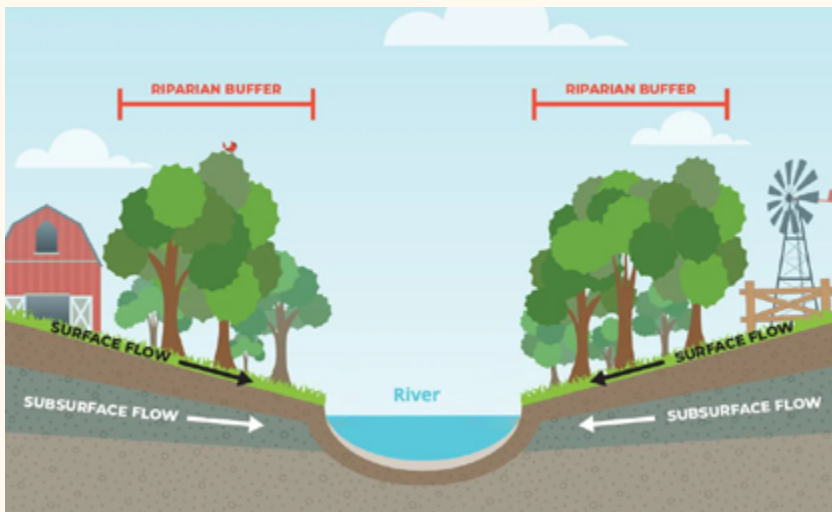
Although placing hard armoring and stabilization such as rock, riprap, or concrete is intended to stabilize riverbanks, it can instead lead to increased stream power and accelerated bank erosion. Similarly, loss of flow or blocking flow to side channels can also lead to increased erosion. Impacts from physical changes such as hard armoring are not isolated to the areas immediately adjacent to the bank stabilization and may be evident across the river, far downstream, and even upstream.

Recommended Practices or Actions

Many options are available for addressing rapid erosion on a particular property. Erosion is a natural process that occurs slowly and somewhat predictably in healthy riparian areas, so if possible, planting trees and shrubs along the banks of the river to create a riparian forest is the most desirable way to address erosion. The next option that can kick-start a riparian buffer is a willow toe treatment that uses willow cuttings to create an interlocking root system. When more protection or armoring is desired, other forms of streambank bioengineering, or using natural materials in addition to or instead of rock, riprap, or other “hard” materials, can be a good fit. These practices are described in more detail below.

Install Riparian Buffer

Protecting, maintaining, or creating a naturally vegetated riparian buffer is the best way to protect the land adjacent to the river channel and riparian area. Streambanks often collapse because they lack vegetation to slow erosion of the soil. The roots of the riparian vegetation, once established, protect the streambank and provide other benefits of riparian forests, such as wildlife habitat and improved water quality.



*Riparian forest buffers are critical for stream health
Cross-sectional diagram by H2Ohio*



Photo by Roddy Beall, Zenobia Consultants



*Willow toe, eight months after installation
Photo from the Colorado Stream Corridor Construction Manual*

Install Willow Toe

Where erosion is occurring along outside bends, intensive planting of dormant vegetative willow cuttings can be incorporated with streambank grading (along with the use of cobble or boulder materials to provide strength). Over time, the cuttings provide a dense root system that adds cohesion and stabilizes the bank. This treatment can provide long-term protection, wildlife and habitat benefits, and a healthy riparian buffer.

Install Post-Assisted Log Structures or Beaver Dam Analog Structures

For small streams or side channels, structures that mimic natural wood jams and beaver dams (called “beaver dam analogs”) can be an effective method for reducing stream power and reducing erosion. Instead of flowing swiftly through the channel and carrying sediment away, pooled water causes deposition of sediment, reversing the erosion process. Nature-based (i.e., low-tech) structures like these are not permanent, so they will often wash out in the spring and need to be replaced, but they are relatively inexpensive and meant to be taken over by beaver or rebuilt periodically. On a larger river, where handmade dams do not span the entire river, log structures can be placed in strategic locations to encourage deposition of sediment instead of rapid erosion. These temporary structures can be installed to redirect stream energy away from eroding banks. Where appropriate, structures can be placed to encourage erosion or bank movement in areas more suitable for that impact. These techniques work with the natural dynamism of the river, instead of locking the channel in place.



Post-assisted log structures redirect stream flow to reduce erosion and increase deposition where desired | Photo by Leaf Ninjas



*Beaver dam analogs cause pooling, reducing stream power and encouraging deposition
Photos courtesy of Joe Leonhard, The Nature Conservancy*

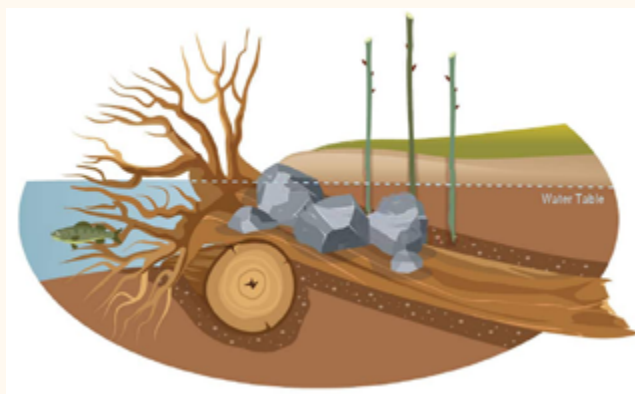
Install Vegetated Soil Lifts

Soil lifts are vertical layers of soil and native seeds wrapped with erosion control geotextile fabric (such as coir matting) and integrated with vegetation (such as willow stakes) to “build” or reconstruct stream banks that have been degraded. Soil lifts provide immediate and short-term structural support, allowing for root development and growth of vegetation, which ultimately provides long-term structural bank stabilization. As the erosion control fabric degrades, the bank is supported by maturing plants.



*Soil lifts during construction
Photo by Kim Lennberg, Alba Watershed Consulting*

Install Root Wads or Large Wood Complexes



*Conceptual cross-section of a river showing erosion control that creates structure and habitat
Diagram by The Watershed Center*

Large wood is a vital component of natural river systems and can be incorporated into riverbanks, the channel itself, or the adjacent floodplain as a restoration treatment. Depending on the application, purpose, and available materials, use of large wood can take the form of single logs, logs with their root systems intact (referred to as “root wads” or “root balls”), or engineered logjams (clusters of strategically placed logs), sometimes called “wood complexes.” Large wood is used for a variety of purposes, often to stabilize streambanks by slowing or redirecting stream currents through



Root wads and riparian forest restoration | Photo by Kim Lennberg, Alba Watershed Consulting

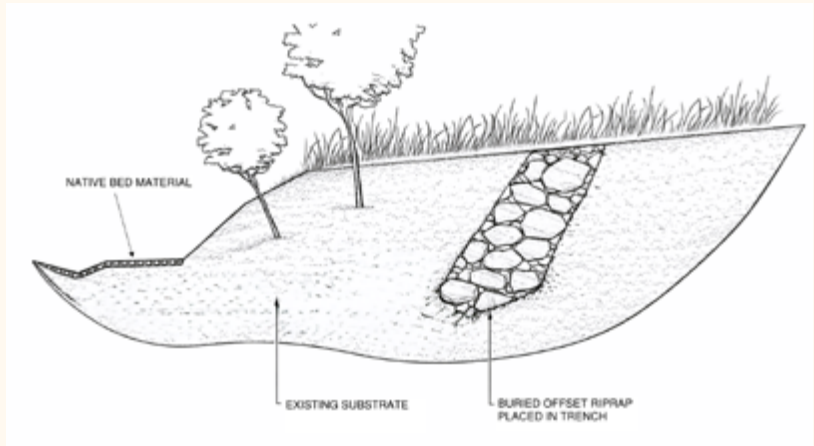
the addition of “roughness” to the channel, bank, or floodplain. If used on the floodplain, large wood can work to capture fine sediments, organic materials, and native seeds for riparian vegetation reestablishment. An engineered log jam consists of the deliberate placement of a matrix of wood to form structures at specific locations and is often used to direct flows away from critical infrastructure and protect banks. Large wood also provides microhabitats and cover for fish and other aquatic organisms.



*Toe wood and bankfull bench at Chuck Lewis State Wildlife Area
Photo by Ben Beall, Zenobia Consultants*

Protect Structures with Setback Riprap

Setback riprap is an engineered structure composed of buried large rocks placed away from the river channel to protect structures or infrastructure at risk of future erosion if the river continues to meander. In the short term, it allows room for flooding, erosion, and channel movement to occur naturally, but offers protection of important infrastructure if the channel migrates toward it. This treatment is an alternative to placing riprap along the bank or a berm at the channel's edge. Setback riprap is buried and covered with soil and revegetated in such a way that it is visually hidden in the landscape.



Conceptual cross section of a river showing setback riprap that allows for a natural streambank and riparian buffer while providing precautionary protection | Detail modified from Colorado Water Conservation Board Emergency Watershed Protection Program



Setback riprap is buried away from channel bank | Photo courtesy of Colorado Water Conservation Board

Install Boulder/Cobble Toe with Floodplain Bench



A boulder toe can be added to riparian plantings in high-risk areas where additional bank movement is unacceptable | Illustration by United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)

In an area where additional stream movement is not allowable for some reason, a boulder toe can provide erosion protection. This approach may introduce an unnatural material type that will have a long-term impact on natural river processes. As such, this technique can lead to long term degradation and should be used sparingly. To reduce impacts on overall river health, regrading the upper portion of the bank after toe installation creates a floodplain bench that allows flood energy to spread out and provides a flat area for additional vegetative plantings.

Install Engineered Grade Control Structures

Grade control structures are man-made river features designed to control the elevation of the riverbed while maintaining floodplain connectivity. Grade control structures can reduce the likelihood of erosion by directing flows away from banks. Grade control can also create beneficial habitats like pools for fish. The most common grade control structures incorporated into river restoration projects are cross vanes and J-hook vanes. Building grade control structures can be costly and may require permitting through the Division of Water Resources (DWR). Installing such structures should be carefully considered and properly engineered to consider upstream and downstream impacts. As these methods fundamentally alter the natural form of the river, they should be used only when deemed absolutely necessary or where they are necessary due to significant historical impacts to the river.



*Grade control structures can control river form
Photo by Kim Lennberg, Alba Watershed Consulting*

Additional Benefits of Implementing Recommended Practices

- Reducing stream power can reduce erosion on the property and for downstream neighbors
- Additional channel and floodplain roughness can mitigate potentially damaging floodwaters during spring runoff and large storms
- Increasing riparian vegetation can help anchor streambanks while also creating wildlife habitat and cooling surface water temperatures
- Encouraging sedimentation can build future pastureland

Reference and Resource Materials

A science-based journal article called [Bank Erosion as a Desirable Attribute of Rivers](#) describes why bank erosion is important for the healthy functioning of river ecosystems.

This [United States Department of Agriculture \(USDA\) Soil Bioengineering Webinar slide deck](#) presents techniques and case studies in successfully accomplishing streambank protection with bioengineering techniques.

[Colorado Stream Corridor Construction: A Guide for Contractors and Operators](#) was developed by the State of Colorado's Technical Assistance Team to improve the quality, function, and aesthetic of construction work in Colorado's stream corridors. It highlights best practices and innovative techniques in river restoration in Colorado.

[Living Streambanks: A Manual of Bioengineering Treatments for Colorado Streams](#) is a detailed manual of streambank bioengineering treatments that is focused on Colorado streams and rivers.

American Rivers authored [a review of restoration projects](#) that provides research and information on the use of low-tech process-based techniques in the restoration of riverscapes on headwater streams.

The USDA [Natural Resource Conservation Service \(NRCS\) Stream Restoration Planning and Design Field Guide](#) is a general field reference and training tool for stream corridor restoration and design.

The Watershed Center's [Regional Stream Stewardship and Recovery Handbook](#) provides a great resource with guidance and consideration for multiple strategies to address stream stewardship practices.

Beaver Coexistence

Common Issues

Beavers provide many benefits to the river system. Their presence is also sometimes challenging because their dams and canals can cause localized flooding, block irrigation ditches and road culverts, and divert water in unexpected ways. They may also damage or cut down a particular tree or set of woody vegetation that is important to a landowner.

Questions to Consider

- Can beavers be allowed to stay on the property? Perhaps on a limited portion of the property?
- Does management allow for the installation of beaver coexistence structures?
- Can some flooding be tolerated at the site if it is controlled at a predetermined level?

Principles of River Health

Beavers are a Keystone Species

Beavers are a “keystone species,” or a species that has an outsized role in supporting its environment. The actions of beavers benefit the ecosystem as a whole and encourage the presence and success of other species. Beavers are “nature’s engineers,” modifying the landscape by building dams and canals that slow and spread water, facilitate the growth of riparian vegetation, expand or create new ponds and wetlands, and maintain a higher water table.

Beavers Slow and Spread Water

Beaver dams slow the water moving through the landscape, allowing it to soak into the soil and spread out onto the floodplain, thereby recharging groundwater, raising the water table, increasing

soil moisture, and supporting late season flows. Beavers also dig and maintain canals on the floodplain as they gather wood, and these canals also help to spread water across the landscape. Beaver ponds are areas where nutrients, metals, sediments, and other solids settle out of moving water onto the pond bottom where they are processed by microbes, thus improving downstream water quality.



These photos were both taken in Routt County in late September, and show that beaver complexes maintain water storage and healthy riparian vegetation, even in late summer | Photos by Kim Lennberg, Alba Watershed Consulting and Roddy Beall, Zenobia Consultants

Homes for Many

Beaver ponds and wetlands are hotspots of biodiversity, hosting many aquatic and terrestrial species such as fish, insects, aquatic mammals, birds, amphibians, reptiles, ungulates, and carnivores.

Protection from Natural Disasters

In addition to ecological benefits, beavers are an effective partner for building resilience to drought, wildfires, and floods. Beaver complexes rehydrate the landscape, slow snowmelt and stormwater runoff, and prevent or correct stream channel incision. These benefits eventually allow for more connected floodplain benches and more robust riparian vegetation. Beaver wetlands keep moisture in the soils and floodplain, supporting abundant vegetation and creating a refuge for animals in the face of drought and wildfires. Beaver complexes also mitigate the damaging effects of floods, including post-wildfire floods, by giving floodwaters and associated sediment and wood a capture area before overtaking downstream infrastructure.

Recommended Practices or Actions

For landowners able to embrace beavers on their property, several methods and techniques are available to help accomplish successful coexistence that are cost-effective, often eligible for grant funding, and require little maintenance, as described below. These actions can be taken by landowners with the guidance provided here as a starting point, and professional training is available through the BeaverCorps Program.

Protect Important Trees with Tree Wrappings



*Metal tree wrappings protect cottonwoods
Photo courtesy of Friends of the Yampa*

Beavers fell trees and limbs for food and building materials and to keep their constantly-growing teeth in check. Protecting highly valued individual trees from beaver gnawing can be accomplished by placing heavy wire cylinders around the base of their trunks. Specifically, install 2x4-inch wire mesh cylinders with a minimum of a 3- to 6-inch gap around the base of the tree trunks, 2 feet above estimated snow level. In the valley bottoms, a 4-foot-high fence is almost always enough. If the adjacent waterbody floods its banks and has a lot of flow power, like on the mainstem Yampa, it can be helpful to drive wooden stakes into the upstream and downstream sides of the wire cylinders and secure them to the cylinder with a short length of wire to add extra stability. Broader fences can be installed as well for an entire stand of trees (such as an orchard). When installed correctly, this method is very effective, inexpensive, and doesn't require maintenance. An alternative to caging is applying a mixture of sand and paint to the bottom 3 to 4 feet of a tree trunk to make the bark "gritty" and undesirable for beavers.

Keep Culverts Open with Starter Beaver Dam Analog

A landowner or land manager may want to preemptively protect a culvert or other structure from increases in beaver activity in areas where beavers are known to be active. This can be accomplished by installing a porous starter dam (similar to a beaver dam analog) 10 to 12 feet upstream of a culvert to prevent beavers from damming directly on the culvert. This method works by encouraging beaver activity to occur well upstream of the culvert rather than inside the culvert. It is important to still consider other design elements such as sediment transport and aquatic passage as part of this mitigation technique.

Keep Culverts Open with Flow Devices



A flow device excludes beavers from a culvert and maintains flow of water | Photo courtesy of Skip Lisle, Beaver Deceivers International

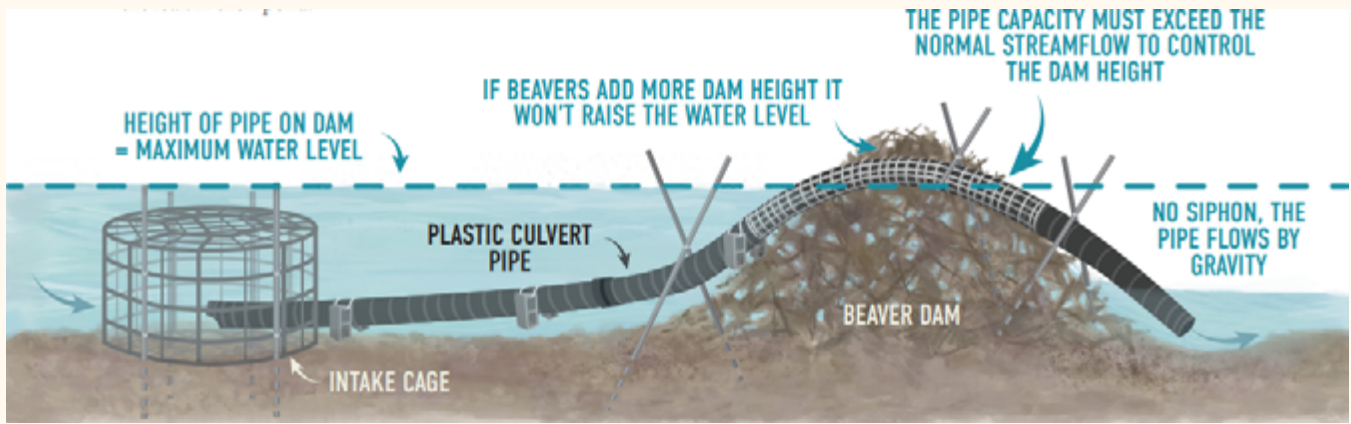
Flow devices, including Beaver Deceivers™, are structures made of wood, wire, and plastic pipe that exclude beavers from a culvert opening while maintaining flow into the culvert. Flow devices are built with enough surface area and strength to tolerate some level of damming, and flow is maintained into the culvert through a polyethylene pipe system that brings water from an upstream “filter fence” into the downstream “receiver fence.” The beavers are allowed to develop their ponds, but the flow device assures that the culvert remains operable.

Manage Flooding with Pond Leveler

As beavers continue to maintain and improve their dam complexes over time, their ponds become larger and can eventually spill into an area that landowners do not want flooded (such as a hayfield). When this occurs, a “pond leveler” pipe can be installed to keep the pond to the desired size by allowing excess water to flow downstream. The pond leveler creates a permanent leak through the beaver dam without allowing beavers to detect the flow of water into the pipe because it is located upstream of the dam and surrounded by a fenced cage, preventing the beavers from getting close enough to the pipe’s inlet to feel or hear flowing water. Water continues to flow through the pipe unless the pond level drops below the peak of the pipe, so the level of the pond is controlled by the height of the pipe.



*A pond leveler maintains the pond level at a certain height
Photo by Roddy Beall, Zenobia Consultants*



Cross section through a pond, showing design of pond leveler | Diagram from Project Beaver

Benefits of Implementing Recommended Practices

- Coexistence with beavers reduces stream power, thereby reducing bank erosion and channel incision on site and further downstream
- Beaver complexes provide great habitat for fish and other wildlife
- Beaver ponds provide stock and wildlife with a source of water during late summer dry-up, when there is little or no water in the creek or river
- Beaver complexes can protect the landscape from the impacts of both wildfire and flooding
- Coexistence with beavers can raise groundwater levels, watering streamside pastures from the roots
- Beavers cutting aspen, willow, alder, and other trees cause the trees to regenerate, improving the quality of the riparian area
- Sediment captured in beaver ponds can create new topsoil for future pastures
- Beaver coexistence is less expensive than trapping, which often needs to be done each year as new beavers move in

Reference and Resource Materials

The [Yampa Valley Beaver Working Group](#) is working to provide beaver coexistence measures at little or no cost to landowners.

Colorado Parks and Wildlife (CPW) is currently developing a [Beaver Conservation and Management Strategy](#) to increase and sustain the prevalence of beaver and beaver-influenced wetlands in suitable habitats for the benefit of Colorado's stream and wetland ecosystems and the array of wildlife species that utilize them.

The US Army Corps of Engineers circulated a comprehensive [Guide to Working with Beavers](#) that shows many examples of fencing and deterrence structures to coexist with beavers in a working landscape.

The Watershed Center developed the [Landowner Guide to Beavers](#), which provides information about the benefits of beavers, details about what beavers need to survive, a brief explanation of coexistence strategies, and links to additional resources.

Utah State University has created a [downloadable design manual](#) to provide restoration practitioners with guidelines for implementing a subset of low-tech tools—namely beaver dam analogues and post-assisted log structures—for initiating process-based restoration in structurally-starved riverscapes.

The [Beaver Institute](#) is a nationwide nonprofit with useful information about beaver behavior and coexistence, as well as the [BeaverCorps training program](#) for non-lethal beaver management.

[The Beaver Restoration Guidebook](#) is an excellent reference document on the science behind the benefits of beaver and beaver coexistence techniques.

[The Colorado Beaver Activity Mapper](#) shows existing beaver complexes and an estimate of the potential total number of ponds that a stream could naturally support. Visit the map and explore different stream segments.

The USDA NRCS Conservation Practice 643: [Restoration of Rare or Declining Natural Communities \(Code 643\)](#), can be used through the Environmental Quality Incentives Program (EQIP) to access cost sharing. EQIP provides payments to restore and manage riparian corridor habitat.

Fisheries

Common Issues

Fish in the Yampa Valley face an array of pressures, such as degraded habitat, movement barriers, rising temperatures, low flows, and competition and predation from invasive fish species. Because so much habitat is found on private land, the role of the landowner in protecting both native and sport fish populations and promoting conservation has never been more important.

Questions to Consider

- Are native fish present? What can be done to support their life cycle?
- Are there diverse habitats within each reach of river or creek including riffles (areas of fast-moving, turbulent water), pools, backwater habitats, side channels, and wood or undercut banks for cover?
- Are there invasive fish species that are harming native and sport fish populations?
- Are there any barriers to upstream/downstream movement of fish?
- Are low flows and/or high temperatures harming fish populations?
- Is there an instream flow water right in this reach, and is it being met?

Principles of River Health

Complexity in Every Segment

Fish require a variety of water depths, flow rates, substrates, and habitat types for success at different life stages. Good stream habitat for both native fish and trout is complex, consisting of deep pools and undercut banks for overwintering and protection from predators, riffles for spawning and for the production of macroinvertebrates (which are their primary food source), and submerged wood, boulders, and side channels for rearing. It is important to have complexity in each segment of the stream.

Temperature and Water Quality Matter



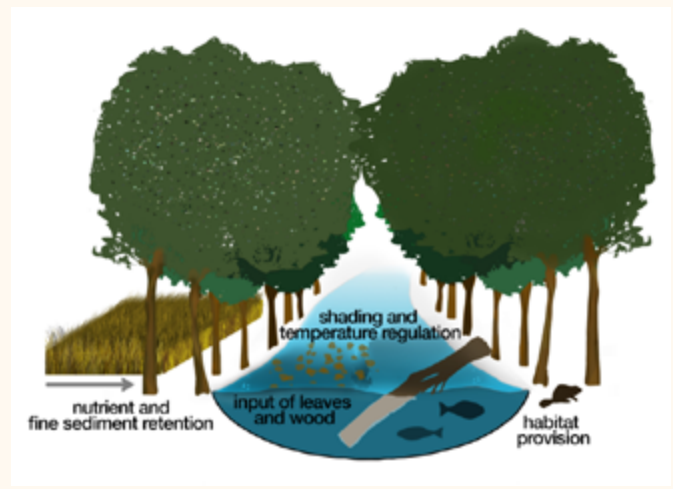
Mountain Whitefish are native to the Yampa River | Photo by City of Steamboat Springs

Fish need cool, clean water to survive. For example, native mountain whitefish congregate in deeper pools and rely on late season flows in tributary creeks to access spawning areas. Cooler water holds more dissolved oxygen than warmer water, allowing fish to breathe. Forested areas along streams and rivers provide shade and help to cool the water. Wetland plants serve to filter water and improve water quality. The deep pools found in beaver complexes provide a cool-water refuge for fish. Beaver complexes also increase subsurface-surface water exchange, further cooling the water during summer months.

Healthy Land = Healthy Fish

A healthy riparian zone, lush with vegetation, provides shade and cover for the stream, keeps water cooler, limits rapid bank erosion, filters out sediment and other pollutants before they reach the stream, and provides habitat for insects that fall into the water, providing a critical food source for fish. Eventually, riparian trees and shrubs also fall into the river, creating instream habitat. Human activity can adversely impact the riparian zone. Removing riparian vegetation up to the stream's edge is a common practice, often to create agriculturally productive land, views of the river, or recreational access. This loss of vegetation weakens stream bank structure, and can lead to extensive erosion during high flows.

Giving livestock (or people) unrestricted access to a stream often results in siltation of the water, eroded banks, nutrient loading from livestock waste, and loss of riparian vegetation and stream habitat.



Cross section illustrating the importance of riparian vegetation on fish habitat | Image from Freshwater Information Platform

Infrastructure as Barriers

Channel-spanning diversion structures and culverts can create unique threats to fish and other aquatic species. Fish need to move throughout a stream corridor to access different areas and habitat types to help them grow, survive, and reproduce. Diversion dams and culverts can fragment this movement. When habitat is fragmented, fish cannot move to desired habitats, and lack of reproduction can lead to reduced genetic diversity in the population. Additionally, fish can become trapped and killed when they swim into irrigation ditches and cannot escape. In addition, undersized culverts create problems for fish and safety hazards during floods or post-fire debris flows.

Flows are Important

Whether the result of drought, irrigation withdrawals, or other causes, low stream flows can be a serious problem for fisheries and stream health. In the summer, low flows can lead to increased water temperature, which results in less oxygen in the water for fish to breathe. Water diversions that pull water from streams during low-flow periods can be especially damaging, because fish require a minimum instream flow for survival. Sweeps of the river (which occur during a “call” when there is not enough water to meet the demands of water rights users) create dry-up areas that are catastrophic for fish. These sweeps often coincide with high temperatures, which create low-oxygen pools that are stressful for fish. Low flows are a problem during the winter as well, because low flows and colder temperatures lead to more ice and less overwintering habitat. Avoiding river dry-up, establishing minimum instream flows, and releasing additional water during a call are ways to support aquatic ecosystems, including fish.

Recommended Practices or Actions

There are several actions that landowners can take to improve habitat for fish. These actions, described below, include designing diversion structures to allow for fish passage, removing unnecessary culverts, modifying culverts to reduce their negative impacts, preventing fish from entering irrigation ditches, improving riparian vegetation, adding large wood, and maintaining minimum flow levels.

Design Diversions with Aquatic Species in Mind

Some fish species, such as trout, are good jumpers, while species like sculpin, suckers, and dace are not. Structures within the river should be designed to allow for upstream/downstream passage of the fish species present within the particular stretch of stream. For example, an impassible diversion dam can be replaced with a rock weir, often using boulders, that allows fish to swim through. Fish ladders create a gradient passageway to allow fish to swim through or around obstacles like culverts, dams, and diversions. Alternatively, jumping pools of specific depth and location can be built so that trout can jump over dams.



The pool below the dam, on the right side of the picture, is designed to help trout jump past the diversion. This is a barrier, however, to species that cannot jump such as suckers and sculpin. Photo by Roddy Beall, Zenobia Consultants



A diversion structure with an ecological rock ramp feature that allows for fish and sediment passage Photos and Project by Flywater, Inc.

Remove or Modify Undersized and Perched Culverts

Culverts can create a significant barrier to fish presence within stream segments. Fish passage may be blocked by undersized pipes or other design issues such as when the downstream end of a pipe is elevated above the stream water surface, or “perched.” Additionally, steep culverts can create a passage barrier by increasing the water velocity flowing through the pipe to a point where fish cannot swim upstream through it. Culverts should be removed if they are no longer required. When they are required, an undersized culvert can be replaced with a design that allows aquatic species passage by attempting to match stream bottom conditions through the culvert, such as “bottomless” arch-culverts or bridges that eliminate culverts altogether.

Culverts should be designed to allow sediment to pass through them; this can most efficiently be done by matching design flow velocities within the culvert with expected stream velocities upstream of the culvert location. Adequately sized culverts and the number of culverts placed should also consider low-flow conditions to maintain year-round stream connection and allow for a 100-year flood event. As a rule of thumb, culverts should provide flow in the bankfull condition plus 2 feet on either side.

Install Fish Screens to Avoid Entrapment

Fish screens are an effective way to prevent fish from entering irrigation ditches. Fish screens allow water to pass into the ditch but keep fish out. A fish screen is often installed at or near an irrigation system headgate. Some designs, while effective, can require maintenance to keep the screens free of sediment and debris.

Restore and Protect Riparian Vegetation

By restoring or preserving riparian forests, landowners can improve fish habitat, cool the stream, prevent erosion of productive land, and keep excess sediment out of the river. Exclusionary fencing or rotational grazing may be important to keep riparian vegetation healthy for the long term. A robust riparian buffer helps fish by increasing cover, food (insects dropped to the channel), habitat (undercut banks, wood), and water quality (decreased water temperatures).

Install Wood Where Appropriate

Large wood can be introduced into the river specifically to support fish by creating deeper pools, increasing cover, providing slow water refuges, and promoting natural stream habitat conditions to support spawning, rearing, and maturing fish.

Potential locations for wood installation are site specific. They are often installed at an outside bend or the tail of an existing pool. Native trees with rootwads intact can be preferable to logs without rootwads as they more closely match natural conditions.

Approximately 20%-30% of the log should be buried into the bank, and

wooden posts can be used to secure it in place. The location and angle of the logs is important to avoid redirecting the flow in undesired ways. Intentional placement of wood in a stream should consider downstream infrastructure such as culverts, bridges, and recreational use, as these structures may move in high flow conditions. Ballast can be used to secure structures in place where necessary.



*Surface-placed large wood structure intended to create more complex flow and scour patterns, as well as provide cover and structure for fish
Photo courtesy of Eagle County Open Space*



Large wood habitat features installed during restoration for habitat, infrastructure protection, and to support sediment transport processes | Photo courtesy of the City of Fort Collins

Keep Water in the River through Efficiency Improvements

Irrigators can improve efficiency by installing gated pipe, lining ditches, or installing sprinkler irrigation. Operators may be able to divert less water from the stream while still delivering the amount of irrigated water to meet crop demands. Water rights holders who are interested and able may contact the Colorado Water Trust to learn more about voluntary water sharing or leasing programs that can allow for more water in the river without harming water rights holders. All of these efforts can result in keeping more water in the main channel to support fish populations. Fish benefit when minimum flows are enough to allow them to move upstream/downstream, from pool to pool, in search of more favorable cover, water quality, and food availability.

Rebuild the Channel



Excavators build a boulder structure where wood structures are not possible | Photo by Peter Van De Carr

In areas where the river is degraded due to historical alterations and land-use changes, channel realignment and restoration may be warranted. Healthy streams typically have alternating deep and shallow areas called pools and riffles, respectively; habitat structures formed by large wood and boulders; and meanders whose spacing and curvature depends on stream size and gradient. In certain circumstances, heavy machinery can be used to reshape the stream channel and force the desired channel form. However, proceed with caution when embarking on this type of

channel restoration; not only does it come with significant design and permitting costs, but often these form-based projects that lock the channel into place while mimicking “natural” river forms fall short if the processes that create these forms are not also restored. Process-based restoration options (both low-tech and high-tech) that seek to restore river function by re-establishing natural processes tend to have more lasting and positive impacts on river health.

Benefits of Implementing Recommended Practices

- Thriving fishery
- Better irrigation systems with reduced maintenance
- Enhanced land values
- Potential income from fishing leases
- Improved water quality

Reference and Resource Materials

Dinosaur National Monument published a [Guide to Important Fish Species](#) that is particularly useful for fish identification in the lower Yampa River Basin

CPW has a [List of Fish of Colorado](#) that is helpful for identification.

Trout Unlimited developed a very useful [Landowner's Guide to Stream Restoration](#) that focuses on the importance of fish species.

Trout Unlimited published [A Handbook for Streamside Owners](#) to provide the basic principles and practices of good streamside management to rural and urban landowners.

The NRCS Conservation Practice 395, [Stream Habitat Improvement and Management](#) could be used for cost sharing through an EQIP program contract. EQIP provides payments to restore and manage riparian corridor habitat.

The [Farmers Screen](#)[™] is a horizontal, passive fish screen design that uses hydraulics to manage debris and protect fish. It has no moving parts and does not require power to operate.

Flooding & Floodplains

Common Issues

High spring flows are an important natural process, and something that sets the Yampa apart from other large western rivers. However, they can be challenging for landowners and land managers. When snow melts, spring floods inundate the floodplain, creating conditions for a fertile river corridor and the renewal of riparian forests and wildlife habitat. This flooding, however, can be unpredictable, endangering infrastructure and livestock, and creating unwanted wet areas. Historically, landowners have used berms, rocks, concrete, and even car bodies to keep water in the channel and off the floodplain. As time goes on, bank stabilization and channelizing the river causes problems such as increased erosion, unhealthy riparian forests, degraded water quality, and a lowered water table.

Questions to Consider

- Is seasonal flooding currently a problem for the operation, or can seasonal flooding be supported and increased to benefit the riverscape?
- What areas of the property can safely handle flooding?
- Which structures or infrastructure (roads, irrigation ditches, buildings, trails etc.) are vulnerable to high seasonal flows? Is it possible to relocate those structures or infrastructure outside of the area of concern?
- Are there historic side channels that flood waters could be directed into?
- Are there armoring and channelization structures that might be increasing flood power and causing bank erosion and channel incision?

Principles of River Health

Flooding is the Primary Driver of Riparian Health

High flows deliver fine sediment and nutrients to the floodplain, building the soil that agricultural producers depend on. Floodwaters also carry native plant seeds to the floodplain, encouraging germination and establishment of trees, shrubs, flowers, and grasses. This seasonal pulse of water recharges wetlands and groundwater tables, which supports wetland plants and animals, and holds water in the soil into the late summer and fall. In addition, fish use the side channels and backwaters filled by these floodwaters for refuge and spawning.

Flooding Protects Downstream Properties

When floodwaters spill out of the river channel and onto the floodplain, stream energy is dissipated. As the energy of water is reduced, its ability to erode and carry sediment decreases. The floodplain acts as a giant sponge, storing water, sediment, and nutrients while reducing the volume of water carried by the channel during spring runoff. Therefore, allowing or encouraging flooding in places where it is safe reduces the potential for dangerous flooding downstream.

The Riverscape Includes the Channels and the Floodplains

The location of a river channel is only one part of a bigger picture. The entire floodplain is part of the riverscape, and the sediments should move as the stream moves dynamically across the valley bottom. Peak flows from spring snowmelt are a key driver of this process, which mobilizes sediments and creates new habitat areas like side channels, gravel bars, islands, and backwaters. Currents separate fine sediment, sand, and cobble into distinct bars, which maintains a diverse landscape that supports diverse plants and wildlife. The annual pulse of water into the valley bottom is critical for many river processes.

Recommended Practices or Actions

Landowners can undertake a variety of actions to improve the natural cycle of flooding on their property while protecting their infrastructure and livestock. Several recommendations are discussed below, including restoring side channels, removing berms, creating room for the river with floodplain terraces, protecting critical infrastructure with off-channel berms or riprap installed at a distance from the bank, relocating infrastructure, adding floodplain roughness, and restoring gravel pits.

Restore Side Channels

If historical side channels no longer receive seasonal flows due to blocking or intentional berm placement, restoring the connection should be a priority. Excavation can reconnect the side channel to the main channel, or large wood jams can be installed to direct flow into the side channel or encourage bank movement to occur. This allows high flows to spread out and reoccupy natural pathways that have been cut off by past land use. These channels act as safety valves, carrying excess water during floods, reducing pressure on the main river channel, and creating valuable habitat for fish and wildlife. Reconnecting these pathways can also recharge groundwater and improve soil health on adjacent lands.



Side channels can be reconnected to reduce flood power and improve floodplain connection
Drawings by Lauren Brown, LVBrown Studio

Remove Berms



Seek opportunities to expand the floodplain | Image by Gregory Leichty, Michael Van Valkenburgh Associates Inc.

Berms or levees built along riverbanks often confine water to the main channel, increasing flood velocity and downstream damage. Removing, ricking, breaching, or lowering unnecessary berms gives the river room to spread out into its natural floodplain. This slows water down, reduces erosion, and allows sediment and nutrients to be deposited across the valley floor, benefiting pastures and riparian vegetation.



*The downstream end of Bear River Park lacks a streamside levee, allowing for healthy seasonal inundation of the riparian wetland as indicated by the arrows
Photo by Roddy Beall, Zenobia Consultants*

Create Room for the River with Floodplain Benching

Floodplain benching involves cutting terraces or “benches” into the riverbank to create an “inset floodplain,” or a set of gradual steps that reconnect the river to its floodplain. These benches provide areas where water can spread during peak runoff, dissipating energy, recharging groundwater, and lowering flood risk. They also create space for riparian vegetation to establish, which further stabilizes banks and improves habitat.

Relocate Infrastructure and Buildings

Where possible, moving access roads, trails, diversion, headgate structures, or even buildings to areas less susceptible to flooding can reduce risk to infrastructure, lower long-term maintenance costs, and lead to improved river health. These actions also reduce the risk of loss of these structures during snowmelt runoff and other high-water events.

Protect Infrastructure with Off-Channel Berms

Avoid the installation of berms right at the channel edge, which disconnects the channel from its floodplain and interrupts important river processes. Instead, consider off-channel berms that are strategically placed alongside or around vulnerable structures such as barns, homes, or roads. These off-channel berms protect specific assets while leaving the river corridor itself more open and functional. The area between the river and the berm can create forest and swale that supports habitat, mitigates flooding, and improves visual appeal. This approach protects infrastructure and also helps to alleviate flood risk to downstream properties by giving the river room to dissipate power.



Setback levees (blue) allow room for a natural river corridor and an active floodplain | Illustration courtesy of Tony Melone



A setback berm in Washington replaces an old levee located close to the river | Photo by Tiffany Royal, Jamestown S'Klallam Tribe

Add Floodplain Roughness



Brush trenches installed on a hydrologically connected floodplain
Photo from the Colorado Stream Corridor Construction Manual

On some properties, the land has been leveled and cleared of vegetation and downed trees. When these elements are lacking, floodwaters can gain momentum in unwanted ways. Adding floodplain roughness elements like riparian forest improvements, large wood on the landscape, brush trenches (installation of live dormant willow or cottonwood cuttings buried in a trench on the floodplain or an eroding streambank), and contouring can help dissipate energy and mitigate flooding effects. Landowners can place wood, allow fallen trees to remain, and engage in riparian forest planting to develop natural roughness elements.

Restore Gravel Pits

Abandoned gravel pits traditionally leave deep, featureless ponds that are disconnected from the river by levees. These disconnected ponds do not provide good wetland or fisheries habitat nor space to accept high spring flows. If the river accesses the gravel pit through channel migration or breaching of levees, these ponds can introduce invasive fish or aquatic species into the river system. Restoration of gravel pits can rehabilitate the floodplain to improve river health. Generally, this involves placing fill into the gravel pit to create shallow banks and benches with undulating bottoms. These projects can be costly and difficult, but the restored wetland can become valuable habitat and floodplain.



Gravel pits like these degrade river health because they are surrounded by artificial levees that prevent the river from accessing its floodplain. They can also be a source of invasive fish and warm, polluted water. | Photo by Roddy Beall, Zenobia Consultants

Benefits of Implementing Recommended Practices

- Reduced impacts on infrastructure
- Increased groundwater storage and raising of water table
- Support of riparian vegetation
- Increased nutrients deposited onto pastures
- Deposition of new topsoil
- Off-channel habitat for young fish during spring runoff
- Reduced erosion during peak runoff

Reference and Resource Materials

American Rivers authored an informative paper called [Reconnecting Rivers to Floodplains](#), which explores the hydrologic and ecological functions that floodplains provide.

The US Army Corps of Engineers developed a [Floodplain Reconnection Guide](#) that includes examples and construction diagrams of floodplain restoration projects.

The Colorado Water Conservation Board's (CWCB's) [Floodplain Stormwater and Criteria Manual](#) is a resource for contractors and practitioners who were designing and implementing projects in the floodplain.

A guide to the [Best Practices for Ecological Reclamation of Gravel Mines](#) was created by the Middle Colorado Watershed Council. It can guide practice and policy. Note that this document must be requested at the link, and will be emailed or mailed to you.

Invasive Plants

Common Issues

Invasive plants, sometimes referred to as “noxious weeds,” are non-native plants that are capable of aggressively displacing native species. Invasive plants can cause serious problems for ecosystem health, wildlife habitat, and agricultural productivity and should be contained, suppressed, or eradicated. Colorado law requires each county to control noxious weeds. Routt and Moffat counties both have active weed programs.

Questions to Consider

- Which invasive species are present, where are they located, and in what amount?
- How are invasive seeds or plants arriving onto the property?
- Do these species reproduce via seed, fragmentation, and/or budding?
- What treatment options are possible and appropriate given proximity to the river, livestock operations, public use areas, etc.?
- Is there a risk that grazing, haying, or landscaping operations might spread seeds or plant segments that can resprout to other locations?

Principles of River Health

Non-native Species Harm the Ecosystem

Native plants and animals have evolved in the Yampa Valley over many thousands of years. They have complex inter-relationships. Non-native species did not coevolve with native species, and because of this, they upset the balance of processes in the ecosystem. For example, non-native species may shade out or overtake the root systems of native plants and pasture grasses, change soil chemistry,

or be poisonous to deer, elk, or livestock. They can also outcompete native species for resources (like sunlight, water, and nutrients), which can greatly reduce biodiversity across the landscape and create an unhealthy monoculture.

The River Carries Seeds

Invasive species spread in various ways, including by releasing seeds and by regrowing from branches, stems, or root material. This spread can be especially problematic in the river corridor because the river itself can carry seeds or plant material long distances. If upstream neighbors are not actively managing weeds, the seeds or plant segments can and will be transported onto downstream properties, especially with the spring flood.

Integrated Weed Management is Best

Integrated weed management means combining multiple strategies rather than relying on a single method. It involves using a mix of biological, cultural, manual, mechanical, chemical, and preventive control practices to manage weeds in a sustainable, coordinated, and environmentally responsible way. Integrated weed management offers the most durable, cost-effective, and ecologically sound framework for the long-term management of invasive plants because it focuses on prevention, diversity of tactics, and ecosystem restoration rather than short-term eradication.

Herbicides Can Hurt the River

Herbicide application is a common and useful tactic to use in managing weeds. However, it should be done mindful of the proximity to the river, water table elevation, and timing of flood irrigation efforts to prevent unintended release of herbicide into nearby waterways. Herbicides in stream habitats can be toxic to aquatic plants, invertebrates, and fish.

Recommended Practices or Actions

Managing invasive plants involves collaboration, planning, employing a variety of techniques. These actions, described below, will protect habitats and the economic viability of ranchlands by reducing the spread of weeds.

Establish Partnerships

Managing weeds is a collaborative effort. Weeds don't respect property lines, so all neighbors must work together. The county weed program, Colorado State University (CSU) extension office, and conservation district can help identify weeds and make a plan to manage them. Local weed personnel are the most knowledgeable about local conditions and the effectiveness of available treatments.



County Weed Program staff are a great partner in land management | Photo courtesy of Steamboat Pilot & Today

Make a Plan



Leafy Spurge is a principal concern along the Yampa River | Photo By Peter Williams, Yampa River Leafy Spurge Project

It is important to first develop a strategy for managing noxious weeds, so the pathway to success is understood. A plan should include the following: what are the desired outcomes regarding invasive plants? What does success look like? How will success be measured? Would an infestation map of the target species be helpful? What are the available options for treatment? What outside resources are available? Who will do the work? What is the available budget?

Use Manual Treatment for a Targeted Approach

Manual treatment is the hands-on removal of invasive plants with hand tools without the use of machinery. Although labor intensive, manual treatments are targeted and can sometimes be less expensive than herbicide application. For example, musk thistle, a biennial, can be killed as a rosette early in its development using a shovel. However, only certain species can be killed by digging or cutting, and these activities can make infestations of some species worse, so it is important to understand the life cycle and biology of the target species.



Manual removal of tamarisk demands dedication and physical labor | Photo by Dave Cawley, Deseret News

Increase Impact with Mechanical Treatment

Mechanical treatment is the use of machines to saw, mow, mulch, bulldoze, or uproot invasive species. This technique can be effective on large plants or large infestations. If treatments cause significant soil disturbance, it is important to consider whether the disturbed soil might be colonized by other invasive species. If so, it may be smart to revegetate the area promptly with native seeds and plants, and to monitor changes over time.

Focus on the Long Term with Biological Control

Biological control (biocontrol) is the introduction of natural enemies (predators, parasites, or diseases) for the long-term reduction or suppression of invasive species. This often requires research and monitoring, and only approved biocontrol agents should be used, so it is important to partner with Colorado Department of Agriculture (CDA) Insectary or a local organization like the Yampa River Leafy Spurge Project.



Aphthona spp. is one of several approved biocontrol agents that have shown promise in leafy spurge suppression in the Yampa Valley
Photo by Peter Williams, Yampa River Leafy Spurge Project

Be Proactive with Cultural Treatment

Cultural treatments are management practices that make environments less suitable for invasive species and more favorable for native or desired species, such as controlled burning, crop rotation, planting competitive native species, or adjusting grazing patterns. These management practices require long-term commitment and planning but are incredibly important on a large ranch or other parcel because they reduce opportunities for weed invasions.

Use Chemical Treatment with Care

The use of herbicides should be thought of as the last step after integrating all other treatments. Herbicides can be highly effective and fast acting, but they are more dangerous to the environment and the river than any other treatment type. The use of herbicides requires careful compliance with the product label and regulations. Not all herbicides are formulated for use near the river. Some common herbicides, like glyphosate (trade name: RoundUp), are harmful to fish and aquatic life. It is very important to learn about each herbicide and to understand that they are each unique. Applicators are legally required to follow labels closely regarding setbacks from the river or other water bodies.

Guide to Controlling Common Invasive Species

The following species are problematic in the Yampa River basin and should be actively treated by landowners and land managers. It is important to implement an integrated management plan, incorporating all of the available treatments. Do not rely exclusively on herbicide application. Pay particular attention to the label's application setbacks from rivers, streams, and water bodies.

Leafy Spurge



Cultural—Do not bale hay from fields with Leafy Spurge, as seeds will be transported. Do not import hay with seeds.

Biological—Flea beetle and longhorn beetles available from Leafy Spurge Project.

Chemical—Targeted application of Tordon® 22K + 2,4-D: apply in the spring or fall. Do not spray into water- is toxic to aquatic life.

Whitetop



Cultural—Avoid overgrazing pastures. Avoid importing topsoil with weed seeds.

Biological—Consult Palisade Insectary website for available biocontrol.

Chemical—Targeted application of Escort and Telar are only effective when sufficient soil moisture is available, with a good non-ionic surfactant.

Various Thistles



Biological—Consult Palisade Insectary website for available biocontrol.

Manual—Dig rosettes using a spade, with at least 4" of tap root.

Chemical—Targeted application of Milestone®, Curtail®, 2,4-D with Tordon®, Telar® or Vanquish® on rosettes, pre-flower.

Russian Thistle



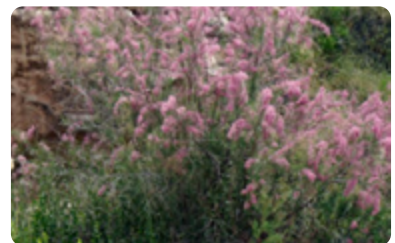
Chemical—Glyphosate is traditionally effective, but Moffat County has a glyphosate-resistant strain. For resistant strains, treat with targeted application of triclopyr, dicamba or 2,4-D.

Russian Olive



Mechanical/Chemical—Cut stump treatment involves cutting trunk and applying herbicide to cambium layer of stump: picloram, triclopyr, or glyphosate plus imazapyr.

Tamarisk



Biological—Consult Palisade Insectary website for available biocontrol.

Mechanical/Chemical—Cut stump treatment involves cutting trunk and applying herbicide to cambium layer of stump: picloram, triclopyr, or glyphosate plus imazapyr.

Management information adapted from Routt County Weed Program and CDA Insectary

Benefits of Implementing Recommended Practices

- Protection of economic productivity
- Health of grazing livestock
- Improved riparian condition and wildlife habitat
- Reduction of burrs, stickers, and thorns when walking property

Reference and Resource Materials

Routt County has developed a very useful [Weed Management Guide](#) that provides guidance on how to treat weeds in our area.

The [Moffat County Weed Program](#) provides integrated pest management programs and recommendations for landowners and operators.

In Moffat County, [Colorado First Conservation District](#) assists in the management, sustainability, and improvement of its natural resources.

The [Yampa River Leafy Spurge Project](#) engages landowners, agencies, educators and organizations to coordinate the establishment of effective programs of integrated management for invasive leafy spurge.

Information about biological control can be found at [Palisade Insectary](#), where the CDA develops effective biocontrols for farmers, ranchers, and landowners.

A comprehensive book for planning invasive species management is [Weed Control in Natural Areas in the Western U.S.](#), which lists each species and discusses various treatments.

CDA publishes a [Colorado Noxious Weed List](#) for the state.

Irrigation Infrastructure

Common Issues

Irrigation systems are the backbone of agricultural operations in the Yampa Valley. There are also many municipal and industrial diversions within stream corridors.

Aging or inefficient infrastructure can create challenges for both landowners and river health. Annual push-up dams, undersized or deteriorating headgates, disconnection of water availability at the point of diversion, and leaky ditches often require frequent maintenance and can disrupt fish passage and sediment transport.

Inefficient diversions may contribute to water loss and reduced late-season water availability. At the same time, conflicts sometimes arise where large wood, sediment, or beaver activity impact irrigation structures.

Questions to Consider

- Is the diversion infrastructure delivering the needed amount of water to the ditch?
- Does the diversion maintain minimum flows in the channel?
- Does the diversion allow for fish passage?
- Does the diversion structure allow for passage of sediment, wood, and recreational boats?
- Is upstream bank hardening causing downcutting of the riverbed?
- Is the diversion structure considered a “push-up dam?”
- What is the level of maintenance required by the current setup?
- Is the streambed dropping and making it more difficult over time to get water to the headgate?

Principles of River Health

Keeping Water in the River is Important to Maintain River Health

Having a minimum “biologically critical” flow is important for aquatic wildlife and riparian forest health. There are methods to study and identify the minimum quantity of water that should be maintained in a stream to support the health of the river. A dry stream in an area where wildlife did not specifically adapt with that condition can be extremely harmful for a system and catastrophic for the wildlife along specific reaches. CPW or other organizations or experts can help to assess flow needs using models such as R2Cross, which is specifically developed for Colorado streams.

Fish and Other Aquatic Wildlife Depend on the Ability to Move Up and Down the River

It is important to remove and reduce the impact of barriers such as push-up dams, low-head dams, and culverts that disrupt river function and pose problems for fish and other aquatic species to move up and downriver. Species rely on movement within the river to find food, reproduce, and take cover from predators.

Frequent Disturbance Within the Stream Channel Can Add Up Over Time

The yearly installation and maintenance of push up dams can cause increased loss of localized streambed sediment. Each year, cobble and rock are pushed up at diversion points to get water to headgates during irrigation season, and then moved within the river channel during spring flows. This constant cycle of unnatural disturbance can lead to excessive erosion and a deepening channel bottom. As a result, establishing an effective push-up dam becomes more difficult each season, further exacerbating impacts to river health.

Late Season Return Flows Help the River

Floodplains and wetlands along the river corridor maintain late season flows by slowly releasing water held on the land. Irrigation infrastructure can sometimes serve the same purpose. Infiltration of water from unlined ditches and flood irrigation can recharge aquifers and raise groundwater tables. Water applied to the land returns to the river weeks or months later.

Streams Move Over Time

Healthy rivers require the movement of the channel within the floodplain to regenerate riparian forests and dissipate the energy of high flows. Therefore, the establishment of a fixed point of diversion for irrigation can conflict with natural river processes. Irrigators should consider ways to access water for irrigation that don't require limiting stream movement.

Recommended Practices or Actions

Irrigators and landowners can undertake a variety of actions to improve diversions while reducing impacts to stream channels and aquatic habitat. Several recommendations are discussed below, including replacing annual push-up dams with permanent structures, incorporating fish and aquatic passage, protecting headgates and pump intakes with debris racks, planning for beaver coexistence, installing headgate automation, and relocating points of diversion where channel conditions have changed.

Replace Annual Push-up Dams



A permanent rock rundown diversion structure doesn't require annual excavation work | Photo by Roddy Beall, Zenobia Consultants

Where possible, the annual practice of pushing up a cobble dam can be replaced with a permanent or semi-permanent structure. A permanent rock diversion reduces annual maintenance requirements and reduces the erosion and channel deepening caused by annual excavation. This also eliminates the presence of foreign materials such as tarps in the waterway. Natural materials or designs that mimic beaver dams can be effective and also support river processes.

Build in Fish Passage

Fish and aquatic passage is the ability of fish or other aquatic species to move through an aquatic system to all the habitats necessary to complete their life cycle. As discussed previously in the Fisheries section, it is possible to retrofit existing diversion structures to allow for aquatic passage. It is especially important to consider aquatic passage with all new structures.



A boulder diversion structure allows fish passage | Photo by Roddy Beall, Zenobia Consultants

Protect Headgates and Pump Intakes with Debris Rack



Adding a wood debris rack protects the headgate so more wood can remain in the river | Photo By RK Trading Company

Wood in the river can snag on diversions and headgates. This creates a nuisance for irrigators and leads to a general feeling that all woody material should be removed from the river and areas adjacent to the river. However, as discussed previously, wood is important for fish habitat and river health. Installation of debris racks at the point of diversion that protect headgates and pump intake shafts can reduce the conflict between irrigators and the presence of wood in the system. The dual objective is to allow the passage of water into the irrigation headgate or pump system while directing wood naturally downstream. Design and placement of debris racks should consider the size of wood in

the system, the angle of the rack, inclusion of a deflector plate in the direction of stream flow, and the location of placement to increase the likelihood that wood will deflect or pass by. While it still may be necessary to periodically remove snags, a debris rack can reduce maintenance needs and improve reliability of water reaching the ditch.

Plan for Beaver Coexistence

The most common complaints regarding “problem beavers” are about dam-building in irrigation ditches causing flooding or disruption of flow. Beaver coexistence is an ongoing process. As discussed in the Beaver Coexistence section, starter dams and flow devices can be built onto a headgate to prevent beavers from obstructing the intake. Infrastructure upgrades can help reduce conflict so that the benefits of beavers for river health can be maximized while irrigation infrastructure is protected.



A flow device on an irrigation headwall protects the ditch without the need to remove beavers | Photo courtesy of Skip Lisle, Beaver Deceivers International

Install Headgate Automation

Adding automated operation to headgates can reduce the need for robust and expensive in-channel diversion structures. Automated operation enables the headgate to open and close automatically based on flow measured in the flume. Without automation, delivery of water to a headgate requires a diversion structure to create the necessary water surface elevation at the point of diversion. Automated operation can reduce the need for physical modification within the channel, thereby reducing passage concerns for aquatic species and recreational users.



Installed automation control | Photo by Eric Peterson, Bureau of Reclamation

Move the Point of Diversion

Streams naturally move over time through erosion, sedimentation, and avulsion. As streams move, it may be necessary to consider moving the irrigation diversion or headgate location. Colorado water law allows for a change in location to the head of a ditch without the need to file for the modification in water court when (a) the channel has changed (cut out, lowered, turned aside, etc.) and (b) the relocation is necessary to maintain the inflow. This flexibility in water law is intended to recognize that river channels migrate over time. Moving a headgate is not an easy decision, but it can improve the delivery of irrigation water, reduce costly channel modifications or engineered solutions to maintain water levels at the headgate, and improve the health of the stream. When choosing a new location, look for opportunities to combine with other ditches, or locate near another fixed point, such as a bridge abutment. Grading work may be necessary to connect the new diversion location to the irrigation ditch network.

Benefits of Implementing Recommended Practices

- More reliable water delivery and reduced annual labor to rebuild or maintain push-up dams
- Cost savings from fewer emergency repairs and more efficient use of diverted water
- Improved resilience of operations during drought years through reduced losses and better flow management
- Reduced maintenance
- Improved infrastructure, which also improves property values

Reference and Resource Materials

The Watershed Center's [Passage Playbook](#) provides guidance for how proponents can work collaboratively with landowners on passage projects by improving their understanding of landowners' perspectives.

Resource professionals can use [The Water Diversion Selection Tool](#) to help identify river- and site-compatible diversion mechanisms and the ecological and logistical tradeoffs of each compatible mechanism.

To explore how flood irrigation supports wetlands, read [Wetland Benefits of Flood-Irrigated Grass Hay](#) by the Intermountain West Joint Venture.

The CWCB developed the [R2Cross Model](#) with technical contributions from CSU to support ecological assessment and streamflow modeling for river health.

Riparian Forest & Buffer

Common Issues

Historically, it was common practice to pull out all vegetation from the banks of rivers and streams. The soil was very fertile next to the river, and converting forest and shrubland to mountain meadow allowed for more agricultural land. After a century, however, it is apparent that the riparian forest was providing protection from erosion, water filtration, habitat for wildlife, and many other benefits. Without riparian vegetation, river health problems, including elevated water temperatures and rapid erosion are becoming more prevalent. The streambank needs new riparian plantings and increased protection to reestablish a healthy forested buffer.

Questions to Consider

- Which areas can be converted to riparian forest?
- Which plant community is appropriate to plant, given the soil, elevation, and conditions of the site?
- What width of riparian forest is appropriate, considering the surrounding land use and landowner objectives?
- How deep is the water table where new riparian trees and shrubs will be planted?
- Is there a water source that can be used to support the establishment of plantings?
- How can grazing be managed to support newly planted vegetation?

Principles of River Health

Riparian Forest is Valuable to a Property

Riparian vegetation helps to solve many problems encountered on a property. The roots create strength and structure in the soil, which prevents erosion. The roots also create turbulence which reduces stream power, thereby reducing the severity of downstream erosion, and the rest of the plant provides roughness on the floodplain which dissipates flood energy. Riparian vegetation shades the river, which lowers its temperature. The plants act as a buffer to capture nutrients and sediment, which improves water quality, and these plants also hold water in the soil, which increases summer flows. In addition to providing critical wildlife habitat for numerous aquatic and terrestrial species, riparian forests also provide quality browse and shade for livestock and help to prevent infestations of invasive species.

Riparian Forest is Important Habitat for Wildlife

Riparian zones make up less than two percent of the American West's land area, but they support the highest density and abundance of plants and animals of any habitat type. In particular, more than 80 percent of wildlife species in Colorado depend on riparian areas for at least part of their life cycle. The combination of river and forest habitats provides food, water, shelter, refuge, breeding and rearing grounds, wintering habitat, and migration corridors for an amazing diversity of birds, mammals, reptiles, fishes, amphibians, and insects.

Different Areas Support Distinct Plant Communities

The specific assemblage of grasses, wildflowers, shrubs, and trees that are appropriate for one area is not necessarily the same as what is appropriate in another area. Plant communities depend on many factors, including elevation, soil, hydrology, river gradient, and climate. It is always important to have riparian vegetation on the banks of the river, but the specific types of plants may vary.

Recommended Practices or Actions

Landowners can undertake a variety of actions to protect and improve riparian forests on the Yampa River and its tributaries. Several recommendations are discussed below, including identifying appropriate plant communities, understanding planting methods for riparian species, selecting strategies for water delivery to support plant establishment, and considering long-term protection of restored areas through conservation easements.

Determine Which Plant Community to Restore

To plan a riparian forest restoration project, one of the first steps is to determine which plants will be best suited for the site, and this is done by developing a reference model. A reference model could be informed by historical photos, or by nearby sites with intact vegetation. The Yampa River Stewardship

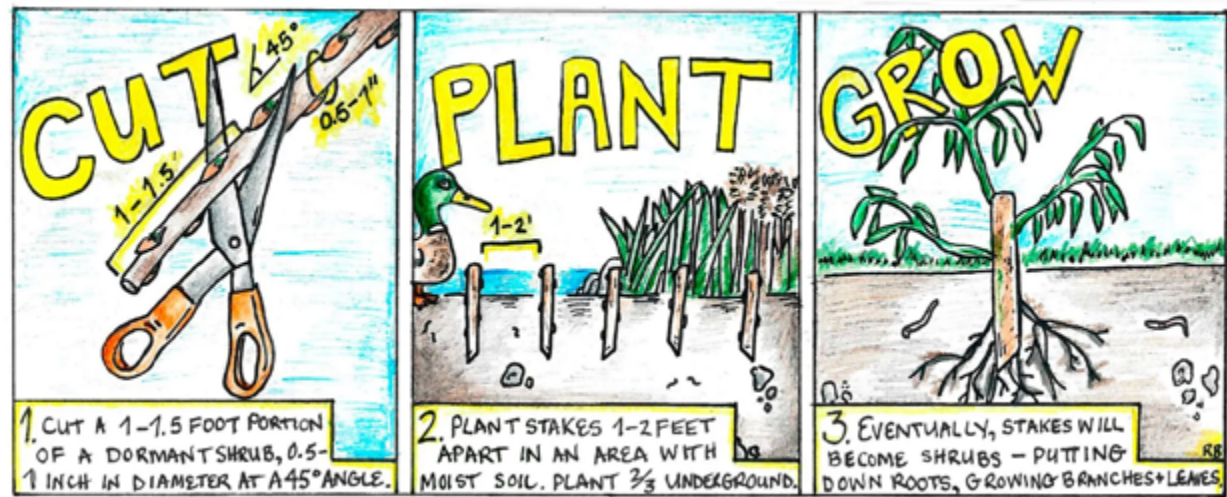
Program has developed a Riparian Planting Palette, which accompanies this Handbook (Appendix 1) and describes six plant communities characteristic to the Yampa River watershed. Compare the Planting Palette to a particular property to determine the mix of trees, shrubs, forbs, and grass species that would be appropriate for that property.



*Diverse plant communities include (clockwise from top left) Coniferous Riparian Forest, Upper Valley Willow Shrubland, Sandbar Willow Shrubland, and Narrowleaf Cottonwood/Dogwood Woodland
Photos by Roddy Beall, Zenobia Consultants*

Understand How to Plant Riparian Species

For successful restoration projects along the Yampa River and its tributaries, it is critical to understand strategies for seeding, planting, or propagation of all the species in the planting palette. Some species, such as grasses, sedges, and herbs, can be planted through a seed mix. Seeds can be purchased from several seed suppliers, and a seed mix can be designed with help from the local CSU Extension, Conservation District, or NRCS. Some species such as willows and cottonwoods can be planted from pole plantings, where a single “pole” of a tree is staked into the soil. Pole plantings (also called stakes) can be a cost-effective strategy because material can be harvested from nearby trees and shrubs, but it is important to use dormant poles and prepare them appropriately.



Simple guide to prepare and plant willow, cottonwood, or dogwood poles | Comic by Nature Conservancy of Canada

Some plants must be planted from rooted stock (a plant with fully-developed roots), and in some circumstances even cottonwoods and dogwoods are more successful from rooted stock. Several nurseries are specializing in developing restoration-quality rooted stock for the Yampa Valley. Restoration-quality seedlings are often grown from seeds collected at the site. Several resources are provided below that describe the process for preparation and planting of poles and rooted material.



Community riparian planting events teach stewardship principles to the next generation
Photos by Ben Beall, Zenobia Consultants

Develop a Strategy for Water Delivery

Riparian plantings need water to establish and thrive. If the plantings are in the right location and at the correct elevation, they should not require supplemental watering because the stream will provide good soil saturation to promote pole planting or seedling establishment. Measure the groundwater depth at the restoration site and determine if plantings can reach the water table.

If the groundwater table is too low, building wood structures can raise the water level to the restoration area. It also may be possible to support beaver to colonize the stream segment, which can raise the water table at the restoration area. If not, it may be necessary to install an irrigation system to support plant establishment. Any strategy for delivering water to plantings on the bank could have water rights implications, and should be carefully considered in coordination with the DWR.

Consider a Conservation Easement

Conservation easements are voluntary agreements between a landowner and a land trust organization that restrict development on a property. Conservation easements limit development to protect certain resources in perpetuity, such as open space, wildlife habitat, agricultural use, scenic vistas, or historic landmarks. If a landowner is interested in creating a permanent agreement that prioritizes and protects the inherent value of the riparian corridor's natural character, that desire can be written into a permanent legal document that is attached to the land despite any changes in ownership. Every property is unique, and every conservation easement is unique, so a landowner must work with a qualified land trust organization, such as Colorado Cattlemen's Agricultural Land Trust, to develop a plan.

Benefits of Implementing Recommended Practices

- Quality browse and shade for healthy livestock
- Habitat for diverse birds, mammals, reptiles, fishes, and amphibians
- Natural water storage for summer flows
- Flood mitigation
- Natural bank stabilization
- Improved water quality
- Reduced soil and land loss

Reference and Resource Materials

The Yampa River Stewardship Program has developed a [Riparian Forest Planting Palette](#) specific to the Yampa River watershed. This guide will help guide practitioners in choosing a site-appropriate plant community.

Western Resilience Center's [Yampa River Forest Restoration Project](#) has been providing riparian reforestation along the Yampa and its tributaries since 2019 on both public and private land. Private landowners interested in implementing a riparian reforestation project can contact Western Resilience Center for input and potential project partnership. Western Resilience Center supports riparian reforestation projects on private lands each year at no cost to landowners.

NRCS Conservation Practice Standard: [Riparian Forest Buffer \(Code 391\)](#), can be used through the EQIP to access cost sharing. EQIP provides payments to restore and manage riparian corridor habitat.

NRCS Conservation Enhancement Activity E643D: [Low-tech process-based restoration to enhance floodplain connectivity \(Code E643D\)](#), can be used through the EQIP to access cost sharing. EQIP provides payments to restore and manage riparian corridor habitat.

The U.S. Forest Service has developed a thorough resource called [Conservation Buffers](#) to help guide the planning and designing of riparian forest buffers.

BLM has written a [Riparian Restoration Guide](#) that provides the basic principles and background information needed to carry out a restoration project.

The Watershed Center made a useful guide for [Willow Stake Planting](#).

Wildlands Restoration Volunteers created a [Guide For Harvesting, Storing, And Planting Dormant Willow Cuttings](#) to convey basic willow biology and fundamental techniques.

The Tamarisk Coalition published [Suggested Methodologies for Cottonwood Pole, Willow Whip Cuttings, and Longstem Plantings](#), which describes techniques for harvesting, storing, and planting various types of plant materials, including dormant cottonwood pole cuttings, willow whip cuttings, and longstem products.

Colorado Cattlemen's Agricultural Land Trust works with landowners to create [Conservation Easements](#) to protect natural resources and preserve the land for farming or ranching.

Stream Crossings

Common Issues

Bridge and culvert design can have a significant impact on river health. If designed and constructed incorrectly, crossing infrastructure can cause problems such as erosion, loss of habitat, changes to channel form, flooding, and maintenance headaches. If the river is considered at the outset, the crossing infrastructure can be more resilient over its lifespan and not impact river health.

Questions to Consider

- Is the opening of the crossing sized sufficiently for the range of expected stream flows?
- Does the size of the opening consider sediment, large wood, and debris in addition to water?
- Are there side channel flows that should also be considered as part of the crossing layout?
- Can an open bottom crossing be considered to allow passage of aquatic species such as fish and macroinvertebrates?
- For large openings or multiple pipe layouts, can low flow be factored into design to maintain critical flow depth for passage of aquatic species?
- Are beavers present in the area?

Principles of River Health

Culverts and Bridges May Restrict Flow and Transport

Undersized crossings can often lead to upstream flooding, alter sediment transport, increase flow velocity in the crossing, cause challenges with woody material moving in the stream, restrict passage of fish and other aquatic organisms, and often severely limit a river's ability to access the floodplain. They also create safety hazards during floods or post-fire debris flows, because large debris can build up upstream and block the flow of water.

Crossings Lock a Stream in Place

Bridges and culverts act as fixed points in a river corridor. Because they anchor the river at a specific location, they interrupt the natural ability of the channel to migrate, braid, avulse, or shift across its floodplain. While crossings are necessary for transportation and water delivery, they impose structural constraints that can cause imbalances in river processes. The river's energy builds up at that fixed point, often causing accelerated erosion, channel widening, or headcutting. A fixed point tends to accumulate excess sediment and wood, changing the channel's direction unexpectedly when the crossing becomes flanked or blocked. When a river is prevented from meandering naturally, this leads to increased erosion where vegetation growth cannot keep pace with altered flow patterns.



*A railroad bridge causes unnatural river dynamics, leading to an odd angle and erosion problems
Photo by Roddy Beall, Zenobia Consultants*

Infrastructure Can Create Wildlife Barriers

Bridges and culverts can create unique threats if they block the movement of fish and other aquatic species. Fish, amphibians, insects, other animals need to move throughout the river corridor, and crossings infrastructure can fragment that movement. When habitat is fragmented, it can hurt individuals and it can also reduce genetic flow to a point that harms the whole population.

Recommended Practices or Actions

Landowners and managers can undertake a variety of actions to reduce the impacts of stream crossings on aquatic species, sediment transport, and natural stream processes. Several recommendations are discussed below, including minimizing the total number of crossings, using widespan bridges where feasible, designing crossings to accommodate low- and high-flow conditions, incorporating aquatic organism passage, planning for beaver coexistence, and modifying or removing undersized culverts to improve water and sediment continuity.

Reduce the Total Number of Crossings

Minimizing the number of stream crossings throughout the region can reduce the overall impact on aquatic species and stream health. Consolidating crossings and using existing crossings will reduce the number of crossings; however, crossings might need to be upgraded to ensure they can accommodate the expected volume and type of traffic. Proper placement of crossings on a landscape scale can help avoid disturbances to hydrologic connectivity and critical habitat areas. For example, it is recommended to place culverts at least 500 meters upstream or downstream of any identified fish spawning beds.

Use Widespan Bridges Where Possible

The best crossing option for river function is a widespan bridge that allows water, sediment, wood, debris, and recreational boaters to pass through during even the highest flow conditions. While they may be an expensive option, the longevity and minimal maintenance required for these structures, in addition to their low impacts on river health, make these an excellent choice where feasible.

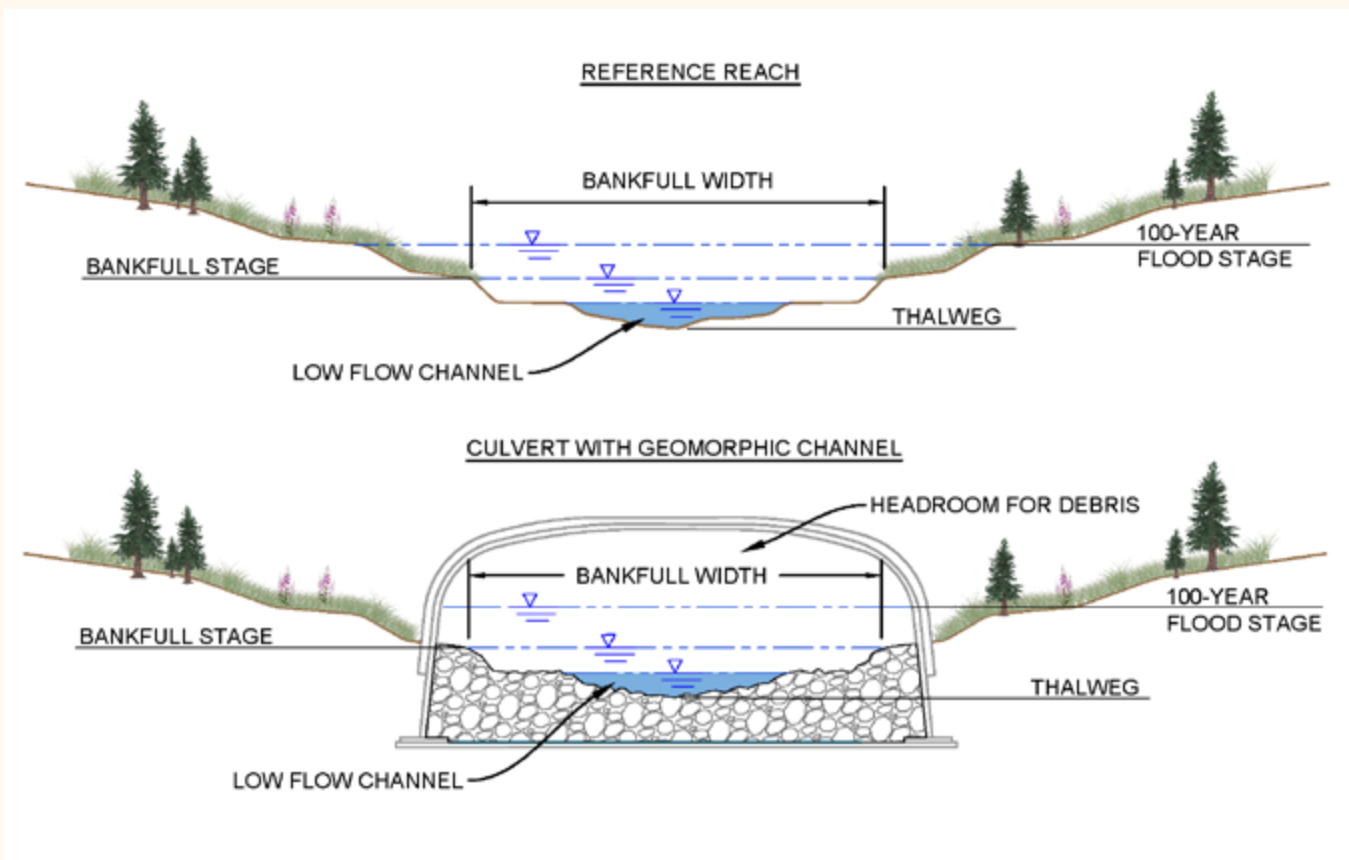


A widespan crossing doesn't have pillars to obstruct the stream | Photo by Roddy Beall, Zenobia Consultants

Design Widespan Crossings and Multiple Barrel Installations for Low-Flow Conditions

The deepest part of the stream channel, or thalweg, is critical during low-flow conditions in order for fish and other aquatic species to move up and downstream. With widespan crossings (large bridges without central support pillars), it is important to consider how low flows will move along the streambed under the crossing. It may be necessary to intentionally create a low-flow pathway that will maintain water depth year-round, instead of spreading the water across a flat concrete channel or large riprap.

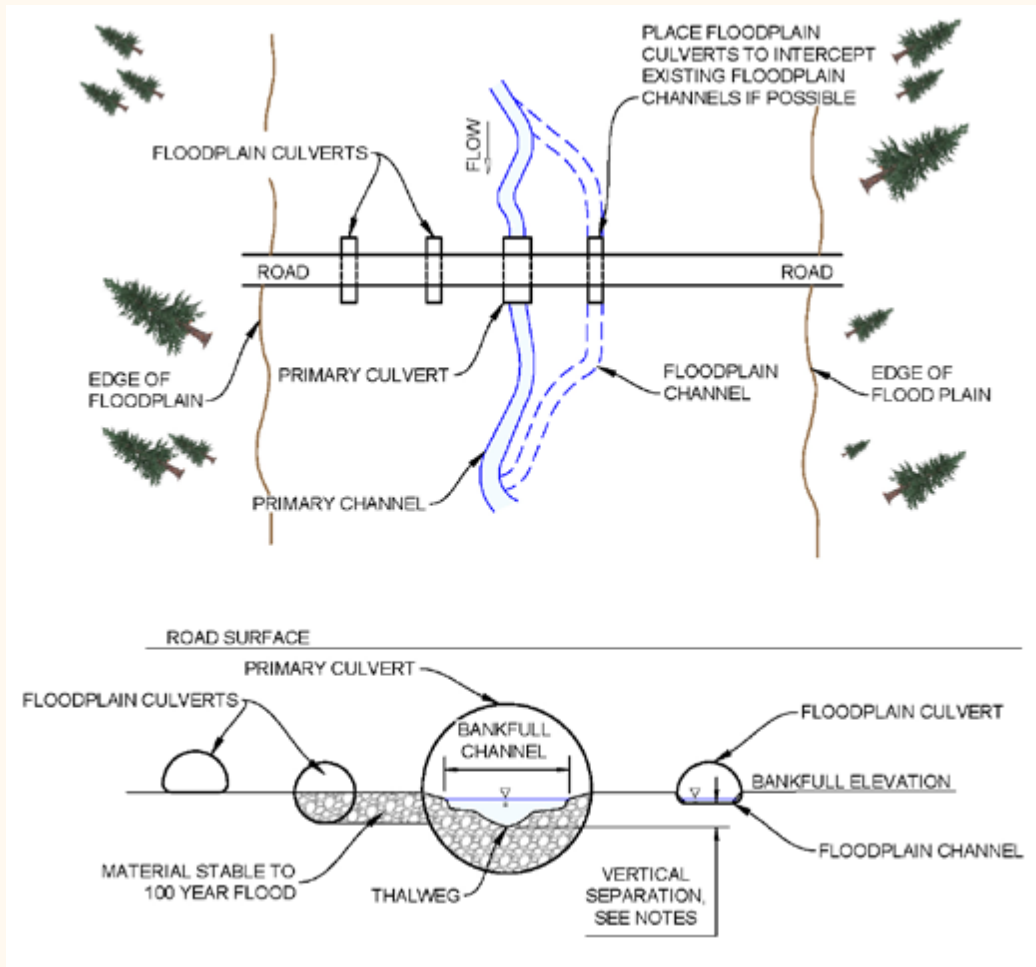
In the case of multiple barrel culvert pipe installations (crossings with several individual pipes or “barrels” installed side-by-side), the barrels should align with the flow and gradient of the river upstream and downstream of the installation. It is important to make sure that one culvert is lower than the others to maintain depth of flow in the thalweg.



Widespan culverts with natural streambed material and low flow channel are preferred to preserve natural stream processes. When one or more culverts are necessary, culvert and channel elevations can be considered for the same purposes. | Diagram by U.S. Fish and Wildlife Service

Install Flood Flow Culverts

Stream crossing designs should consider high flow events such as large storm events and spring snowmelt. An important addition to a stream crossing could be one or more flood flow culverts, which could be located away from the channel location, and may not flow during all storm events. Flood flow culverts can be placed at elevated locations within the floodplain that allow flood flows to equalize across the floodplain and avoid concentration of flow at the primary channel. Flood flow culverts are especially important where side channels are present or where the potential for formation of side channels or stream movement exists.



This figure is a plan view of a road crossing of a stream channel and its floodplain. The primary channel (solid blue) has a primary culvert, and a floodplain channel (dashed blue) has a floodplain culvert. Additional floodplain culverts are situated within the floodplain, outside of the channels. | Diagram by U.S. Fish and Wildlife Service

Keep Culverts Open with Beaver Coexistence Strategies

As discussed in the beaver coexistence section, living with beavers is an ongoing process that requires some proactive measures. Culverts can be protected by building fences, by building a porous starter dam upstream of a culvert, or by creating a steeper stream gradient at the inlet to the culvert that is not conducive to beaver dam construction. Beavers provide many benefits to a property, but culverts and ditches must be protected.

Design Culverts with Aquatic Species in Mind

As discussed in the Fisheries section, some fish species, such as trout, are good jumpers, while species like sculpin, suckers, and dace are not. Culverts should be designed to allow for upstream and downstream passage of the fish species present within the particular stretch of stream. Culverts with undersized pipes, or where the downstream end of the pipe is elevated above the stream water surface (“perched”) are particularly problematic. Additionally, steep culverts can create a passage barrier by increasing the water velocity flowing through the pipe to a point where fish cannot swim upstream through it. Culverts can be replaced with a design that matches stream bottom conditions through a “bottomless” arch-culverts design or a bridge that eliminates culverts altogether.



This “bottomless” pipe arch culvert maintains natural stream bottom conditions | Photo by Trout Unlimited

Remove or Modify Undersized Culverts for Water and Sediment

Culverts should be designed to allow sediment to pass through them; this can most efficiently be done by matching design flow velocities within the culvert with expected stream velocities upstream of the culvert location. Adequately sized culverts and the number of culverts placed should also consider low flow conditions to maintain year-round stream connection and at least a 100-year flood event. As a rule of thumb, culverts should accommodate flow in the bank full condition plus two feet on either side.

Benefits of Implementing Recommended Practices

- Improved crossings are a long-term solution and don't often have to be replaced or maintained
- Improved infrastructure improves property value
- Reduced maintenance time
- Reduced flooding

Reference and Resource Materials

The [Routt County Unified Development Code](#) has Waterbody Crossings standards in section 3.31.G, which is found on page 151.

The [Resilient Crossings Handbook](#) is a guidance document for private landowners considering replacing or updating their crossings. It was developed by a partnership between the Fourmile Watershed Coalition, the Coal Creek Canyon Watershed Partnership, the Coalition for the Poudre River Watershed, and the Saint Vrain Creek Coalition as a resource for property owners in response to the 2013 floods on the Colorado Front Range.

The US Fish and Wildlife Service (USFWS) provides a great resource for culvert installation that keeps in mind low flow design, passage of sediment and woody material, and mitigation of stream flow processes including floodplain preservation [Culvert Design Guidelines for Ecological Function](#).

The Federal Highway Administration has developed a [technical design resource](#) for helping to consider aquatic species passage for culvert installation projects.

Streamside Landscaping

Common Issues

Many landowners value the appearance of their riverfront and want easy access to the water. Sometimes, this leads to a preference for “clean” banks, where large wood, shrubs, or tall grasses are removed. While this may create a tidy look, easier access, or better views, it can unintentionally compromise river health by removing the very features that stabilize banks, provide shade, and create habitat. Over time, simplified riverbanks can become more prone to erosion, higher water temperatures, and a loss of fish and wildlife.

Questions to Consider

- Am I removing large wood or natural materials from the stream channel or banks to make my property look “clean?”
- Does my landscaping support native riparian vegetation, or have I converted the bank to lawn or non-native plants?
- Is fertilizer being used on streamside landscaping?
- If I want river views or access, can I achieve this while keeping most of the riparian forest intact?
- Are there ways to design my property so that it benefits both people and wildlife?

Principles of River Health

Aquatic and Terrestrial Wildlife Depend on the River and Floodplain

River and riparian health should be improved where possible to support both water- and land-based wildlife populations in the Yampa Valley. Although Colorado's riparian zones comprise only 2 percent of its land area, more than 80 percent of wildlife species depend on riparian areas for at least part of their life cycle.

Rivers are Naturally “Messy”



Streamside landscaping can significantly alter the riparian corridor | Photo by Roddy Beall, Zenobia Consultants

Large wood, fallen trees, and dense vegetation may not always look tidy, but these components are critical for a healthy stream system. Wood slows the flow of water, creates pools and riffles, fosters a complex stream channel, and provides cover for fish and wildlife. Riparian plants shade the river, filter runoff, and stabilize banks. Simplifying

a riverbank to make it look orderly often removes these important elements, reducing habitat and making the river more vulnerable to erosion. Maintaining a naturally intact riparian buffer can still allow for views, trails, or sitting areas while supporting river function.

Recommended Practices or Actions

Streamside landscaping choices play an important role in maintaining healthy rivers, stable banks, and diverse wildlife habitat. This section highlights approaches that emphasize working with natural riparian vegetation, including keeping existing riparian forests intact, selectively creating view corridors, retaining large wood and standing dead trees where safe, and restoring native buffers in place of manicured lawns to support a more natural and resilient riverscape.

Leave Riparian Forest in Place

Avoid the temptation to cut down or remove willows, cottonwoods, alders, and native grasses to create a manicured interaction with the stream edge. Preserve native vegetation with at least a 30-foot buffer width (preferably a 60-foot buffer width or more).

Create View Corridors

If river views or access are important, selectively clear small areas for sightlines or walking paths while keeping most of the riparian forest intact. Strategically remove as little vegetation as possible.

Leave Large Fallen Wood and Standing Dead Trees

Instead of removing logs or branches from the river corridor, consider leaving them in place or repositioning them safely if necessary. Large wood helps slow water, reduce erosion, and build diverse fish habitat. In addition, retain standing snags (dead trees) where it is safe to do so. They provide critical nesting and perching sites for birds and other wildlife.

Restore Native Riparian Buffers and Foster an Aesthetic Focused on Landscaping to Maximize Wildlife Habitat

Where riparian forest has been removed, replace lawn or ornamental landscaping near the river with native shrubs, trees, and grasses along the streamside. These provide food and shelter for birds, pollinators, and mammals while improving bank stability and water quality.



Instead of a manicured estate, consider the beauty of a natural, wild riverscape | Photos by Alexander Pope (left) and Mark Abusamra (right)

Benefits of Implementing Recommended Practices

- Increased property value and beauty as a result of maintaining a natural, attractive river corridor
- More wildlife viewing opportunities, including birds, fish, and pollinators
- Increased fishery health and better fishing
- Reduced erosion and flooding risk thanks to stronger, deeper-rooted vegetation
- Lower maintenance costs compared to lawns or non-native landscaping

Reference and Resource Materials

The Coalition for the Poudre River Watershed's [“Wood is Good: The Vital Role of Wood in River Health” fact sheet](#) presents the role and benefits of the presence of wood in Colorado streams and rivers.

Professor Ellen Wohl of CSU published an essay called [“Messy Rivers are Healthy Rivers”](#) about the benefits of physical complexity in a river corridor.

Western Resilience Center created a [Guide to Yampascaping](#) that provides useful information and resources on the process of transforming a yard or other piece of land into one that is more appropriate to the Yampa Valley region.

Streamside Livestock Grazing

Common Issues

Cattle production is an important agricultural commodity and has formed the cultural and economic backbone of the region. In a changing industry such as agriculture, ranchers have to be good stewards of the land to ensure the land is profitable, productive, and protected for the future generations of the ranch. Balancing profitability and protecting natural resources can be challenging, and compounded by also navigating the best practices to protect water quality and sustain a thriving ecosystem both above and below the soil surface. Livestock utilization of the riparian corridor may lead to problems like increased erosion, water quality problems, and degradation of the riparian forest. Livestock management is especially important near the river due to the importance of water resources to the region.

Questions to Consider

- Are plant species providing adequate forage quality for livestock?
- Are plant species in riparian buffers providing high nutrient uptake to capture nutrient runoff before entering the river?
- During spring snowmelt, is manure from winter pastures being contained or filtered before it flows into the river?
- Can livestock be excluded from some riparian areas?
- Can livestock be rotated appropriately to support riparian health?
- If livestock are allowed to graze in riparian areas, do they spend more time in the riparian areas than in other zones of the grazing area? How should that be considered in stocking rate calculations?
- Can alternative sources of water for livestock be located away from the stream to reduce the impacts of livestock on riparian areas and natural channels (e.g., off-channel watering)?

Principles of River Health

Presence of Cattle in Riparian Areas Can Lead to Adverse Impacts

Ranchers may want to utilize riparian areas for livestock grazing, but the timing, intensity, frequency, and duration are key considerations. Riparian soils are generally high in moisture, but they are particularly vulnerable to compaction and drying due to hoof action. The wetland vegetation found in riparian areas prevents erosion, but overgrazing decreases plant cover. This is especially problematic if overgrazing is occurring near the outside bends, where the risk of erosion is highest. Overgrazing of riparian areas can reduce soil moisture and soil organic carbon and can contribute to channelization and downcutting of the river.



Livestock grazing on a Routt County stream | Photo by Roddy Beall, Zenobia Consultants

Cow manure contains nitrogen and phosphorus, which are fertilizers. If too much fertilizer enters the river, it can contribute to water quality problems downstream like algal blooms, which are rapid increases in algae populations that can deplete oxygen in the river, block sunlight, and be toxic to people and wildlife. Manure also can have heavy metals, pathogens such as *E. coli*, or antibiotics that can negatively impact the river.

The impact of livestock on the riparian ecosystem and the river depends on the management of grazing operations adjacent to the river. When cattle are rotated through riparian pastures with only low to moderate levels of grazing, they can create beneficial diversity in the willow and cottonwood stands. However, unmanaged or continuous grazing almost always leads to degradation of land resources and water quality.

Riparian Forest as a Buffer

A healthy riparian forest can be an effective buffer for the river. Excess manure, herbicides, or fertilizers might run off the pasture, but the trees, shrubs, and grasses can capture these nutrients and pollutants, slowing and reducing the amount that is released to rivers and reservoirs. Healthy plants lead to good soil health, because biodiversity of above ground species creates additional microbial activity below the soil surface, resulting in better filtration of water, higher organic matter content, and higher nutrient availability over time. The riparian forest also provides many other benefits to the river such as shading and wildlife habitat, as discussed in the Riparian Forest and Buffer section.

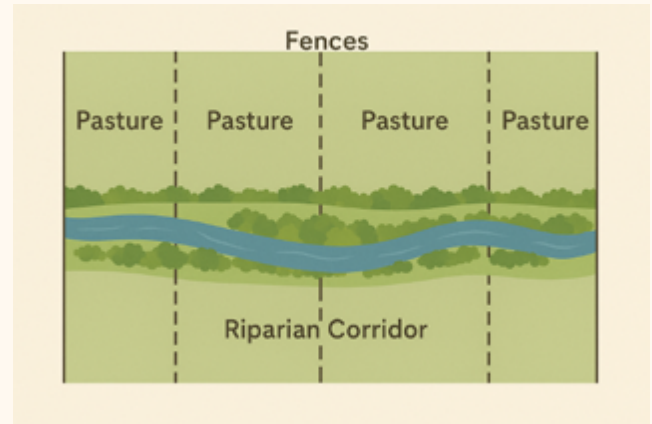
Recommended Practices or Actions

There are several ways to manage livestock grazing in and around the river. These approaches may require additional planning and management, but the improved riparian conditions will provide benefits for both the operation and river health.

Implement Rotational Grazing in Riparian Pastures

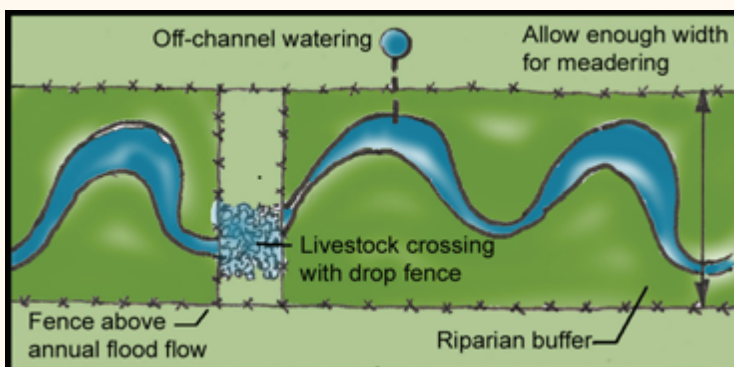
If livestock must have access to the river for water, or they must have access to the riparian forest for habitat and forage, it is important to actively manage grazing to protect river health. Short-duration grazing may be allowable within some riparian buffers. To protect soil and vegetation health, grazing should not occur when soil is wet, when plants are emerging or setting seed, or when plant cover is limited or stressed by dry conditions.

Grazing and trampling can be beneficial when combined with adequate rest for the plants. Rest is the key concept in rotational grazing, centering around whether the plants get enough time to regrow before being grazed again. If they do, the range quality becomes more robust. As stock density increases, trampling increases, which affects every plant equally, unlike grazing which only affects the desirable plants. Livestock rotation is an art and a science, with timing and duration depending on the animals' selective grazing patterns and the life cycles of different plants during different times of the growing season.



Conceptual plane view showing multiple riparian pastures for rotational grazing. Each pasture includes access to the river, but monitoring of plant conditions, including the riparian plants, can inform when to rest each pasture | Diagram by Zenobia Consultants

Install Fencing to Exclude Livestock from the Riparian Forest



Conceptual plane view diagram showing exclusionary fencing above the annual flood flow. The riparian forest buffer is protected from grazing impacts, and an off-channel water source is available for the livestock. | Diagram from USDA

One potential solution to limiting riparian zone grazing is to fence cattle out of the riparian forest. This will allow for the willows, alders, dogwoods, and cottonwoods to grow into a healthy riparian forest, and for native grasses, sedges, forbs, and pollinator plants to take root, providing wildlife habitat and controlling accelerated bank erosion. The riparian forest will shade the river and filter out excess nutrients.

In this strategy, fencing should be installed higher than the level of the annual flood flow and allow enough width for the stream to meander. Additional perpendicular fencing can demarcate river crossing locations, which can be graded and hardened with cobble. Virtual fencing could also be considered.

Install Off-Channel Watering

The benefit of off-channel watering is that it provides multiple locations where cattle can drink. This reduces the herd's dependence on the river and the riparian corridor. If several pastures have water sources away from the river, livestock can be rotated away from the river to allow the riparian vegetation to rest. For example, springs and seeps can be developed, or small reservoirs called "livestock water tanks" can be built in tributary drainages that are dry 80% of the year. These types of structures require registration with the DWR, but they don't necessarily require a decreed water right, because water basins or tanks can be filled with snowmelt or with ditch water during times of free water.

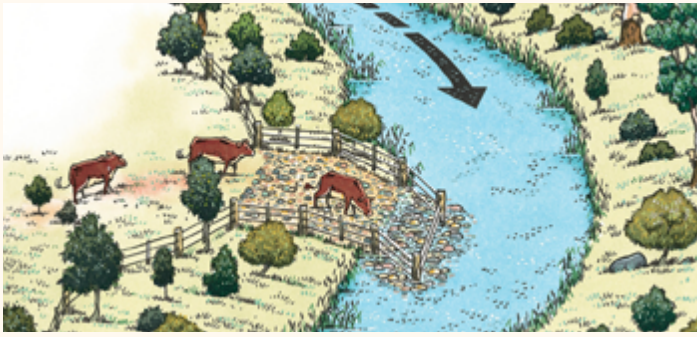


Livestock water tanks reduce pressure on the riparian corridor by providing important water sources away from the river | Photos by Roddy Beall, Zenobia Consultants

File Water Rights Applications for all Uses and Practices

Water rights can be complicated, but it is always advisable to file for water rights for all water uses. Even if it will be a junior right, remember that it will be senior to water rights filed in the future. If a landowner would like to permanently change a Surface Water Right to a reservoir right, a change in water right application can be submitted to allocate a portion of the water right to a Water Storage Right for a pond or reservoir, and that modified right will retain its year of issuance.

Install Hardened Access Points for Livestock Watering



A hardened access point on the river's inside bend | Illustration by Paul Lennon

Hardened livestock watering access points are designed to let livestock drink directly from a river or stream while minimizing erosion, sedimentation, and habitat damage. Typically built with rock and gravel, the slope should be gradual (<4:1). By concentrating livestock in a single controlled area, riparian habitat can improve in protected areas and fecal contamination is reduced. The best location for an instream watering point is on the inside of

a bend, where the flow velocity and erosive energy of the river is lowest. This location is also safer for the cattle and, because it is a depositional environment, reduces sedimentation and nutrient loading. Selection of a livestock access point should take into account the bank gradient and soil type, as cobbles and gravels are more suitable for access than clays and topsoils.

Follow Fertilizer Best Practices

Adhere to best practices when applying nutrients. Perform soil tests to determine the right amount and type of fertilizer to apply, and never apply it on frozen soils. Follow setback laws, avoiding applying fertilizer too close to water bodies. Consider whether manure on winter pastures may be sitting on frozen soils, and whether that manure is running off of that frozen surface with the spring snowmelt. Consider adding legume plants to pastures for natural nitrogen fixation rather than using synthetic nitrogen sources.

Partner with NRCS

The NRCS can provide valuable resources for designing a Grazing Management Plan or a Nutrient Management Plan. Specific grazing management practices (such as physical and virtual fencing) can be applied for through EQIP to address specific resource concerns like water quality and habitat improvement.

Benefits of Implementing Recommended Practices

- Increased property values due to the variety of water sources for livestock
- Riparian vegetation that provides shade and browse for livestock
- Increasing wildlife on the property
- Improving long-term river health will build productive pastures for future generations
- Improved soil health on the property
- Potential compensation for implementation of grazing management practices
- Decreasing fertilizer use saves money

Reference and Resource Materials

The [Savory Institute](#) has developed resources to implement holistic management, including regenerative agriculture in grazing.

The Journal of Rangeland Applications published a [comprehensive resource on grazing management tools and practices](#) to restore riparian functions.

NRCS Conservation Practice [Grazing Management](#) could be implemented in a cost-sharing program through EQIP. EQIP provides payments to restore and manage riparian corridor habitat.

A NRCS [Conservation Planning Activity Grazing Management Plan](#) would involve collaborating with a Technical Service Provider to plan grazing related conservation treatment activities for one or more resource concerns.

DWR has provided a [Synopsis of Colorado Water Law](#), which includes guidelines on reservoirs and livestock water tanks.

NRCS has created a useful [Handout on Spring Development](#).

Water Quality

Common Issues

Water quality in the Yampa Basin is generally good, but several recurring issues threaten long-term health. Nutrient loading from fertilizers, livestock operations, and degraded septic systems can contribute to harmful algal blooms in reservoirs and slow-moving stream reaches. Elevated stream temperatures during late summer low flows place stress on fish and aquatic life, while sediment from eroding banks, road crossings, and upland runoff reduces clarity and habitat quality. In urbanized segments of the river, stormwater carries pollutants such as salts, oils, and pesticides directly to the river, and localized *E. coli* contamination may occur where livestock or failing septic systems are close to the channel.

Questions to Consider

- Where does stormwater runoff from my property, road, or lot end up? Could it carry pollutants to the stream or river?
- Is there room within the property to add buffer zones or design stormwater runoff facilities?
- Is the septic system being inspected and pumped often enough to prevent leaks or failures?
- Could irrigation return flows from fields be carrying nutrients, sediment, salts, or warmer water to the stream or river?
- Are livestock or corrals located close enough to a stream or ditch that runoff could carry waste into the river?
- Has riparian vegetation been removed, causing the sun to shine directly on the river?

Principles of River Health

Too Much Aquatic Plant Growth Can Degrade River Health

Nutrients, particularly nitrogen and phosphorus, are important for plant growth. That is why they are often added to agricultural fields as fertilizers. However, when excess nutrients run off into the river, they can cause an increase in the growth of aquatic plants and algae. The problem can be especially serious in reservoirs, where nutrients build up, fuel the excess growth of plants and algae, and can lead to serious environmental and human health problems.

Rivers are Sources and Sinks of Nutrients

Any section of river can be a source of pollution. If excess water is flowing off a pasture, it could be a source of nutrients in the river, because manure or fertilizer could be carried into the river. If excess erosion is occurring, it can be a source of phosphorus to the river, because phosphorus naturally binds to soil particles.

Alternatively, any section of river can act as a sink, capturing and absorbing nutrients and helping to solve the problem. Dense riparian vegetation can catch the excess fertilizer flowing off a pasture, and riparian plants can convert those pollutants to healthier forms. Beaver complexes capture sediment, acting as a sink and protecting downstream water quality. These examples show that a wide range of land use and river management decisions on any section of river can make a big difference regarding water quality in the river and in downstream reservoirs.

A Healthy River Has Built-in Filters



Riparian vegetation filters water during spring floods, improving water quality | Photo by Kent Vertrees, Friends of the Yampa

Riparian wetlands are considered the “kidneys” of the river because they filter out sediment, nutrients, and chemicals from the water. Wetlands might be found in a secondary channel that fills during spring flood, in an off-channel swale that fills from groundwater, or in an area that is watered by irrigation return flows. Either way, an area with saturated soils will grow specialized wetland plants that are excellent filters. It is important to help the river water flow into these wetland areas so that the water can be filtered.

River Temperatures are Influenced by Shading and Flow

The State of Colorado monitors temperature thresholds for stream segments based on the uses of the waterbody. In the case of the Yampa River, the segment from the confluence with Oak Creek to the confluence with Elkhead Creek is frequently hotter than the temperature standard, especially during times of low flow in the river (mid- to late summer). This condition leads to stress for fish and other aquatic species within this segment. Elevated temperatures are a result of many factors, including riparian vegetation which mitigates solar exposure on the river, its tributaries, and the reservoirs along its reach.

Recommended Practices or Actions

Landowners can employ several actions to improve water quality through land management practices. As discussed below, these actions include restoring and maintaining riparian vegetation; managing livestock use in streamside areas; capturing and infiltrating stormwater runoff before it enters waterways; properly inspecting and maintaining septic systems; increasing connections between streams, floodplains, and wetlands; and encouraging or allowing beaver activity where appropriate to enhance natural filtration and nutrient processing.

Restore Riparian Vegetation

Establish or expand vegetated buffers to shade rivers, reduce sediment, and filter runoff. Trees and shrubs create shade, which cools the water and soil. A complex riparian forest that has dense, healthy vegetation of many different species will provide the greatest water quality benefit. See the Riparian Forest & Buffer section for more discussion.



*A degraded segment (left) lacks vegetation. An intact riparian buffer (right) provides shading and water filtration
Photos by Roddy Beall, Zenobia Consultants*

Manage Livestock

Grazing management in riparian areas is critical to maintain soil health, productivity of grass, and the health of the riparian forest buffer. Strategic fencing and rotational grazing plans are effective at reducing direct impacts, and the installation of off-channel watering systems and other property enhancements will promote long term balance between the uplands and the riparian. For more discussion of this topic, refer to the Streamside Livestock Grazing section.

Capture Stormwater Runoff Through Infiltration and Natural Buffering Prior to Entering Waterbody



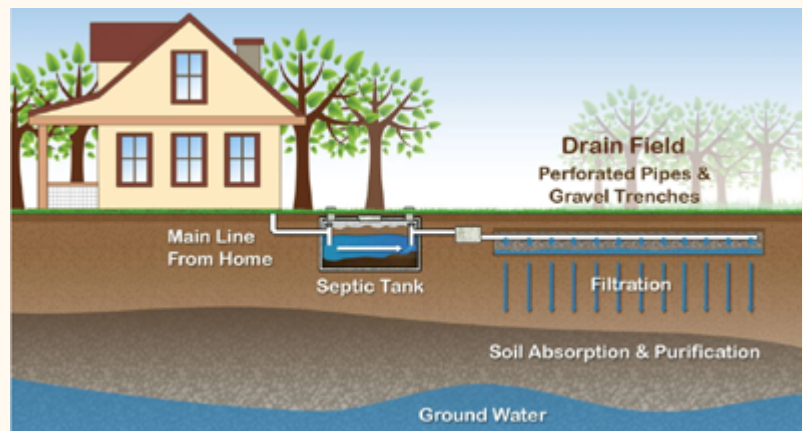
For urban runoff or irrigation return flows, an infiltration pond filters water through sedimentation and wetland plants | Photo courtesy of Bryan Malloch

Runoff from an urban landscape or a livestock pasture may carry excess nutrients, sediment, fertilizer, or pollutants. Wherever possible, direct water into a vegetated area like a filter strip, riparian buffer, natural wetland, or engineered infiltration pond instead of emission directly into waterways, ditches, or stormwater piping systems.

The plants in these buffer zones can help capture excess fertilizer, pollutants, and sediment. Infiltration ponds are shallow, engineered basins designed to temporarily store stormwater runoff and allow it to soak into the ground, improving water quality and recharging groundwater. In urbanized areas, infiltration ponds, filter strips, and permeable paving can be used together.

Properly Inspect and Manage Septic Systems

Perform regular inspections and maintenance of septic systems. Consider replacement of outdated systems or those identified as performing poorly. As seen in the diagram below, septic tanks and leach fields are often near the water table and can introduce pollutants. Consider moving septic leach fields further from the stream corridor or replacing septic tanks with connections to municipal sewage treatment where available.



A septic tank and leach field are designed to treat household wastewater, but they may pollute nearby groundwater or waterbodies | Diagram by Clean Earth Septic

Increase Floodplain and Wetland Connection

Look for opportunities to increase the river's ability to access secondary channels, streamside wetlands, and the floodplain. As water moves into these areas, it can be filtered by plants, and nutrient-rich sediment can be deposited. This may involve the installation of large wood to encourage water to flow into these wetlands, or the removal of streambank riprap or berms. In some cases, it could involve regrading streambanks to create floodplain benches or to create connection pathways to historic oxbows or side channels.

Encourage or Allow Beaver on the Property

Beavers create floodplain wetland complexes that filter nutrients through a combination of physical, chemical, and biological processes. Beaver dams slow and spread water, allowing for suspended sediments and particulate-bound nutrients to settle instead of moving downstream. In addition, the low-oxygen conditions created in beaver ponds are ideal for denitrification, a microbial process that converts nitrate into nitrogen gas, facilitating removal of nitrogen from the aquatic system.

Benefits of Implementing Recommended Practices

- Improved water quality will enhance habitat for aquatic and terrestrial wildlife
- Water quality improvements will help limit or prevent recreational closures at downstream reservoirs and river segments
- Human health benefits
- Preventing nutrient and soil runoff saves money and improves soil

Reference and Resource Materials

For a USDA Guide on Conservation Buffers, visit [Conservation Buffers: Design Guidelines](#) or [download the PDF here](#).

The Mile High Flood District provides [details and design criteria](#) for the installation of stormwater treatment best management practices.

Water Education Colorado created a [Citizen's Guide to Colorado Water Quality Protection](#), which provides an overview of water quality issues important to Colorado. It also tackles the complex water quality protection framework, including laws and regulations, on a national, state, and local level.

Water Quantity

Common Issues

Water quantity (streamflow) can be extremely low, particularly in the summer and fall, impacting irrigation, instream flow needs for aquatic organisms, and recreation. As discussed in the Fisheries and Irrigation Infrastructure sections, having a minimum instream flow is important for aquatic wildlife and riparian forest health. Furthermore, the amount of snowpack and timing of snowmelt has changed in the last few decades. As climate change advances, it is especially important to work cooperatively among neighbors to find collaborative solutions. Under warmer, drier conditions, the timeframes that the basin's rivers and streams are "on-call" will increase, meaning not all water rights holders will receive their decreed amount of water. Although Yampa Basin landowners cannot change the amount of snow that falls in the mountains, or the timing of snowmelt, there are opportunities to implement innovative and cooperative solutions to meet the realities of a changing world.

Questions to Consider

- What is the residence time of rain or snowmelt on the property? Are there opportunities to increase the amount of time the water is retained on the property, rather than sending it downstream too quickly?
- Are upstream neighbors employing effective practices to slow and detain water, such as flood irrigation, beaver coexistence, or beaver mimicry?
- Are upstream neighbors supporting riparian forests and wetlands to slow and retain water?
- Are upstream neighbors diverting water, causing flows to decrease or causing dry-up points?
- Are there instream flows in the reach? If so, are these instream flows consistently being met?

Principles of River Health

Residence Time

When a drop of water enters the upstream end of a property, it will be on the property for a certain amount of time before it flows off the downstream end. If the river is straight and fast, it may only take a few minutes for that drop to be gone. If, however, the river bends in many meanders, and then a logjam pushes the water out of the main channel into a wetland area, the water could stay much longer. It could stay in the willows and cattails of the wetland, and then seep down into an aquifer before returning to the river channel. In total, the residence time of that drop could be weeks or months. If every landowner increases the complexity of water's path across their property, the overall residence time of water in the Yampa Basin, could be increased significantly.

Nature's Reservoirs

In a lush, healthy riparian corridor, everything holds water. Wetlands, pools, and ponds along the river corridor fill with water in the spring and hold water for many months. The soil itself holds a significant amount of moisture. Water that pools on the floodplain enters the groundwater and underground aquifers, which can be expansive and slow moving. If the riparian corridor has healthy vegetation, the duration of water retention can be extended further. A dense forest of willows, cottonwoods, and alders is a powerful tool to hold water.

Flood Irrigation Fills Aquifers

Flood irrigation can recharge groundwater and retune flows, delaying them until later in the season when they flow back into the river as return flows. Flood irrigation may not change the amount of water in the system overall, but it does change the timing of flows down the river. This delay in river flow may help increase the amount of water in the river in the summer and fall when flows are at their lowest.

Existing Reservoirs and Natural Dams Provide Late-Season Flow Support

Upstream reservoirs are important water storage assets. Private dams and stock ponds also store water. Beaver dams detain water and spread water into lateral channels across the floodplain. In some places where beaver coexistence is not possible, low-tech process-based restoration treatments like post-assisted log structures and beaver dam analogs (described in the section on Bank Erosion) can help to detain water and increase groundwater storage. A downed cottonwood tree in the river, even though it is not a dam, increases storage of water because it creates friction in the water column that pushes water sideways into the soil. Even small dams can have a big impact—in small ephemeral streams high in the watershed, small dams that are only one rock tall can noticeably increase soil saturation and help protect and build wet meadows.

The River Needs Water

Water quantity is important for our needs, but fish, plants, and animals in the river depend on water being in the stream for their very survival. “Dry-up points” are caused when an irrigation structure diverts all of the water from the river into a ditch. Taking all of the water is called “sweep,” and it can be catastrophic to the aquatic wildlife in the stream segment below the diversion. As water users seek ways to improve water quantity for beneficial uses, it is also important to maintain a minimum instream flow so that a source of cool, clean water is available for the plants and animals that need it. CPW or other organizations or experts can help to assess flow needs using models such as R2Cross, which is specifically developed for Colorado streams.

Recommended Practices or Actions

Landowners can employ several actions to help address water quantity concerns. As discussed below, these actions include reconnecting the river to its floodplain to enhance natural storage; slowing the movement of water using natural and low-tech structures; allowing water to remain in the river during low-water periods; developing instream flow protections; and temporarily leasing water rights to support river health while maintaining water rights security.

Allow Water onto the Floodplain

The floodplain serves as a natural reservoir. Wherever possible, allow the river to access its natural historic floodplain. Do not armor banks or build berms and where they already exist, consider their removal. A historic oxbow, secondary channel, or floodplain swale could be managed as a bog, marsh, or wetland: filling with water during spring floods and slowly releasing water through the aquifer back to the river. Collectively, a watershed-wide effort to increase floodplain wetlands could increase late summer water for all users. Restoring wetlands could qualify for NRCS cost sharing through practice 643: Restoring Rare or Declining Community, or through Conservation Reserve Program land rental rates. Wetlands can be incredibly valuable habitat for diverse plants and wildlife species, even if they are only inundated during part of the year.

Slow the Water



A post-assisted log structure detains water in the channel | Photo by Eli Smith, National Forest Foundation

Historically, logjams and beaver dams filled most streams, creating a series of pools like beads on a string. These pools detain water and extend flows into the late summer. Beaver complexes can even turn some ephemeral streams into perennial streams. To help maintain water quantity, support and increase natural or natural-like structures in the river, such as trees, boulders, large wood, logjams, and beaver dams. Build low-tech process-based structures to jump start natural processes. Water will pool above and below these structures, slowing its flow downstream.

Allow Water to Flow Past the Headgate in Times of Low Water

“Use it or lose it” is a phrase heard often in Western water law. However, a landowner choosing not to divert their full water right does not necessarily put that water right at risk of loss. In fact, having records that show use of the water right once every 10 years can be sufficient to maintain the right. This means that water rights do not need to be used in full every year. During a low-water year, voluntarily reducing water diversions to keep water in the river is a valuable tool to protect river health. This ethic has been traditionally understood in the Yampa Valley, as neighbors let water flow past their headgates to help downstream neighbors and to protect the health of the river. Keeping that tradition alive is a key tool to maintain flows in the river.

Develop Instream Flow Rights

Over the decades, state lawmakers have officially recognized new “beneficial uses,” including in-channel water for recreation and instream flows for the environment. Only the CWCB can hold rights for instream flows, and only government entities can hold recreational in-channel diversion rights. These flows can be evaluated using stream flow modeling to identify flow needs to support river health.

Lease Water Rights

Landowners may consider a temporary lease of some or all of their water right as a useful way to support river health. This can be a beneficial part of managing a water rights portfolio without the risk of abandoning the water right. A water rights lease is an option for absolute water rights only. Water can be leased in 5 out of 10 years to the CWCB with support from the Colorado Water Trust. This agreement protects against loss of the water right, keeps the water right tied to the land, and can be a source of income. A surface right water lease could be a good option in connection with upgrades to improved irrigation efficiency, irrigation structure upgrades, or rotational management of pastures. When changing irrigation management, it is important to monitor for and respond promptly to any landscape changes, such as the emergence of invasive plant species. Landowners can discuss their water rights portfolio with the Colorado Water Trust if they are seeking creative ways to keep water in the river when they do not need it for their operations.

Benefits of Implementing Recommended Practices

- Increased summer and late season water
- Increased wildlife habitat
- Improved instream habitat for fishing and recreation
- Source of income or support through surface water right lease

Reference and Resource Materials

Utah State University developed a [Design Manual for Low-Tech Process-Based Restoration of Riverscapes](#) that provides practical, low-tech tools and training to repair degraded riverscapes using natural processes.

The CWCB developed the [R2Cross Model](#) with technical contributions from CSU to support ecological assessment and streamflow modeling for river health.

NRCS Conservation Practice 643 is [Restoration of Rare or Declining Natural Communities \(Code 643\)](#), which can be used through EQIP. EQIP provides payments to restore and manage riparian corridor habitat.

The [Colorado Water Trust](#) is a statewide nonprofit organization whose mission is to restore water to Colorado's rivers and streams. They are an excellent resource to consult for creative ways to use market-based solutions within the confines of Colorado water law to secure water for environmental purposes.

Wildlife Habitat

Common Issues

Whether an animal lives in the river or on land, many species depend on the river corridor. Much of the riparian forest along rivers was cleared for development or agriculture in the last century, impacting wildlife through habitat degradation and disconnection. River and riparian health should be improved where possible to support wildlife populations in the Yampa Valley.

Questions to Consider

- Is the riparian forest connected upstream and downstream to create a movement corridor, or is it disconnected?
- Are there movement corridors from the river up into the uplands?
- Is there habitat diversity on the landscape (forest, shrubland, grasses, wetland)?
- Is there habitat diversity in the river (pools, riffles, glides, wood, backwaters, side channels, bars)?
- Are fences wildlife friendly? Do fences specifically account for migrating wildlife to allow crossing and reduce potential for entanglement?
- Does the riparian area support river health?

Principles of River Health

The Riparian Corridor is Especially Important

Riparian areas comprise less than two percent of the land area of most western states, yet up to 80 percent of all wildlife species are dependent upon riparian areas for at least part of their life cycles. Wildlife needs access to the water, food, shelter, and movement corridors that riparian areas provide.

Complexity is King



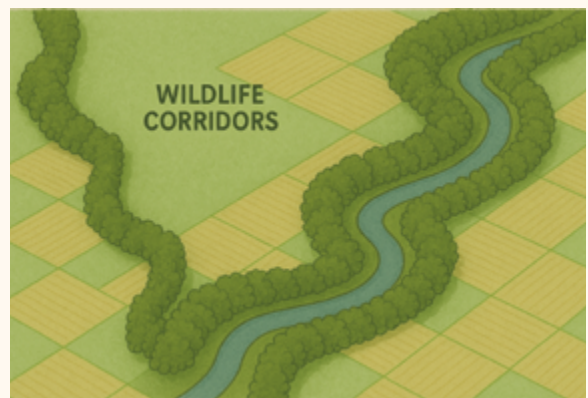
This “messy” river segment provides wonderful diversity of habitat for wildlife | Photo by Kim Lennberg, Alba Watershed Consulting

When evaluating a property for its wildlife habitat value, consider how much “physical complexity” exists along the river. In the water, it is beneficial to have some places that are shallow, other places that are deep; some places where the water is flowing quickly, and other places where it is pooled behind a logjam or beaver dam. On shore, there should be similar complexity. There should be an undulating surface and “microtopography,” where some places are higher and others lower, some places are drier and others wetter. If there are trees, some should be alive, others standing dead, and others fallen onto the ground or into the channel. Each of these different variations will create a niche for wildlife to live in. For landowners interested in enhancing wildlife habitat, do not try to clean up the “mess;” such attempts to simplify the landscape will reduce the habitat for animals. According to Dr. Ellen Wohl, an

expert on Western river systems: “Natural river corridors are messy. They include floodplain wetlands; secondary or partially cutoff channels; instream obstructions from large wood, beaver dams, and large boulders; and downstream variations in the bed, banks, and channel shape.”

Corridors and Connections

All wildlife, even the smallest critters, need to move across the landscape. Many of these animals would prefer to remain protected by vegetation as they move. Wildlife movement can be supported by restoring vegetated corridors across the property. Animals also need to move parallel to the river, so it is important that the riparian vegetation be continuous up and down the stream. Wildlife may also need to move between the riparian zone and the uplands, so it is important to have vegetated corridors that are as continuous as possible. Fences installed to create pastures or define property boundaries pose a barrier to movement and can result in entanglement and death—this risk is greatest for young elk, deer, and antelope. A study by Utah State University found that for every 2.5 miles of fence, one ungulate is killed every year. It is likely that every property has patches of native vegetation, so connecting those patches can help wildlife thrive.



Continuous wildlife corridors along the river and into the uplands | Diagram by Zenobia Consultants

Messy Rivers are Good Homes

Within the river itself, obstructions like downed trees, logjams, racked wood, and beaver dams create habitat for fish and other aquatic wildlife. Additionally, these types of impediments direct the water laterally into side channels, oxbows, backwaters, and riparian wetlands. It is very important to leave the “messy” elements in place, and if they have been removed, to install new structures or create conditions to restore natural processes to enhance wildlife habitat.

Recommended Practices or Actions

Landowners can take a variety of approaches to enhance wildlife habitat along rivers and streams while supporting healthy riparian systems. As discussed below, these approaches include protecting and improving riparian forests, designing wildlife corridors that connect the river to upland habitats, installing or modifying fencing to allow safe wildlife movement, increasing the presence of woody material in the river corridor, reconnecting secondary channels, expanding seasonal flooding of riparian wetlands, and assisting or supporting beaver activity to promote diverse and resilient habitat.

Protect and Improve Riparian Forest

Riparian forests provide critical habitat for many species. Songbirds nest in the shrubs, while osprey, herons, and eagles nest in cottonwoods. Sumac, serviceberry, and buffaloberry provide fruits, while willows provide browse for moose and elk. Sandhill cranes nest in the sedges and cattails. A riparian forest can be imagined as a three-story building. The bottom floor is filled with grasses, sedges, and wildflowers. Above that, the second level is dense with shrubs such as dogwood, willow, and alder. Rising overhead, the top floor forms an airy penthouse in the cottonwood canopy. Not every location in the watershed will have the same forest, so refer to the Yampa River Stewardship Project’s Riparian Planting Palette (Appendix 1) to design the appropriate ecosystem for elevation and river gradient.

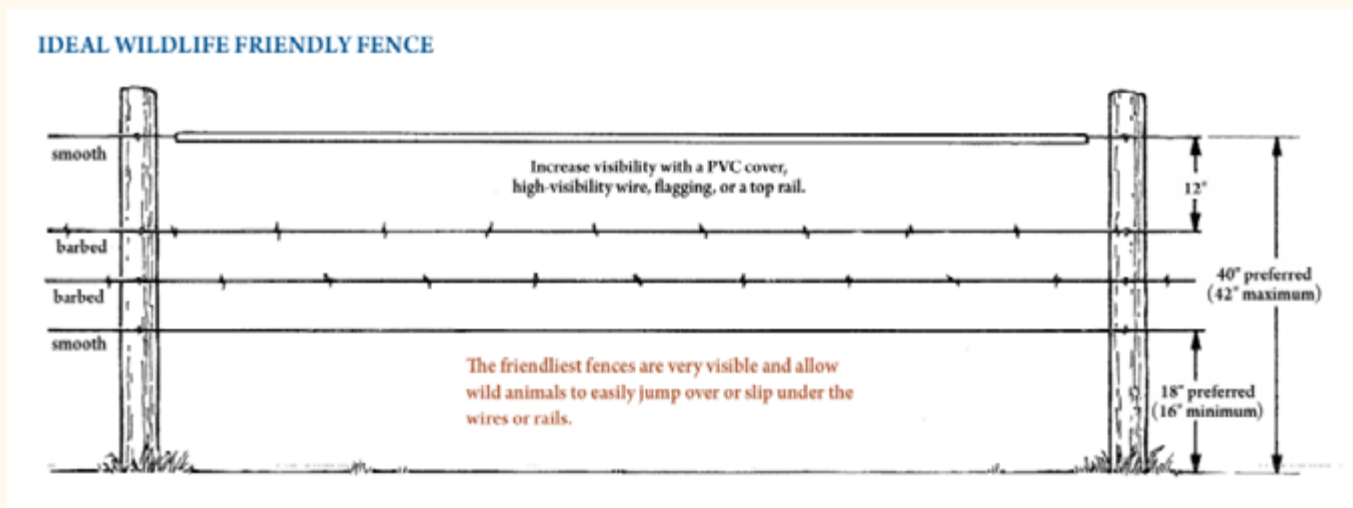
Design Wildlife Corridors from the Riparian to the Uplands

Elk, deer, antelope, foxes, and other wildlife spend most of their time in the uplands, but they depend on the river for water, and they find nutritious food at the water’s edge. They often travel from the uplands to the river in the evening or morning and prefer a corridor of vegetation. Create a corridor of shrubs and trees connecting into the uplands, and assess fences and road crossings to remove obstacles.

Install or Replace Fencing to be Wildlife Friendly

Installed fencing should take into account not only livestock but also movement of wildlife, especially deer and elk. Fencing should be installed above the annual maximum flood flow level and allow enough width for the stream to meander. These guidelines help control cattle and enable wildlife movement:

- Place fencing wire on the same side of fence posts as the domestic animals
- Use a smooth wire or rounded rail for the top, and smooth wire at the bottom
- Make sure the top rail or wire is no higher than 42 inches
- Leave at least 12 inches of space between the top two wires where entanglement most frequently occurs
- Keep a minimum of 16 inches between the bottom wire or rail and the ground.
- Space fence posts at least 16 feet apart
- Provide gates, drop-downs, removable sections, or other passages for animals to cross where they tend to gather and livestock is seasonally present
- Add a rail, high-visibility wire, flagging, or other clearly visible marker to the top wire of the fence



Fence design considerations to allow for safer wildlife passage | Illustration courtesy of E.R. Jenne Illustration

Increase Woody Material in the River Corridor



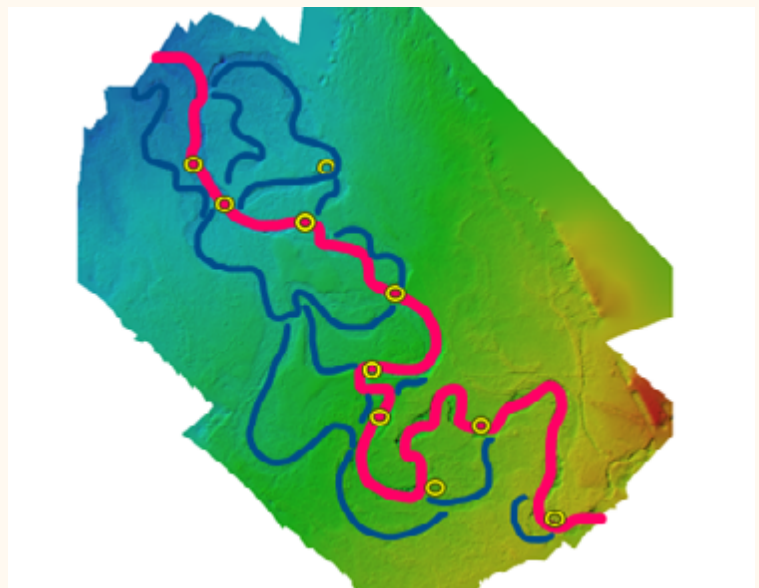
Presence of woody material along the river corridor improves diversity of wildlife habitat | Photo by Kim Lennberg, Alba Watershed Consulting

Large woody material, also referred to as large wood, is typically described as fallen trees, logs, and branches that are at least four inches wide and six feet long. Traditionally, large wood has been removed from streams in an effort to clean up stream channels and to prevent localized flooding. But as discussed in the Fisheries section, large wood helps create a more diverse aquatic habitat. Exposed logs are also used as basking and perching sites by reptiles, amphibians, and birds. Fallen trees create cover and hiding places for fish and other aquatic organisms. As water flows over and

around large wood, localized scouring of the bed and banks creates pools and undercut banks that provide additional shelter and act as resting areas for fish. Finer substrate, such as small gravel, is typically deposited upstream of large wood as flows are slowed, creating important spawning habitat for some fish species.

Reconnect Secondary Channels

Land management over the past century has led to the simplification of rivers and streams into a single channel. On some properties, landowners built berms and stacked car bodies to close off secondary channels. In other areas, the removal of riparian vegetation, wood, and beavers eventually led to the river's simplification. Reconnecting secondary channels could restore high flow or overflow pathways to dissipate flooding and erosion. It could also restore wetland habitat for birds, nursery habitat for cranes, or low-flow refuge for fish. As seen in the diagram below, some sites have many secondary channels that rarely or never receive streamflow.



Digital surface model of a segment of the Yampa showing the current channel (red) and historic secondary channels (blue). Log structures at strategic locations (yellow icons) could reconnect secondary channels | Diagram by Roddy Beall, Zenobia Consultants

Increase Seasonal Flooding of Riparian Wetlands

When spring floods overflow the banks and enter the floodplain, they reinvigorate the habitat by bringing water, nutrient-rich sediment, and seeds onto the land. Annual flooding supports a rich and diverse riparian landscape, creating habitat for wildlife. In areas where it is acceptable, increase flooding onto the floodplain by adding wood, installing or encouraging logjams, and encouraging beaver dams in the stream or river.

Assist and Support Beaver Activity

As discussed in the Beaver Coexistence section, beaver complexes create diverse wildlife habitat and riparian forests. Consider installing beaver mimicry structures such as beaver dam analogs and post-assisted log structures to provide improved conditions for beaver activity. Often, beavers will colonize the human-made structures and promptly work to improve and maintain them. As water spreads along the valley floor from beaver activity, the overall footprint of the riparian area expands.

Benefits of Implementing Recommended Practices

- Wildlife viewing
- Wildlife habitat
- Hunting and fishing opportunities
- Income from guiding or leasing

Reference and Resource Materials:

Professor Ellen Wohl of CSU wrote an essay [Messy Rivers are Healthy Rivers](#) about the benefits of physical complexity in a river corridor.

NRCS published a useful [Stream and Riparian Corridor Habitats](#) handout describing what NRCS will pay for through the EQIP program.

CPW's [Colorado Wildlife Habitat Program](#) is a voluntary, incentive-based partnership program focused on habitat protection and public access.

The Watershed Center published the [Wood is Good Fact Sheet](#) on the role and benefits of large wood in Colorado streams and rivers.

Funding

The Yampa River Stewardship Program would like to help landowners and land managers obtain funding to implement improvements along the Yampa River and its tributaries. There are several sources of available funding, described in the table below. The Yampa River Stewardship Program supports the design multi-benefit projects that meet landowner objectives such as agricultural productivity while simultaneously improving conditions for river health. A successful project design might be able to obtain funding from one (or several) of the funding opportunities listed on the following pages.

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
Yampa River Fund	Yampa River Fund funding opportunities include: 1. Voluntary, market-based water leases and releases from reservoirs that will enhance river flows. 2. Restoration actions that will improve riparian, in-channel, streambank, and aquatic habitat, with a special focus on addressing temperature issues. 3. Agricultural infrastructure improvements that will generate combined agricultural, environmental, and recreational benefits.	April 1	May	a. Public (government): municipalities, enterprises, counties, and State of Colorado agencies. Federal agencies are eligible, but the agency needs to demonstrate why a local non-federal partner should not be the grant recipient. Federal agencies are encouraged to partner with local entities b. Public (districts): authorities, Title 32 special districts, conservancy, conservation, and irrigation districts, and water activity enterprises.. c. Private Incorporated: this is limited to mutual ditch companies, homeowners' associations, and nonprofit corporations. d. Non-governmental organizations: typically nonprofit.	www.yampariverfund.org
CWCB Water Project Loan	The CWCB Water Project Loan Program provides low-interest loans for the design and construction of agricultural, municipal and hydrologic projects in Colorado. A minimum loan request of \$100,000 is recommended.	Applications for loans less than \$10 million are accepted at any time.	Rolling, Approximately one year from application date	Any private or public entity that can contract with the state and that can establish and document the need for the project. The project sponsor must show that the project is technically, economically, institutionally and financially feasible.	Water Project Loan Program DNR CWCB CWCB Water Funding Explorer
CWCB Colorado Water Plan Grant	Program funding categories include Water Storage & Supply, Water Sharing Agreements, Conservation & Land Use Planning, Engagement & Innovation, Agricultural, and Watershed Health & Recreation	July 1 and Dec 1 (twice annually)	September and March	Governmental entities: municipalities, districts, enterprises, counties, and State of Colorado agencies. Federal agencies are encouraged to work with local entities. Covered Entities as defined in Section 37-60-126, C.R.S., are eligible if the applicant has adopted an approved water conservation plan. Private entities: mutual ditch companies, non-profit corporations, and partnerships	Colorado Water Plan Grants DNR CWCB CWCB Water Funding Explorer

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
CWCB Healthy Rivers Fund	This fund supports projects that promote the improvement and/or protection of the condition of the watershed. Types of projects include: water quality and/or water quantity monitoring; participation in the development and/or implementation of total maximum daily loads; implementation of watershed-related recommended practices, flood protection, channel stability, and a wide variety of other riparian, streambank and habitat restoration efforts.	Last day of February	Mid-April	Eligible applicants include locally-based watershed protection groups who are committed to a collaborative approach to the restoration and protection of lands and natural resources within Colorado's watersheds.	Colorado Healthy Rivers Fund DNR CWCB CWCB Water Funding Explorer
CWCB Water Supply Reserve Fund Grants	This fund provides funding to assist Colorado water users in addressing their critical water supply issues and interests including technical assistance regarding permitting, feasibility studies and environmental compliance; studies or analysis of structural, nonstructural, consumptive and nonconsumptive water needs, projects or activities; design of structural projects or activities; and infrastructure replacement or maintenance projects	February 1, April 1, June 1, August 1, October 1, December 1	Approximately one year from application date	1. Governmental entities: municipalities, special, water and sanitation, conservancy, conservations, irrigation and water activity enterprises, counties and State of Colorado agencies. Federal agencies are encouraged to work with local entities. Covered Entities as defined by Section 37-60-126, C.R.S., are eligible IF the applicant has adopted a CWCB approved Water Efficiency Plan. 2. Private entities: mutual ditch companies, non-profit corporations, individuals and partnerships, etc. Requests must be approved by the Yampa/White/Green Basin Roundtable. Contact the Basin Roundtable to review their respective guidelines.	Water Supply Reserve Fund Grants DNR CWCB CWCB Water Funding Explorer

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
CWCB Fish and Wildlife Resources Fund Grants	This fund grants money to mitigate impacts on fish and wildlife resources. Grant funds can be used for mitigation, enhancement, and species recovery projects	Rolling Applications accepted throughout the year	Approximately one year from application date	Eligible parties for all grants for New Projects are limited to the operators of the water facility for which mitigation and enhancement are needed. Eligible parties for Species Recovery Grants include established non-profit organizations, watershed coalitions, local governments, conservation and water conservancy districts, and Colorado's tribal governments.	Fish and Wildlife Resources Fund Grants DNR CWCB CWCB Water Funding Explorer
CWCB Diversion Measurement Installation Program	Available for the installation of measurement structures, such as flumes, weirs and pumps. Eligible water users will receive a measurement structure, installed at their point of diversion, at no cost to them.	End of January	Work performed by State contractor—target fall installation	Water users with a missing or faulty measurement device	Diversion Measurement Installation Program DNR CWCB CWCB Water Funding Explorer
RESTORE Colorado Program (Restoration and Stewardship of Outdoor Resources and the Environment)	RESTORE supports large-scale habitat restoration and stewardship projects across public and private lands	RFP available: August	Approximately 5-8 months from application date	Eligible applicants include non-profit 501(c)(3) organizations, U.S. Federal government agencies, state government agencies and other political subdivisions of the state, local and municipal governments, Tribes, and educational institutions. Ineligible applicants include businesses and unincorporated individuals.	RESTORE Colorado Great Outdoors Colorado

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
Upper Yampa Water Conservancy District Diversion Infrastructure Improvement Project	Available for headgate or measuring device construction or replacement for water users within the Upper Yampa Water Conservancy District boundary. Installation must occur from the point of diversion. Tier 1 applicants can apply for a 50% reimbursement of project costs, up to \$5,000. Tier 2 funding is available for larger projects	Funding has been extended through May 1, 2026. Rolling application timeline	No limitation; expenditures are also reimbursable for completed work	<ol style="list-style-type: none"> 1. Public agencies including local governments such as municipalities and counties, special districts such as irrigation or conservation districts, and all public authorities 2. Private corporations including mutual ditch companies, homeowners associations, and partnerships 3. Non-governmental organizations including non-profit and for-profit organizations and corporations 4. Private landowners and individuals 	Diversion Infrastructure Improvement Grants - Upper Yampa Water Conservancy District
Upper Yampa Water Conservancy District Community Grant Funding Project	Community grants support projects that align with the mission, vision, and strategic plan of the Upper Yampa Water Conservancy District: infrastructure improvement, water supply planning, river restoration, water quality, or education and outreach projects.	Rolling program with an open application process	Approximately 2-3 months from application (dependent upon Board meeting dates)	<ol style="list-style-type: none"> 1. Public agencies including local governments such as municipalities and counties, special districts such as irrigation or conservation districts, and all public authorities 2. Private corporations including mutual ditch companies, homeowners associations, and partnerships 3. Non-governmental organizations including non-profit and for-profit organizations and corporations 4. Private landowners and individuals 	Community Grant Funding - Upper Yampa Water Conservancy District
Colorado River District Community Funding Partnership	These grants fund multi-purpose water projects on the Western Slope in five project categories: productive agriculture, infrastructure, healthy rivers, watershed health and water quality, and conservation and efficiency	Rolling basis (Quarterly determination for most projects)	Approximately 4-5 months from application date	Project proponents include stakeholders such as individuals, local governments, corporations, private entities such as mutual ditch companies, non-profit corporations, and partnerships.	Community Funding Partnership - Colorado River District 2025
Colorado River District Irrigation Company Financial Sustainability Pilot Grant	Help irrigation and ditch companies on the Western Slope strengthen their long-term financial health and prepare for critical infrastructure investments	February	Approximately 4-5 months from application date	Irrigation and ditch companies on the Western Slope located in the Colorado River District's territory, own or operate an irrigation ditch, and be able to contract with an engineering or consulting firm to develop a CIP and rate study	<p>Pilot Program Description</p> <p>Community Funding Partnership - Colorado River District 2025</p>

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
Bureau of Reclamation WaterSMART Water and Energy Efficiency Grants	Reclamation provides 50/50 cost share funding to irrigation and water districts, tribes, states and other entities with water or power delivery authority. Projects conserve and use water more efficiently; increase the production of hydropower; mitigate conflict risk in areas at a high risk of future water conflict; and accomplish other benefits that contribute to water supply reliability in the western United States	Program currently on-hold	Program currently on-hold	Category A: <ul style="list-style-type: none"> • States, Tribes, irrigation districts, and water districts; • State, regional, or local authorities, the members of which include one or more organizations with water or power delivery authority; and • Other organizations with water or power delivery authority. OR Category B: <ul style="list-style-type: none"> • Nonprofit conservation organizations that are acting in partnership with, and with the agreement of, an entity described in Category A. 	WaterSMART Water and Energy Efficiency Grants Bureau of Reclamation
Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP)	NRCS' flagship conservation program helps farmers, ranchers and forest landowners integrate conservation into working lands. Reimbursable funds contingent upon check-out of various conservation practices performed to standard	Inquire at any time, by contacting the local NRCS office.	Approx 6-15 months depending on project specifics, grant is reimbursable	Eligible Agricultural producers	EQIP NRCS
CDA Noxious Weed Program Annual Grants	These grants provide additional financial resources for on-the-ground noxious weed management	December	May	"Local governing bodies," including counties and municipalities. Other eligible entities include conservation districts, non-profit organizations, and organized private entities such as road associations, and homeowner's associations, who have adequate capacity to carry out effective noxious weed management projects.	Noxious Weed Program Annual Grants CDA

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
Colorado Cattlemen's Agricultural Land Trust (CCALT) Additive Conservation Program Payment for Ecosystem Services	This program implements projects that support long-term stewardship goals and conservation values. These projects will have multifaceted objectives that support both operational and ecological needs. Example projects may include: fire mitigation, river restoration, habitat enhancement, grassland improvement, and water infrastructure upgrades. The "Payment for Ecosystem Services" model compensates landowners for hosting and maintaining restoration sites.	Coordinate at any time with CCALT Director of Stewardship		Landowners who have already conserved their properties with a CCALT conservation easement	Landowners - Colorado Cattlemen's Agricultural Land Trust
USFWS Partners for Fish and Wildlife Program	This program provides free technical and financial assistance to plan, design, supervise and monitor customized habitat restoration projects	Inquire at any time by contacting the state coordinator	Approximately 3-9 months depending on project specifics, grant is reimbursable	All private landowners interested in restoring wildlife habitat on their land	Partners for Fish and Wildlife U.S. Fish & Wildlife Service
CDA and Colorado Department of Revenue Agricultural Stewardship Tax Credit	This tax credit is meant to encourage the practice of qualified stewardship practices on a farm or ranch, including any practice that increases soil health, improves water efficiency, or creates more diverse and beneficial ecosystems while maintaining the productivity of the farm or ranch.	November for following tax year credit eligibility		Qualified Taxpayer applying for an Agricultural Stewardship Tax Credit in a given year.	Agricultural Stewardship Tax Credit CDA
Yampa Valley Beaver Working Group	Grant funding is available to complete on-site physical mitigation measures to allow beavers to co-exist on a landowners' property. Requires a 25% landowner match.	Rolling Basis	Rolling Basis	Landowners	www.friendsoftheyampa.com/yampa-valley-beaver-working-group/
Colorado Ag Water Alliance Drought Resiliency Projects	Program funds projects that demonstrate proof of concept for conservation of consumptive use and/or long-term drought resiliency while maintaining profitability (alternative crops, water use efficiency, and hay/forage, livestock, and soil improvements)	December	Following year	Colorado agricultural producers and landowners and their partners	Drought Resiliency Projects coagwater

Grant Opportunity	Description	Application Date	Timeline to Funding Availability	Who is Eligible to Apply?	Website
CPW Wetlands for Wildlife Grants	A voluntary, collaborative, and incentive-based program to restore, enhance, and create wetlands and riparian areas in Colorado. CPW annually seeks applications for wetland and riparian restoration, enhancement, and creation projects to support the goals of this program.	Due in February	June	Local governments, other state and federal land management agencies, tribes, non-profit habitat conservation organizations, and private companies.	Wetlands CPW

Closing Summary—A Shared Vision

The Yampa River is one of the last wild rivers in the Colorado River Basin, and its long-term health depends on the stewardship of the landowners, land managers, and practitioners who live and work along its banks. This Handbook has outlined practical, science-based actions that support both land management goals and the ecological integrity of the Yampa River system. Across all topics—erosion, flooding, fisheries, beaver coexistence, irrigation infrastructure, invasive plants, water quality and quantity, riparian planting, grazing, and habitat restoration—a central theme emerges: working with natural processes leads to durable, multi-benefit outcomes.

Healthy rivers rely on dynamic movement, functioning floodplains, diverse riparian vegetation, habitat complexity, and clean, cool water. Many of the most effective strategies highlighted in this guide are nature-based and low-cost: restoring riparian buffers, modifying grazing patterns, improving stream crossings, adopting fish-friendly diversion designs, enhancing stormwater infiltration, or installing beaver coexistence structures. When implemented collectively, these actions strengthen watershed resilience, reduce long-term maintenance costs, support agricultural productivity, and improve the quality of land and water for future generations.

Next Steps for Landowners

Landowners are encouraged to begin with a site visit from the Yampa River Stewardship Program to identify property-specific needs and opportunities. From there, developing a phased stewardship plan can help prioritize actions over time—balancing river health, agricultural operations, and infrastructure protection. Many beneficial improvements can be implemented quickly, while larger restoration efforts may be supported through numerous funding programs described in this Handbook. Collaboration with neighbors, conservation districts, and partner organizations amplifies impact and improves outcomes across property boundaries.

Looking Ahead

Future work in the Yampa Basin will be strengthened by expanding riparian reforestation, restoring secondary channels, modernizing irrigation and crossing infrastructure, supporting beaver activity where appropriate, improving aquatic connectivity, and increasing the use of low-tech, process-based restoration techniques. As climate and water availability shift, cooperative water management and wetland expansion will become increasingly important. Continued participation in the Yampa River Scorecard Project will help track progress and guide adaptive management.

A Shared Commitment

Every landowner's efforts—large or small—contribute to a healthier Yampa River. Protecting and restoring this river is both a responsibility and an opportunity: to sustain agricultural lands, enhance wildlife habitat, and ensure that the Yampa remains vibrant and resilient for generations to come. The Yampa River Stewardship Program is committed to supporting landowners and land managers to advance this collective vision for a thriving watershed.

Appendices

Appendix 1: Yampa Valley Riparian Forest Guide

Simplified Planting Palette

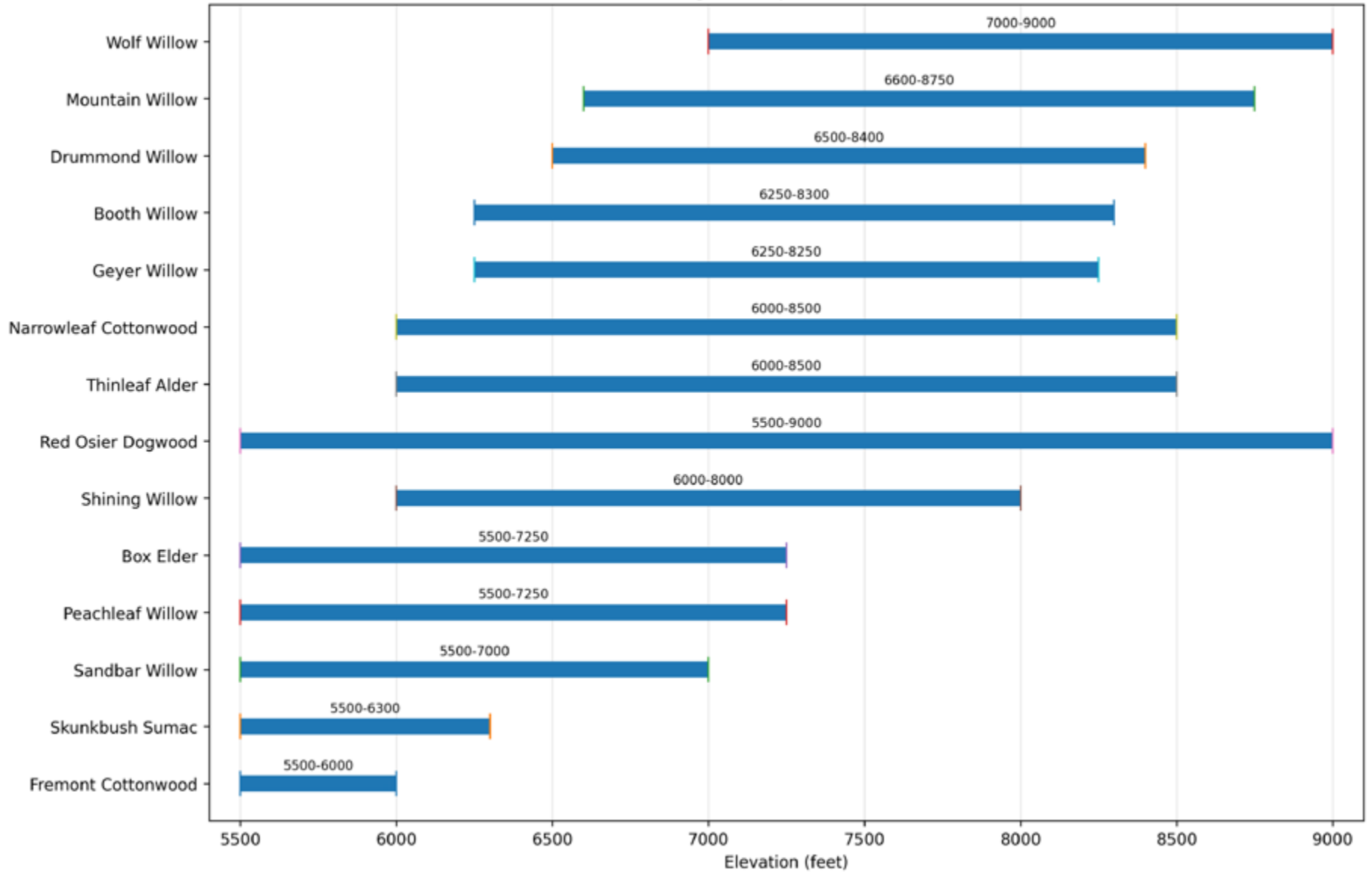
It is important to design a planting palette that is appropriate for the specific property. There is great variation of altitude, soil, and stream morphology throughout the Yampa Basin, and this guide presents six planting palettes to consider.

It is important to note that each location has its own site-specific characteristics and variations that may need to vary from these examples. It is advisable to contact the Yampa River Stewardship Program to consider a site-specific assessment into how these palettes may be modified for a specific location.

Elevation

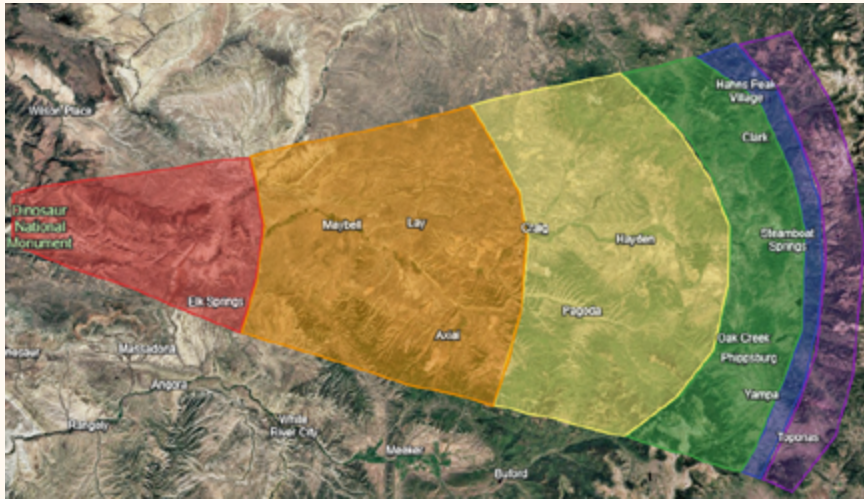
Different plants thrive at different elevations. Compare the project area's elevation to the chart on the following page. This can give an idea of the plant species that might be appropriate for the site. This is not a hard-and-fast rule, because many additional factors like soil, stream gradient, and aspect to the sun will also affect the plants that will thrive on the site.

Elevation Ranges of Riparian Trees and Shrubs

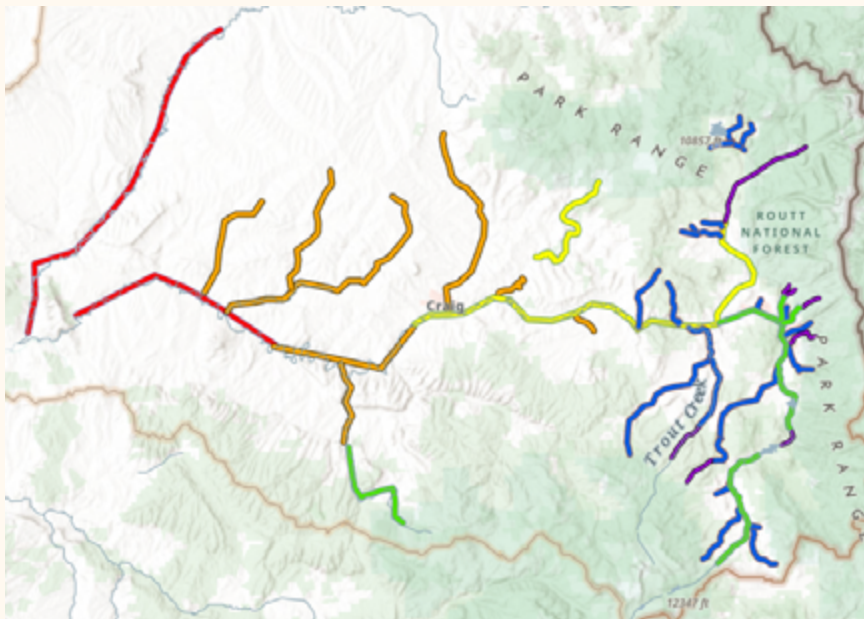


Plant Communities

This resource presents 6 different planting palettes for restoration projects on the Yampa and its tributaries. Consider the project site's location in the watershed and compare it to the following conceptual drawings. This will give a general idea of the palettes to explore. Be sure to look at several palettes to find the plant community that most closely matches nearby reference sites.



-  Coniferous Riparian Forest
-  Upper Valley Willow Shrubland
-  Narrowleaf/Alder Woodland
-  Narrowleaf/Dogwood Woodland
-  Sandbar Willow Shrubland
-  Freemont/Sumac Woodland



To find reference sites, look for intact areas of native riparian vegetation on or near the property. Find the chapter of this guide that most closely matches that plant community. The reference site can also potentially serve as the source location for restoration cuttings. It is sometimes advantageous to source restoration plant material from nearby instead of bringing plants from faraway sources.

Coniferous Riparian Forest



Photo By Roddy Beall, Zenobia Consultants

Coniferous or “evergreen” riparian forests are common in the headwater systems of Routt County, often in or adjacent to the Routt National Forest, where streams have steep gradients, and the substrate is coarse-textured (rock or cobble).

Elevation range: 7,700-12,000 feet

Plant Community Assemblage Suggestions:

- **Trees and Shrubs**

o Mixed Spruce and Fir species	10%
o Thinleaf alder (<i>Alnus incana</i>)	20%
o Mixed willow (<i>Salix drummondiana</i>)	30%
o Red osier dogwood (<i>Cornus sericea</i>)	20%
o Gooseberry (<i>Ribes inerme</i>)	5%
o Western snowberry (<i>Symphoricarpos occidentalis</i>)	5%
o Sarvisberry (<i>Amelanchier utahensis</i>)	5%
o Woods' rose (<i>Rosa woodsii</i>)	5%

- **Forbs/Grasses Seed Mix**

Common Name	Scientific Name	PLS lbs/acre
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	2.0
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.8
o Canada wildrye	<i>Elymus canadensis</i>	1.3
o Blue wildrye	<i>Elymus glaucus</i>	0.9
o Nebraska sedge	<i>Carex nebrascensis</i>	1.1
o Baltic rush	<i>Juncus balticus</i>	0.8
	TOTAL	7.9 lbs/acre

Restoration:

- Willows via dormant soaked pole plantings
- Alder via rooted stock
- Gooseberry, snowberry, sarvisberry, rose, or other shrubs via rooted stock
- Forbs and grasses via seeding or rooted stock

Upper Valley Willow Shrubland



Photo By Roddy Beall, Zenobia Consultants

Riparian forests dominated by willows are important for habitat, water quality, and increasing groundwater retention. The upper valley willow shrubland community is appropriate on gently-sloping montane floodplains in soils saturated from precipitation, irrigation runoff or return, hillside seepage, or impounded by log structures. Stream channels are wide and meandering.

Elevation range: 7,100-9,500 feet

Plant Community Assemblage Suggestions:

- **Shrubs**

- | | |
|---|-----|
| o Booth's willow (<i>Salix boothii</i>) | 20% |
| o Drummond's willow (<i>Salix drummondiana</i>) | 20% |
| o Geyer's willow (<i>Salix geyeriana</i>) | 20% |
| o Wolf willow (<i>Salix wolfii</i>) | 10% |
| o Shining or Pacific willow (<i>Salix lucida</i>) | 5% |
| o Thinleaf alder (<i>Alnus incana</i>) | 20% |
| o Woods' rose (<i>Rosa woodsii</i>) | 5% |

- **Forbs/Grasses Seed Mix**

Common Name	Scientific Name	PLS lbs/acre
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	2.0
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.8
o Canada wildrye	<i>Elymus canadensis</i>	1.3
o Blue wildrye	<i>Elymus glaucus</i>	0.9
o Nebraska sedge	<i>Carex nebrascensis</i>	1.1
o Baltic rush	<i>Juncus balticus</i>	0.8
	TOTAL	7.9 lbs/acre

Restoration:

- Flooding and siltation via low-tech process-based restoration and/or beaver establishment
- Willows via dormant soaked pole plantings
- Alder via rooted cuttings
- Rose via seeding or by hardwood cuttings, softwood cuttings, root suckers or layering
- Forbs and grasses via seeding

Narrowleaf Cottonwood / Thinleaf Alder Woodland



Photo By Roddy Beall, Zenobia Consultants

Deciduous-dominated forests and woodlands are common along narrow, fast-moving stream reaches in montane areas of Routt County. This community has an overstory dominated by narrowleaf cottonwood and an understory dominated by thinleaf alder.

Elevation range: 6,000-9,600 feet

Plant Community Assemblage:

- **Trees/Shrubs**

o Narrowleaf cottonwood (<i>Populus angustifolia</i>)	30%
o Thinleaf alder (<i>Alnus incana</i>)	30%
o Shining or Pacific Willow (<i>Salix lucida</i>)	10%
o Red osier dogwood (<i>Cornus sericea</i>)	10%
o Drummond's willow (<i>Salix drummondiana</i>)	5%
o Water birch (<i>Betula occidentalis</i>)	5%
o Quaking aspen (<i>Populus tremuloides</i>)	5%
o Sandbar willow (<i>Salix exigua</i>)	5%

- **Forbs/Grasses Seed Mix**

Common Name	Scientific Name	PLS lbs/acre
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	2.0
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.8
o Canada wildrye	<i>Elymus canadensis</i>	1.3
o Blue wildrye	<i>Elymus glaucus</i>	0.9
o Nebraska sedge	<i>Carex nebrascensis</i>	1.1
o Baltic rush	<i>Juncus balticus</i>	0.8
	TOTAL	7.9 lbs/acre

Restoration:

- Cottonwood via rooted stock or dormant soaked pole plantings
- Alder via fall seeding or rooted stock
- Willows via dormant soaked cuttings
- Dogwood via dormant soaked cuttings
- Forbs and grasses via seeding

Narrowleaf Cottonwood / Red Osier Dogwood Woodland



Photo By Roddy Beall, Zenobia Consultants

The narrowleaf cottonwood/red osier dogwood woodland is the flagship riparian community along the unconfined valleys of the Yampa and Elk Rivers. This community is characterized by high cottonwood cover, with a very diverse understory that is often dominated by dogwood but has significant variability and a number of locally subdominant species.

Elevation range: 5,400-8,700 feet

Plant Community Assemblage:

• Trees/Shrubs

- | | |
|---|-----|
| o Narrowleaf cottonwood (<i>Populus angustifolia</i>) | 20% |
| o Red osier dogwood (<i>Cornus sericea</i>) | 20% |
| o Thinleaf alder (<i>Alnus incana</i>) | 5% |
| o River hawthorne (<i>Crataegus rivularis</i>) | 5% |
| o Shining or Pacific willow (<i>Salix lucida</i>) | 5% |
| o Serviceberry (<i>Amelanchier</i> spp.) | 5% |
| o Woods' rose (<i>Rosa woodsii</i>) | 5% |
| o Quaking aspen (<i>Populus tremuloides</i>) | 5% |
| o Rocky mountain maple (<i>Acer glabrum</i>) | 5% |
| o Twinberry honeysuckle (<i>Lonicera inbolucrata</i>) | 5% |
| o Drummond's willow (<i>Salix drummondiana</i>) | 5% |
| o Chokecherry (<i>Prunus virginia</i>) | 5% |
| o Sandbar willow (<i>Salix exigua</i>) | 5% |
| o Boxelder (<i>Acer negundo</i>) | 5% |

- **Forbs/Grasses Seed Mix**

Common Name	Scientific Name	PLS lbs/acre
o Western wheatgrass	<i>Pascopyrum smithii</i>	1.8
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.3
o Canada wildrye	<i>Elymus canadensis</i>	1.0
o Basin wildrye	<i>Leymus cinereus</i>	1.0
o Thickspike wheatgrass	<i>Elymus lanceolatus</i>	0.8
o Fowl bluegrass	<i>Poa palustris</i>	0.5
o Nebraska sedge	<i>Carex nebrascensis</i>	0.8
o Baltic rush	<i>Juncus balticus</i>	0.5
o Creeping spikerush	<i>Eleocharis palustris</i>	0.3
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	0.2
	TOTAL	8.2 lbs/acre

Restoration:

- Cottonwoods via rooted stock or dormant soaked pole plantings
- Dogwood via dormant soaked cuttings
- Alder via fall seeding or rooted stock
- Willows via dormant soaked cuttings
- Forbs and grasses via seeding

Sandbar Willow Shrubland



Photo By Roddy Beall, Zenobia Consultants

Sandbar Willow (*Salix exigua*) is the dominant shrub in the important big valley sandbar willow shrubland community, primarily at lower elevations with sandy soils. This plant community thrives along river corridors that often flood or where sand bars are moving via erosion and deposition.

Elevation range: 3,400-6,200 feet

Plant Community Assemblage:

- **Shrubs and Trees**

o Sandbar willow (<i>Salix exigua</i>)	30%
o Fremont cottonwood (<i>Populus fremontii</i>)	10%
o Western snowberry (<i>Symphoricarpos occidentalis</i>)	10%
o Red osier dogwood (<i>Cornus sericea</i>)	10%
o Boxelder (<i>Acer Negundo</i>)	10%
o Skunkbush sumac (<i>Rhus trilobata</i>)	5%
o Silver buffaloberry (<i>Shepherdia argentea</i>)	5%
o Woods' rose (<i>Rosa woodsii</i>)	5%
o Golden currant (<i>Ribes aureum</i>)	5%
o Narrowleaf cottonwood (<i>Populus angustifolia</i>)	5%
o Peachleaf willow (<i>Salix amygdaloides</i>)	5%

- **Forbs/Grasses Seed Mix**

Common Name	Scientific Name	PLS lbs/acre
o Western wheatgrass	<i>Pascopyrum smithii</i>	1.8
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.3
o Canada wildrye	<i>Elymus canadensis</i>	1.0
o Basin wildrye	<i>Leymus cinereus</i>	1.0
o Thickspike wheatgrass	<i>Elymus lanceolatus</i>	0.8
o Fowl bluegrass	<i>Poa palustris</i>	0.5
o Nebraska sedge	<i>Carex nebrascensis</i>	0.8
o Baltic rush	<i>Juncus balticus</i>	0.5
o Creeping spikerush	<i>Eleocharis palustris</i>	0.3
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	0.2
	TOTAL	8.2 lbs/acre

Restoration:

- Removal of dominant invasives (Tamarisk, Russian olive, etc.)
- Willows via soaked cuttings
- Rosa via seeds, cuttings
- Cottonwoods via soaked cuttings
- Box elder via cuttings, rooted stock
- Forbs and grasses via seeding

Fremont Cottonwood / Skunkbush Sumac Woodland



Photo By Roddy Beall, Zenobia Consultants

At the watershed's low elevations, the dominant plant community is a woodland identified by Fremont cottonwood, generally in an open canopy woodland, with a variety of shrubs and grasses. These are low elevation floodplains on large streams with fine-textured substrate and year-round flow.

Elevation range: 3,400-6,200 feet

Plant Community Assemblage:

• Shrubs and Trees

o Fremont cottonwood (<i>Populus fremontii</i>)	10%
o Skunkbush sumac (<i>Rhus trilobata</i>)	10%
o Peachleaf willow (<i>Salix amygdaloides</i>)	5%
o Silver buffaloberry (<i>Shepherdia argentea</i>)	5%
o Boxelder (<i>Acer negundo</i>)	5%
o Sandbar willow (<i>Salix exigua</i>)	5%

• Forbs/Grasses Seed Mix

Common Name	Scientific Name	PLS lbs/acre
o Western wheatgrass	<i>Pascopyrum smithii</i>	1.8
o Slender wheatgrass	<i>Elymus trachycaulus</i>	1.3
o Canada wildrye	<i>Elymus canadensis</i>	1.0
o Basin wildrye	<i>Leymus cinereus</i>	1.0
o Thickspike wheatgrass	<i>Elymus lanceolatus</i>	0.8
o Fowl bluegrass	<i>Poa palustris</i>	0.5
o Nebraska sedge	<i>Carex nebrascensis</i>	0.8
o Baltic rush	<i>Juncus balticus</i>	0.5
o Creeping spikerush	<i>Eleocharis palustris</i>	0.3
o Tufted hairgrass	<i>Deschampsia cespitosa</i>	0.2
	TOTAL	8.2 lbs/acre

Restoration:

- Removal of dominant invasives (Tamarisk, Russian olive, etc.)
- Cottonwoods via dormant soaked pole plantings
- Willows via dormant soaked cuttings
- Sumac via root and softwood cuttings (most effective before freezing weather). Best seed germination is from fall and winter planting.
- Buffaloberry via seed, sown in mid-September or rooted stock

Appendix 2: Yampa River Scorecard Project

The Yampa River Scorecard Project is a long-term river health monitoring and evaluation program for the Yampa River Basin that rates the overall condition of different segments of the Yampa River and articulates results of the ecological health and function through a “scorecard” using 9 river health indicators. The Yampa River Stewardship Program supports projects that will lead to improvements in the Scorecard scores due to protection, restoration, and recovery.

River Health Indicators



FLOW REGIME

The pattern of water supply from the watershed. Represented by a hydrograph, the magnitude, duration, frequency, and timing of flows interact with the landscape to determine river functions. Flow regime is considered the “master variable” related to river health.



SEDIMENT REGIME

The production, transport, and deposition of sediment. Largely determines channel form and dynamics. An altered sediment regime can impact stream form and function, aquatic habitat quality, channel stability, and can damage infrastructure.



WATER QUALITY

The quality of water in a river segment. Influenced by natural geological processes and human activities (upstream land and water uses). Water quality supports recreational uses, ensures public health, and supports wildlife and fish habitat.



HABITAT CONNECTIVITY

Pathways for movement of aquatic wildlife up and downstream, and terrestrial wildlife to move through the channel, floodplain, and upland. Barriers include dams, fences, etc.



RIVERSCAPE CONNECTIVITY

The degree to which water can access and hydrate the surrounding riverscape and engage the valley bottom in fluvial processes. Reduced by hydromodifications, channel modifications, levees, riprap, drainage ditches, development, or fill.



RIPARIAN CONDITION

The degree to which riparian areas support river health and critical functions. Riparian vegetation mitigates the impacts of flood flows, stabilizes banks, provides habitat, shades the stream, and much more.



RIVER FORM

The river channel shape and geometry. Influenced by geology and hydrology, as well as floodplain uses like roadways or grazing. Riparian vegetation, woody material, and beavers improve channel form by altering hydraulics and erosional patterns.



STRUCTURAL COMPLEXITY

The degree of diversity of physical composition of a stream, like water depth/velocity patterns, bed and bank features (large wood, bars, backwaters, split flows, beaver activity), and substrate material. Complex physical structure is better habitat for aquatic species.



BIOTIC COMMUNITY

The health of resident aquatic biota including microbes, algae, aquatic plants and insects, fish, amphibians, and any other organism that is part of the aquatic biological community for all or part of its life.

The Yampa River Stewardship Program provides recommended practices or actions to address common concerns. Addressing the concerns on the left side of the table below in accordance with the recommendations of the Stewardship Program will likely lead to improved scores for the River Health Indicators across the top of the table.

River Health Indicators

	Flow Regime	Sediment Regime	Water Quality	Habitat Connectivity	Riverscape Connectivity	Riparian Condition	River Form	Structural Complexity	Biotic Community
Bank Erosion									
Beaver Coexistence									
Fisheries									
Flooding & Floodplains									
Invasive Plants									
Irrigation Infrastructure									
Riparian Forest & Buffer									
Stream Crossings									
Streamside Landscaping									
Streamside Livestock Grazing									
Water Quality									
Water Quantity									
Wildlife Habitat									

Concerns

Table 1. Implementing recommended practices and actions for concerns (left side of the table), will improve river health indicators(across the top of the table)

Appendix 3: Yampa River Desired Future Conditions

In February of 2025, the Yampa River Stewardship Program hosted an inclusive, targeted outreach campaign to landowners and practitioners directly responsible for the condition of the river. This involved three stakeholder meetings held in various locations throughout the Yampa Valley to illuminate a collective vision for the Yampa’s future. Across the top of the table below are Desired Future Conditions that were collectively identified through that community process. Addressing the concerns on the left side of the table below in accordance with the recommendations of the Stewardship Program will likely lead to advances toward the Desired Future Conditions listed across the top of the table.

Desired Future Conditions













































	Thriving Agricultural Lands Agricultural Lands	Water Quality and Quantity	Preserve Intact Natural Areas	Riverscape Connectivity – Harmonizing Land Use and Natural Flooding	Rehabilitate Historically Impacted Areas	Streamside Improvement – Riparian Condition and Wildlife Habitat Improvement – Riparian Condition and Wildlife Habitat	In-channel Improvement – Water Availability, Erosion, Passage, and Natural Complexity
Bank Erosion							
Beaver Coexistence							
Fisheries							
Flooding & Floodplains							
Invasive Plants							
Irrigation Infrastructure							
Riparian Forest & Buffer							
Stream Crossings							
Streamside Landscaping							
Streamside Livestock Grazing							
Water Quality							
Water Quantity							
Wildlife Habitat							

Table 2. Implementing recommended practices and actions for concerns (on the left side of the table), will promote desired future conditions (across the top of the table)