# Colorado Beaver Conservation and Management Strategy

Colorado Parks and Wildlife

Draft for Public Comment - November 2025

# Preface

The following article was published in several Colorado newspapers in the summer of 1902. The ecological benefits of beavers emphasized by Commissioner Harris early in the previous century are echoed today in this Strategy. May readers find inspiration in his vision for beaver restoration.

These ecological benefits, along with cultural and intrinsic values of beaver, have been understood and celebrated by Indigenous peoples for whom Colorado has been the traditional homelands since time immemorial, and who continue to play a vital role in stewarding natural and cultural resources statewide.

## WORK FOR BEAVERS

### PLAN TO UTILIZE THEIR DAMS

**Colorado Game and Fish Commissioner Believes that Beaver Dams Can be Made Valuable as Irrigation Reservoirs—Estimates that One Beaver Will Do as Much Work as a Man.**

Among the many waiting to see F.H. Newell, the chief of the geological survey, who is expected here this week to look over the Colorado field with a view to the establishment of national irrigation works, is Charles W. Harris. Colorado game and fish commissioner, says the Denver Republican of July 16th. Mr. Harris has a plan which he believes will spread the benefits of government aid over the entire Rocky mountain region.

"If the government will spend about $1,000,000 a year in the propagation and distribution of beavers, there will be plenty of water in every stream that comes down through the mountain valleys to the plains," said Mr. Harris last night.

"The beaver is an indefatigable dam builder. With trees and stones and mud he throws a barrier across a stream, which will resist the floods of spring, and all through the summer holds suspended several thousand gallons of water. This water is slowly seeping out through the bottom of the stream, under the dam, keeping the flow- constant all through the summer. All summer, too, the beaver is at work, making the dam thicker and higher and stronger. Now, if you have 1,000 beavers at work In a stream, building dams, the amount of water which will be stored

altogether will be enormous. And In the dry season, all this water goes down the stream. A small trickle may be coming down at the head of a chain of beaver dams, or there may be no water at all, but below the chain of ponds you will find a strong flow of water.

"Years ago there were millions of beaver in the mountains of Colorado, and no one ever complained of a shortage of water then, but the value of their pelts doomed them to destruction. There is a sufficient number of the animals left to form the basis of a comprehensive scheme for replenishing the supply. Let the government start beaver farms, and let it provide also for the protection of the beaver dams and the colonies along the streams, and it need not be long before there are beavers at work in every valley. Many of the mountain valleys, which were once a succession of grassy meadow's [sic], made by the beavers, are now dry gorges, and the fertile soil, which backed in behind the dam has all been washed away again. To establish a new colony in the new surroundings would require that the beavers be fed until they had framed their own environment, so to speak, and had the roots of rushes to fall back upon for a winter diet. But if the beavers were propagated on a beaver farm, they could easily be trained to subsist on alfalfa or potatoes. Human aid might also be extended, to a degree, in the building of their dams, to assure their strength. This done, the beaver would attend to the rest.

"I estimate that each beaver will do as much work in a year as a man could do in building dams and storing water. Now it would not cost more than $2.50 a head to raise the beaver. Their working life is about ten years. So for $2.50 the government can duplicate for ten years the work of a man. They can show no such result from any other plan that has been suggested, that I have heard of."

Mr. Harris is having a large number of photographs taken of the beaver colonies, which still remain in the state, showing how the water supply Is conserved, and he is collecting also the testimony of the men living along the streams which were once always flowing, but which have formed the habit of drying up since the beavers were exterminated. He believes he can make a convincing showing, and that his plan, which on the face of it may look chimerical, will in the end appeal strongly to the minds of the government experts.

*Source: The Antonito Ledger (Antonito, CO), 23 Aug. 1902. Colorado Historic Newspapers Collection. Colorado State Library.*

# Acknowledgements

Many staff from Colorado Parks and Wildlife (CPW) and other Colorado agencies were involved in the creation of the Beaver Strategy, including the Department of Natural Resources (DNR), Colorado Water Conservation Board, Division of Water Resources, and the Attorney General's Office (AG). We thank the CPW Beaver Working Group, which was composed of 26 CPW staff, 1 DNR, and 1 AG staff. We thank the CPW internal review team, which included the Beaver Working Group, as well as additional staff assigned by CPW's Executive Management Team, for their helpful edits and contributions to the final Beaver Strategy. We are also grateful for the participation of CPW property managers in a survey concerning beaver conflicts on CPW lands, for the valuable information they provided.

We are grateful for the teamwork and dedication of the "Core Team" of Beaver Strategy drafters. The Colorado Natural Heritage Program, including Sarah Marshall and Lee Grunau, provided organization oversight and technical expertise in beaver and wetland mapping and conservation. The Keystone Policy Center team, including Julie Shapiro, Brianna Brumbaugh, and Margaret McGuirk, facilitated weekly team meetings, the drafting process, and public and stakeholder engagement. Their commitment to objectively capturing all public and stakeholder values and interests related to beaver management shows through in this document. We thank Jackie Corday of Corday Natural Resources Consulting for the wealth of knowledge on beaver management planning, and for her drafting contributions in the Beaver Strategy.

The Beaver Strategy is a reflection of all of the thoughtful input we received through public scoping and stakeholder engagement, for which we are grateful. We thank the many people who have come before us conserving beaver in Colorado and across North America. We are grateful for Indigenous people who lived alongside beaver in the lands we now call Colorado since time immemorial. We are also grateful for the early efforts to restore beavers in the mid 20th Century by the Colorado Game and Fish Commission, and for their reports that provided valuable insight into historical beaver biology and management in Colorado. Several public figures have played a critically important role in elevating beaver conservation in the collective conscience of Coloradans, and we would like to specifically thank Sherrie Tippie for her pioneering work in this realm.

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# Executive Summary

## Introduction

Across the historical range of the beaver in North America, including Colorado, a major wildlife conservation movement is emerging to restore the species and its ecosystem benefits into formerly occupied habitats. As the state wildlife agency, Colorado Parks and Wildlife (CPW) has been actively managing beaver for many decades. Yet increasingly, CPW staff, stakeholders, and the public have expressed interest in CPW taking a more proactive role in beaver conservation and management.

The purpose of the Beaver Conservation and Management Strategy (BCMS, or the 'Beaver Strategy') is 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.**

## Strategy Outline

The Beaver Strategy provides a framework for greater leadership, coordination, and resources to support beaver conservation and management in Colorado. The Beaver Strategy is intended as a higher-level foundational document for beaver management, articulating major goals, needs, and recommended actions. It is not a detailed operational or implementation plan with specific action timeframes or budgets. The Beaver Strategy was informed by robust engagement with CPW staff and external stakeholders, experts, and the public.

The Beaver Strategy includes the following chapters:

**Chapter 1: Introduction and Purpose** introduces the need and background for the Beaver Strategy, describes the Beaver Strategy development process, and articulates Strategy values and visions of success.

**Chapter 2: Beaver Natural History and Ecology in Colorado** outlines the natural history and ecology of beaver in Colorado, along with cultural and intrinsic values, focusing on relevant information for beaver conservation, restoration and management.

**Chapter 3: Population and Habitat Status and Monitoring** presents historical and contemporary approaches to estimating beaver populations and the extent of beaver wetlands in Colorado, along with proposed new approaches.

**Chapter 4: Beaver Harvest Management** outlines current Colorado regulations on avocational harvest of beaver, reviews historic harvest data and significant changes in harvest management, provides information on other sources of beaver mortality, and recommends sustainable avocational harvest strategies.

**Chapter 5: Beaver Restoration Opportunities** outlines the need for beaver restoration in Colorado, along with methods and strategies for identifying and increasing the pace and scale of beaver restoration activities statewide.

**Chapter 6: Living with Beaver—Nonlethal Conflict Resolution** describes goals and strategies to support nonlethal approaches to human-beaver conflicts in order to maintain beaver benefits while resolving common problems (e.g. flooding roads, culvert blockage).

**Chapter 7: Translocation Policy and Protocol** summarizes the use of translocation in beaver conservation, and considers strategies and methods to optimize beaver translocation in support of beaver restoration goals.

**Chapter 8: Goals, Strategies, and Actions** summarizes future-forward approaches to each topic, as well as cross cutting needs.

## Strategy Goals

Chapters 3-7 each outline a single, major goal along with strategies and recommended actions to achieve the goal. The primary goals of the Beaver Strategy are summarized below:

**Overarching Strategy goal:** Increase beaver populations and beaver-occupied wetland habitats in Colorado until social or ecological carrying capacity is reached.

**Population and Habitat Status and Monitoring:** Improve knowledge of beaver wetland habitat and beaver populations in Colorado at multiple scales.

**Beaver Harvest Management**: Manage beaver populations for continued sustainable avocational harvest.

**Beaver Restoration Opportunities:** Support a thriving beaver population in Colorado by identifying opportunities and encouraging strategic restoration of ecologically and socially suitable historical, but currently unoccupied, beaver habitats.

**Living with Beaver and Nonlethal Conflict Resolution:** Promote the widespread adoption of nonlethal solutions to common beaver conflicts when such solutions are appropriate and feasible.

**Translocation Policy and Protocol:** Optimize translocation as a tool to support restoration objectives by providing a standard permitting process that maximizes translocation success while reducing the risk of disease and Aquatic Nuisance Species (ANS) spread.

Figure ES-1. A series of beaver ponds along a stream in the Uncompahgre National Forest, showing common beaver habitats including ponds and willow shrubland. Photo: Jackie Corday.

# Chapter 1: Introduction and Purpose

## Purpose

The purpose of the Beaver Conservation and Management Strategy (BCMS, or the 'Beaver Strategy') is 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 Beaver Strategy will guide CPW to achieve the purpose through strategic actions in collaboration with partners to support beaver-related restoration and coexistence implementation, improved data collection and mapping, and education, outreach, and capacity building. The Beaver Strategy will also provide guidance and structure for a variety of public and private partners and communities for their watershed health efforts. Further, the Beaver Strategy will interact with and support other statewide efforts relevant to beaver conservation and restoration, including Colorado's Water Plan, Colorado's Outdoors Strategy, the State Wildlife and Action Plan, and Colorado's Strategic Plan for Climate-Smart Natural and Working Lands.

## Need — Why a Beaver Conservation and Management Strategy, and Why Now?

- There has been a widely-recognized historic reduction in the beaver population in Colorado and across North America since European settlement. The reduction of beaver and beaver wetlands on the landscape has resulted in losses of ecological function in Colorado's watersheds, with negative ramifications for our people and ecosystems.
- Beaver management touches many diverse sectors in society, e.g., landowners and agricultural producers, local governments, stream and wetland restoration professionals, sportspeople, transportation managers, water users and managers, and wildlife advocates. Many Colorado residents with diverse interests and backgrounds care about beaver management.
- There is an increased level of interest in beaver management in Colorado recently, primarily due to increasing awareness of the importance of beaver as a keystone species. Many agencies and organizations are promoting beaver wetland

restoration to provide ecological benefits and ecosystem services, such as natural water storage, improved water quality, and flood, drought, and wildfire mitigation.

- Beaver activity (e.g., dam-building and tree-felling) sometimes creates conflicts with various human land, water, and transportation management objectives. There is a need to balance beaver restoration with these objectives, and to provide additional tools and resources to mitigate beaver conflicts.
- There is a need for a focused approach to beaver conservation and management that provides consistent perspectives, guidance, and well-defined strategies to implement in collaboration with our partners.

# Background

Across the historic range of the beaver in North America, including Colorado, a major wildlife conservation movement is emerging to restore the species and its ecosystem benefits into formerly occupied habitats.

- Restoration practitioners are increasingly using low-tech, process-based techniques (including beaver dam analogs) to reconnect incised streams to their floodplains, improve riparian vegetation, and increase habitat suitability for beaver to promote recolonization.
- Beaver are increasingly being live-trapped and translocated to mitigate conflicts and promote beaver establishment in unoccupied areas of their historical habitat.
- More efforts are being made to coexist with beaver, using techniques to prevent tree felling and culvert plugging, and to control pond levels preventing flooding of roads, trails, and agricultural lands.
- And, regulations for managing avocational harvest and the lethal take of beaver in conflict situations are being increasingly scrutinized.

As the state wildlife agency, CPW has been actively managing beaver for many decades.

- CPW implements beaver wetland restoration on its properties, and provides funding to external partners for these activities on other public and private lands.
- CPW addresses beaver conflicts on its properties by installing coexistence structures, translocating beaver, and occasionally using lethal control.

- CPW permits other public and private land manager-led translocations, and has assisted with holding beaver during translocation activities.
- CPW veterinarians investigate the causes of beaver mortality when unknown.
- CPW regulates the avocational harvest of beaver, including season dates, bag limits, and methods of take.
- Historically, CPW conducted research on beaver to better understand their ecology and to guide management.

Increasingly, CPW staff, stakeholders, and the public have had interest in CPW taking a more proactive role in beaver conservation. This Strategy provides a framework for greater leadership, coordination, and resources to support beaver conservation and management.

## Values

CPW manages beaver under the following value system:

- CPW values beaver as a keystone species and for providing multiple ecological and ecosystem services benefits.
- CPW values using science-based, data-driven approaches to beaver management.
- CPW values efforts to restore beaver and beaver wetlands.
- CPW values avocational harvest of beaver by sportspersons, and the sustainable use of beaver for meat, fur, leather, and glands.
- CPW values the important role that public and private land and water managers play in supporting wildlife and wetlands, and their ability to resolve beaver conflicts on their property.
- CPW values the broad array of stakeholders and interests in beaver conservation and management in Colorado.

These values, and extensive expert, stakeholder and public feedback, guided CPW's efforts in developing this Strategy.

# Overarching Goal

Increase beaver populations and beaver-occupied wetland habitats in Colorado until social or ecological carrying capacity is reached.

# Visions of Success

- Colorado has a thriving beaver population, and historical beaver wetland habitat is recovering.
- Beaver have been restored in many formerly occupied watersheds that contain adequate habitat.
- Watershed health has improved, increasing resilience to droughts, floods, and wildfire, and wetland habitat condition and biodiversity has increased.
- Stream-wetland corridor restoration efforts are targeted strategically to maximize successful recolonization by beaver and minimize conflicts with human infrastructure.
- Land and water managers and the public have a greater understanding of the value of beaver, and a greater desire for coexisting with them.
- Translocation of beaver is conducted selectively to minimize risks of pathogen transmission, while maximizing successful reestablishment.
- Abundant beaver and sustainable management strategies support avocational harvest without compromising restoration efforts.
- Networks of trained practitioners exist in all major watersheds to restore beaver and their habitat, and to provide rapid response to land and water managers experiencing beaver conflicts to assist with nonlethal solutions when feasible.
- State, federal, county, and municipal governments are working together and supporting nonprofits and diverse stakeholders and communities to promote living with beaver and the wetlands they create.
- Public and private land and water managers are engaged as key partners in beaver and wetland restoration.
- Lethal take of beaver causing conflicts is reduced by providing additional tools, resources, and assistance for public land managers and Colorado's working lands.

# Strategy Structure

The Beaver Strategy is intended as a higher-level foundational document for beaver management in Colorado, articulating major goals, needs, and recommended actions. It is not a detailed operational or implementation plan with specific action timeframes or budgets.

Each of the primary chapters (i.e., Population Status, Harvest Management, Restoration Opportunities, Living with Beaver, and Translocation Policy and Protocol) explores the relevant context and trends and concludes with a single, major goal followed by strategies and recommended actions to achieve the goal.

Additional information, resources, and tools are included as appendices to this Strategy.

# Strategy Development and External Engagement

## CPW Internal Working Group

CPW initiated this Strategy by first conducting intensive internal engagement with CPW staff on the topic of beaver management. Six internal working groups were formed, comprised of 26 staff from all major organization units. These groups included Population Status and Harvest Management, Restoration Area Prioritization, Translocation Policy and Protocol, Coexistence Best Management Practices, Research Needs and Prioritization, and Stakeholder Engagement and Collaboration.

These working groups met monthly from November 2024 through February 2025, generating more than 50 hours of productive discussions. These initial discussions were valuable in identifying how CPW could improve beaver management on its own lands and provide information for public and private land managers who are also interested in beaver-related restoration. The discussions were foundational in shaping priority topics for external expert, stakeholder, and public engagement.

## Scoping

### External Engagement

Recognizing the complexities of beaver management and the scope and scale of both the Beaver Strategy and the public engagement process, CPW leadership provided resources to hire external consultants to work with CPW staff on external engagement and Strategy drafting.

In April 2025, CPW contracted with the Colorado Natural Heritage Program (CNHP) at Colorado State University to provide overall management of the Beaver Strategy's development. CNHP is a valued interagency partner of CPW, and has successfully assisted CPW with developing other major planning initiatives, including the State Wildlife Action Plan and the Habitat Conservation and Connectivity Plan. In June 2025, CNHP enlisted the support of subcontractors to complete various tasks, including Keystone Policy Center to manage external engagement. A core team of CPW and CNHP staff and subcontractors was formed to lead the Beaver Strategy's development, with weekly meetings to date.

Initial external engagements were conducted during July – August 2025. Eleven sector-based focus groups were formed to provide feedback to shape the Beaver Strategy. These focus groups included Agriculture and Landowners, Beaver Advocates, Funders, Local Governments, Nuisance Wildlife Operators and Wildlife Rehabilitators, Sportspeople, Transportation and Infrastructure, Tribal and Indigenous, Water Users and Managers, Watershed Coalitions, and Wildlife and Conservation. Two-hour virtual meetings were held with each focus group, with the core team presenting background information and thought-provoking questions to guide the discussions. Primary topics were Population Status and Monitoring, Avocational Harvest Management, Restoration, Coexistence, and Translocation. Approximately 170 people participated in the focus group meetings. The PowerPoint presentation given during the meetings was shared with the attendees and posted on CPW's EngageCPW website.

Two additional cross-sector focus group meetings were held in September 2025 to share and test additional concepts, with representatives selected by the core team for their active engagement in the initial focus group discussions, and for their leadership within sectors.

Additionally, a Technical Advisory Team was formed to strengthen the scientific foundation of the Beaver Strategy. The Technical Advisory Team included public agency representatives from both within Colorado and other states. This team met three times during August 2025 with discussions focused on Restoration, Coexistence, and Translocation.

Finally, an EngageCPW web page was created to facilitate public feedback on the Beaver Strategy. The page contained background information on the Beaver Strategy, audio-visual recordings of the presentation used during focus group discussions, links to further information about beaver, and a comment form that was open from July 30, 2025 through August 31, 2025. More than 300 public comments were submitted through the form.

All Scoping Phase input is synthesized in written reports found in Appendix C of the Beaver Strategy.

### Tribal Engagement

Initial invitations to collaborate on the development of the draft Strategy were extended to the Southern Ute Indian Tribe and Ute Mountain Ute Tribe during the Scoping Phase. Additional outreach and engagement with the Southern Ute Indian Tribe and Ute Mountain Ute Tribe on the draft Strategy will be invited in this next phase of review leading to the final Strategy.

Additionally, a separate Tribal and Indigenous focus group was developed for purposes of capturing perspectives from other Tribes that have known historical presence in Colorado and American Indian/Alaskan Native and Indigenous populations currently residing in Colorado.

## Strategy Drafting

Scoping phase input significantly informed the development of the draft Strategy. This Strategy was written by the core team and reviewed by designated CPW staff members, including the Executive Management Team, before being released for public feedback during November – December 2025.

## Strategy Finalization

Draft Strategy feedback will inform the final Strategy, which will be released in late February 2026. Input received on the draft will be synthesized in a written report and included in Appendix C of the final Strategy.

Figure 1-1. Beaver in its native habitat along a stream in early winter. Photo provided by Colorado Parks and Wildlife.

# Chapter 2: Beaver Natural History and Ecology in Colorado

## Introduction and Chapter Purpose

This chapter outlines the natural history and ecology of beaver in Colorado, focusing on relevant information for beaver conservation, restoration and management. Beaver ecology sets the stage for each topic in the Beaver Strategy - from estimating historical vs. contemporary beaver populations to identifying and prioritizing beaver restoration sites and coexisting with beaver in diverse landscapes across Colorado.

## Beaver in Colorado

North American beaver (*Castor canadensis*) were historically abundant across Colorado, likely residing in every major watershed in the state and ecosystems from the mountains to lowland rivers and streams in the Great Plains and Colorado Plateau as they do today. Indigenous people have lived alongside and often relied on beaver and their habitats for ecological and cultural values for thousands of years in what we now call Colorado. The more recent colonization by European settlers in the 1800s fundamentally altered how beaver and humans lived together, dramatically reducing beaver numbers and habitats through trapping and land and water development in urban, mining, and agricultural areas (Naiman et al. 1988).

Only in recent decades has scientific research begun to document the magnitude of beaver habitat loss and the degree to which beaver create, maintain and otherwise influence the physical structure and ecological function of wetland and riverine habitats in Colorado and across their North American range (e.g., Naiman et al. 1988, Polvi and Wohl 2013, Castro and Thorne 2019). Many historical drivers of beaver habitat degradation persist today and have resulted in overall stream impairment statewide. In particular, stream and river disconnection from floodplains due to factors like flow alteration from dams, diversions, and roads, creates challenges for beaver returning to the full array of habitats they historically occupied. More recent causes of degradation include reduced stream flow in headwater streams from declining snow pack and drought, larger and higher intensity wildfires, loss of suitable forage through overgrazing by domestic and wild ungulates, and increased human-beaver conflicts with development in former riparian habitats.

# Beaver as a Keystone Species

In addition to their intrinsic and cultural values, beaver are considered a keystone species in modifying the hydrology, chemistry, physical structure, and species present in the wetland and riparian habitats they occupy (e.g., Naiman et al. 1986, Mills et al. 1993). Keystone species are those that have a disproportionate influence on an ecosystem, relative to their abundance (Power 1996). By constructing dams and lodges, and excavating ponds and canals, beaver slow the flow of water, create aquatic habitat, connect streams and rivers to their floodplains, and collect sediment and organic matter in the calmer water upstream of dams. Through their foraging activities, beaver fell and chew trees and shrubs, changing habitat structure and sometimes stimulating new growth of woody species such as willows and cottonwoods (e.g., Baker et al. 2005). When beaver abandon ponded habitats, shoreline habitat is often created for species like shorebirds and plants found on sandbars and mudflats.

Wetland habitats associated with, and modified by, beaver in Colorado include wet meadows, wetland-riparian shrublands, emergent marsh and open water ponds, and sand bars and shorelines (Figure 2-1). Other habitats influenced by beaver include aspen and wet spruce-fir forests in the mountains, along with cottonwood riparian forests at lower elevations.

Figure 2-1. Beaver-influenced wetland in the Roaring Fork watershed, showing common beaver habitats including willow shrubland, wet meadow, emergent marsh, and adjacent wet spruce-fir forest. Photo: Sarah Marshall 2019.

# Beaver Life History and Habitat Needs

Beaver are highly adaptable in the habitats they use in Colorado, from valley-wide wetland complexes in the mountains to ditches and canals in more developed areas. At times, their use of less desirable habitats like seasonal irrigation ditches results in conflicts with humans. In the habitats they select, beaver consume and use herbaceous wetland plants like sedges and cattails along with woody wetland and riparian plant species including cottonwood, aspen, willow, birch, and to some extent alder (Rutherford 1964). Gerwing et al. (2012) refer to beaver as "picky generalists" in their selection and avoidance of closely related willow species. When desirable plant species are limited, beaver will consume less preferred plants and incorporate a variety of found objects from pipes and lumber to branches and logs from species like pine into their dams and lodges. While beaver are best known for building dams using trees and large shrubs, they also use small shrubs, herbaceous plants such as cattails, and sediment in areas like the Great Plains where woody vegetation is sparse.

The relative proportion of dam-building and non-dam building beaver in Colorado is unknown and likely fluctuates frequently, with dam-building beaver typically modifying a more extensive area of surrounding wetland and riparian habitat. Beaver residing in bank dens along rivers, streams, ponds, and lakes still modify their environment through bank excavation and herbivory focused on woody plants like willows and cottonwoods as well as herbaceous wetland plants.

Upon settling in suitable habitat, beaver live in colonies of around 3-8 animals including breeding adults, kits (1st year juveniles), and yearlings (2nd year juveniles) that are typically related family members (Rutherford 1964, Sun et al. 2000). Colonies occupy connected aquatic habitats including a single pond or lake, reach of stream, or series of ponds. Within a colony's territory, beaver may use multiple lodges and bank dens during the summer, but converge into a single lodge or den with a food cache of partially submerged branches for the winter (Rutherford 1964).

Relative to other rodents, beaver have a low population growth rate due to small litter size, annual frequency of reproduction, and late age at reproductive maturity (3 years). Population matrix models have shown that kit and yearling survival is the most critical factor in population viability (Boyle and Owens 2007). Kits are also much more

susceptible to predation by bears, wolves, coyotes, mountain lions, bobcats, and domestic dogs.

Young beaver most commonly disperse to nearby habitat as two-year-olds, often traveling several kilometers downstream in the spring (Sun et al. 2000). Dispersal patterns may vary between male and female beaver, and sometimes include trips back upstream following initial downstream travel. Dispersal is also when many human-beaver conflicts happen, as beaver are searching for and establishing their new territory.

Beaver require core habitat with standing water of sufficient depth (around 1 meter) to escape predators and safely travel between foraging areas, lodges, and dens. Additionally, beaver dispersal requires connected aquatic habitats upstream and downstream with sufficient surface water and food along rivers, streams and other waterbodies. In the absence of deep enough standing water in ponds, lakes, and rivers, beaver excavate canals and construct dams and ponds to slow the flow of water along stream reaches and valley bottoms with gentle slopes.

While beaver occupy core habitat associated with deeper water, they forage for food and construction materials at distances up to 100 meters from water, influencing the structure and composition of the tree and shrub canopy of adjacent forests (e.g., Rutherford 1964). Beaver herbivory on willow, aspen and cottonwoods may be complicated by wild ungulate and domestic livestock grazing and browsing, which can reduce both the available woody vegetation for beaver and the recovery of woody riparian and wetland vegetation (Baker et al. 2005, McColley et al. 2011).

## Habitat for Priority Wildlife Species

As a keystone species, and in creating their own habitats, beaver support numerous wetland and riparian plant communities and wildlife species. Beaver are considered a priority species for the CPW Wetlands for Wildlife Program, and provide habitat benefits for a host of priority aquatic and terrestrial wildlife species included in the most recent State Wildlife Action Plan (SWAP 2025). A list of Tier 1 and Tier 2 SWAP Species of Greatest Conservation Need (SGCN) known to use beaver habitats in Colorado is provided below.

- Various waterfowl species (especially Mallard; CPW Wetlands Tier 1) use beaver habitats during the breeding season and for stopovers during spring and fall migration.
- Southwestern Willow Flycatchers (Tier 1) breed and forage near beaver ponds in the San Luis Valley.

- Eastern Black Rails (Tier 1) are likely associated with beaver-modified emergent marsh wetlands in southeastern Colorado.
- Greater Sandhill Cranes (Tier 2) nest in beaver ponds in the central Colorado mountains.
- Barrow's Goldeneyes (Tier 2) use beaver ponds for breeding.
- Boreal Toads (Southern Rocky Mountain population; Tier 1) breed in mountain beaver ponds and use dams and lodges for winter hibernacula (Crockett 2023).
- New Mexico and Preble's Meadow Jumping Mice (Tier 1) use ponds and other wetland-riparian habitats maintained by beaver in their respective ranges in southwest and eastern Colorado (USFWS 2018, USFWS 2023).
- Northern Leopard Frogs (Tier 1) inhabit a suite of beaver associated habitats from ponds to wet meadows.
- Various bat species (Tier 1, 2) forage for insects, and drink from beaver ponds.

Beaver have more complex interactions with species such as the Tier 1 SGCN Cutthroat Trout, providing benefits and challenges to species management and recovery that are covered in greater detail in the Restoration (Chapter 5) and Translocation (Chapter 7) chapters.

## Beaver Ecology Informs Beaver Strategies

As a valuable member of Colorado's wetland and riparian ecosystems, beaver will continue to shape wetland and riparian habitats across our state in the future. While Colorado's current beaver population and extent of beaver habitats are likely a fraction of their historical extent and some lost or impaired beaver habitats will be difficult to recover under contemporary land use, water management, and climate conditions, there are still abundant opportunities for conserving and restoring beaver and their habitats statewide. In this Strategy:

- Beaver population estimates (Chapter 3) rely on the habitats beaver create as indicators of beaver activity at a statewide scale, but seek to refine the level of beaver occupancy vs. relic habitat features that may persist for many decades following beaver occupation (e.g., Laurel and Wohl 2018).
- Beaver restoration opportunities (Chapter 5) consider suitable beaver habitat characteristics and beaver dispersal alongside human activities to maximize the

ecological benefits of restoring beaver to habitats they once occupied across Colorado.

- Understanding beaver ecology, and documenting the full suite of remaining beaver-modified habitats helps us effectively live alongside, manage, and minimize human conflicts with beaver through coexistence (Chapter 6) and translocation (Chapter 7).

# Chapter 3: Population and Habitat Status and Monitoring

## Introduction and Chapter Purpose

This chapter presents historical and contemporary approaches to estimating beaver populations and the extent of beaver wetlands in Colorado, along with proposed new approaches moving forward.

## Context and Trends

Beaver were a historically abundant species in Colorado, and across much of North America. Beaver abundance in all of North America has been estimated at between 60 and 400 million individuals prior to European settlement (Seton 1929). The contemporary continental beaver population estimate has declined to between 6 and 12 million individuals (Naiman et al. 1988). Although the historical number of beaver in Colorado is not known, it is generally believed that long-term statewide trends mirror continental trends, and that the population in Colorado is greatly reduced from former levels.

Beaver populations and the habitats they create are dynamic. For example, some existing beaver wetlands are unoccupied, yet still provide beneficial ecosystem services improving watershed health. While estimating numbers of beaver is important, especially for managing avocational harvest, the extent of beaver wetlands is a more effective metric for gauging progress towards the primary plan goal of "an increasing trend in beaver populations and beaver-occupied wetland habitats in Colorado until social or ecological carrying capacity is reached."

Beaver wetland habitat estimates will directly feed population estimates (see below) needed for evaluating harvest rates, but ***CPW does not intend to develop abundance-based beaver population goals.***

## Methods for Estimating Beaver Populations

Numerous beaver population estimation methods have been employed across their North American range. These techniques have varied based on the spatial scale of inference, available technology, and aircraft. If projects involve marking individual beaver, it is possible to estimate numbers via mark-recapture techniques (Mayer et al. 2020).

Larger-scale investigations have used aerial survey protocols in various fixed-wing aircraft to count active beaver lodge numbers (e.g., Johnston and Windels 2015). These surveys rely on observer detection of fresh food caches or fresh mud on each lodge from about 200 m above the ground. Fixed-wing aircraft tend to be more useful in linear or transect-based surveys. Helicopters can also be used more efficiently for aerial observations of active food caches. Kohn and Ashbrenner (1995) used a helicopter, quadrat-based survey approach to detect active colonies within randomly-selected areas. As with most lodge or dam complex survey techniques, these approaches tend to underestimate bank-denning beaver. Aerial survey techniques can be expensive, and are generally not employed at scales larger than national forests (e.g., Beck et al. 2008).

As drone, computer and camera technology have continued to improve, both remote-sensing and video-based assessment of beaver colonies and evidence of recent beaver activity have shown promise in replacing aspects of manned aerial applications (Puttock et al. 2015) and can supplement ground-truthed observations (Fairfax et al. 2023, Marshall et al. 2024, Wan et al. 2025).

## Historical Surveys and Estimates of the Colorado Beaver Population

Formal, ground-based beaver surveys in individual stream segments around the state began as early as 1939 (Colorado Game and Fish Commission 1941). The objectives of these surveys were to assess the present population, vegetative conditions, carrying capacity, and the numbers of beaver to be “cropped” (i.e., lethally trapped or translocated) or numbers to be “planted” (i.e., reintroduced via translocation). Detailed notes and field maps of habitat conditions and beaver colony locations are available in these historical accounts, which may prove useful for future watershed assessments of beaver restoration potential. In 1941, Colorado’s State Game and Fish Commission director announced “not an estimate, but an actual count” of between 48,000- 50,000 beaver based on results of these surveys (Rocky Mountain News 1941).

By the 1950s, fixed-wing aircraft were being employed for these beaver stream surveys. Colony detections were compared among different aerial observers, and between aerial and ground observations. Limitations of the aircraft-based technique were identified (Swope 1954, Hay 1955, Hay 1958).

Collaborations between the Colorado Cooperative Wildlife Research Unit at Colorado State University and the Colorado Game and Fish Department focused on beaver

productivity and habitat use in three distinct regions of Colorado (plains, northwestern mountains, and southwestern mountains). Researchers used trapping data from 39 mountain colonies to estimate an average number of beaver per colony. The researchers also ranked beaver carrying capacity based on primary mountain habitat types (aspen and willow) and the condition of woody vegetation in terms of canopy coverage and height, growth rate, and health (Rutherford 1964).

By the 1960s, the Colorado Department of Game, Fish and Parks had developed a statewide range map for beaver in its Long Range Management Plan for Game Species (Rutherford 1965). In this document, Rutherford states, "It is known that a population estimate of 60,000 beaver is very much on the conservative side," but no documentation for this number was presented. Intensive efforts to inventory beaver populations and habitats subsided after the 1960s.

## Mapping Beaver Wetlands

To date, the National Wetland Inventory (NWI) is the most comprehensive map of beaver-occupied wetland habitats across the United States. Commonly mapped beaver habitats in the NWI include ponds with standing water, former ponds with exposed sediment or vegetation, and floodplain shrublands and wet meadows supported by an elevated water table or flooding from beaver dams and ponds. In Colorado, the NWI includes around 50,000 acres of beaver-modified wetlands mapped over the last four decades.[1] Many of these wetlands are concentrated in the mountains, where NWI mapping has typically not been updated since the 1970s and 1980s (Figure 3-1). Beaver also inhabit streams, ponds and lakes across the state where recent mapping is limited to local and community science data collection (e.g., iNaturalist).

[1] Using the beaver modifier in NWI mapping, which is applied to beaver ponds and associated wet meadow, shrubland, and exposed sediment wetlands. Mapping data available at: *https://www.fws.gov/program/national-wetlands-inventory/wetlands-data*

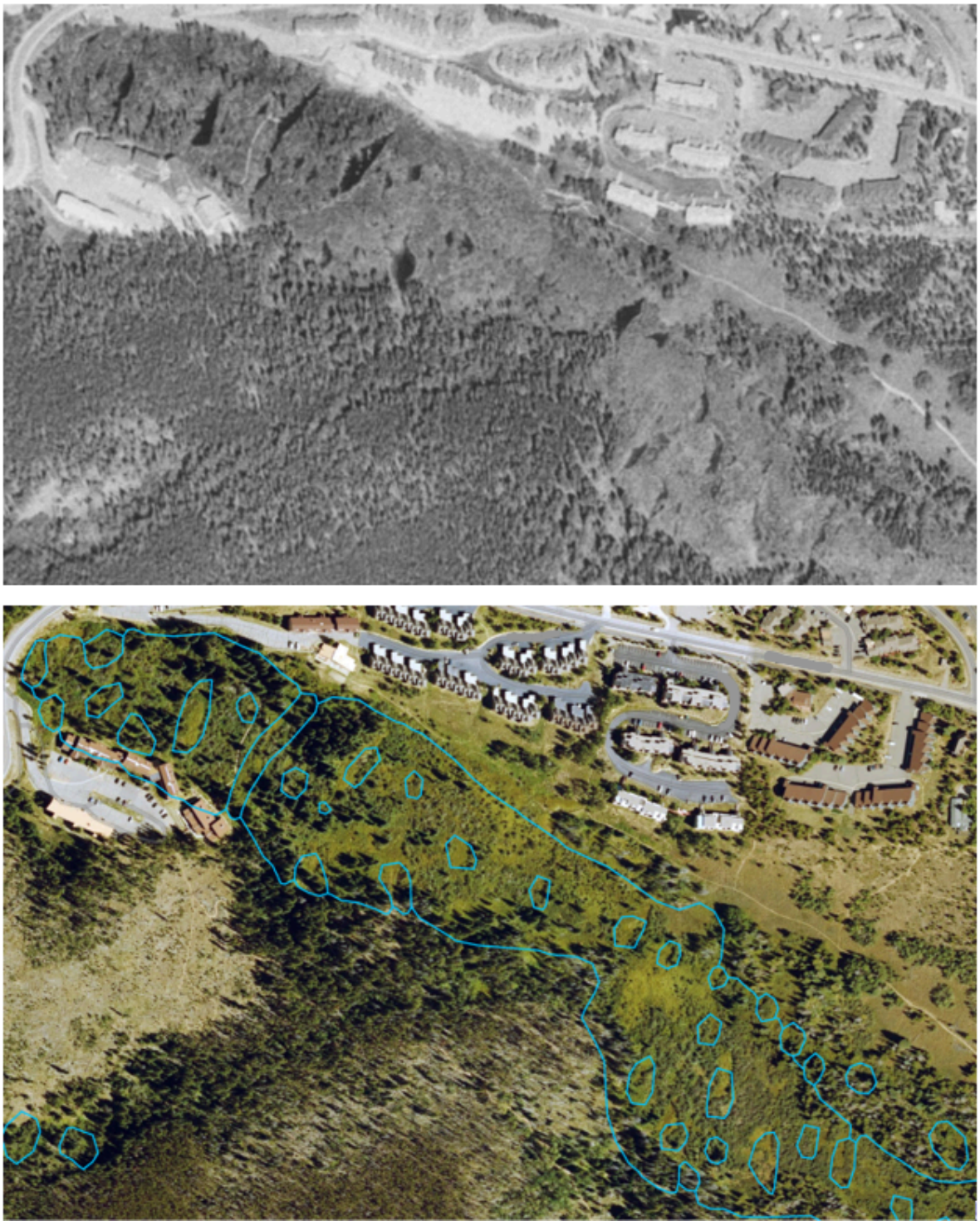


Figure 3-1. Historical beaver wetland complex in the Blue River watershed, showing beaver-modified wetlands in imagery from 1999 (above) and 2023 (below). The 2023 image includes the most recently updated NWI wetland mapping from 1983 (wetland boundaries shown in blue), and shows the loss of beaver ponds and transition to a drier willow shrubland in the absence of beaver activity for more than a decade.

Existing and relic beaver ponds are often identifiable in aerial (typically National Agricultural Imagery Program, or NAIP, for the NWI) and satellite imagery, allowing wetland mappers and modelers to map beaver ponds and associated wetlands across large geographic regions with less time and effort than the original manual NWI mapping (e.g., Marshall et al. 2024). Recent beaver pond modeling in the Colorado Beaver Activity Mapper (COBAM) has shown that around 90% of Colorado's beaver ponds are in the mountains, with the highest concentration of ponds located west of the Continental Divide in the headwaters of the Colorado River (Figure 3-2). Comparing COBAM data with the NWI, there are more than 25,000 acres of mapped beaver-modified wetlands that have not been occupied by beaver in the past decade. These acreage estimates are likely low compared with the extent of beaver habitat prior to the 1800s.

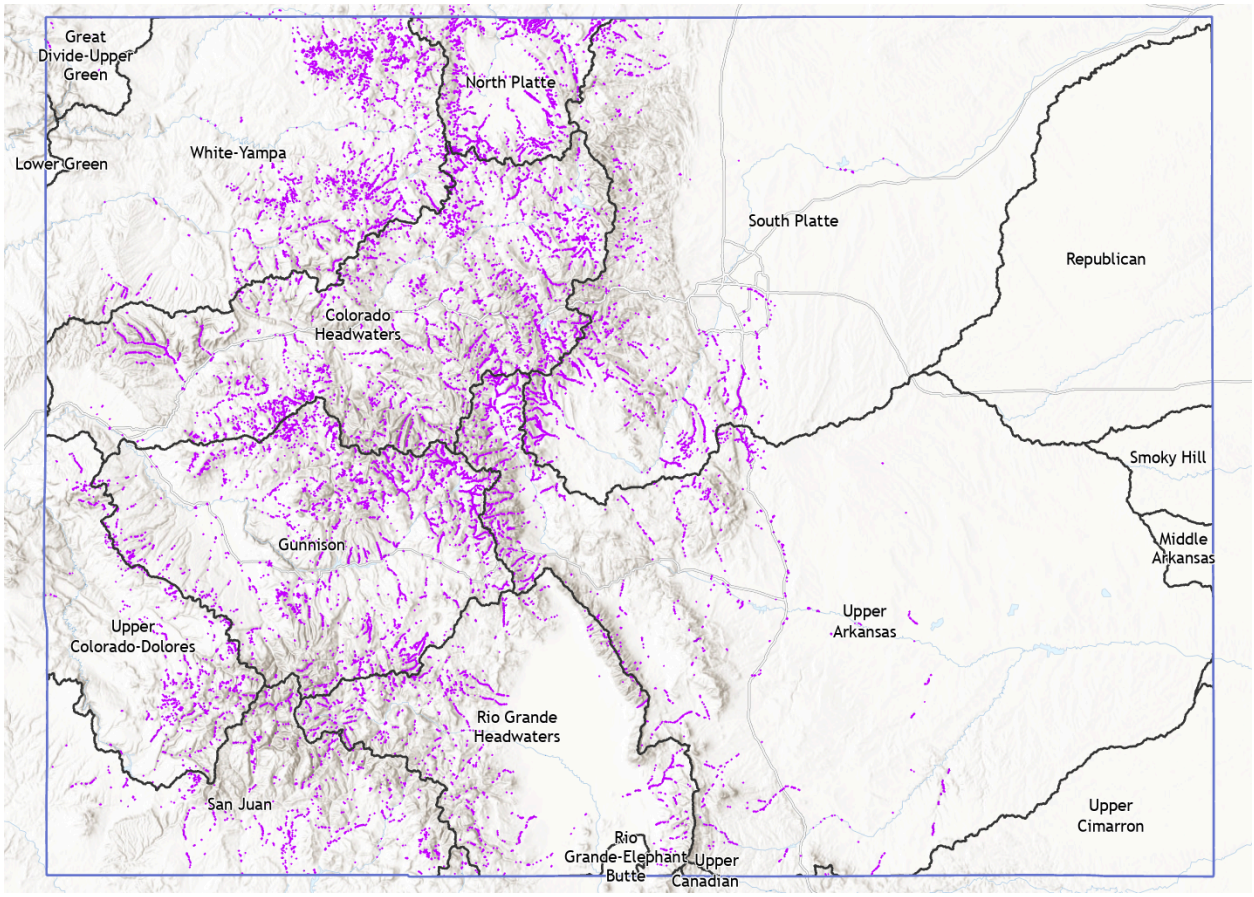



Figure 3-2. Distribution of recent (2013-2021) beaver habitats (shown in purple) associated with dams and ponds across Colorado, using pond data from the Colorado Beaver Activity Mapper and U.S. Geological Survey 4th level Hydrologic Unit Code (HUC4) watersheds for reference.

# Contemporary Beaver Population Estimation and Trends

While occupied suitable habitat provides a proxy for the level of beaver activity, estimating how many beaver reside in watersheds across Colorado can help inform broader beaver habitat protection and harvest management. Recent work to map beaver ponds across Colorado provides an opportunity to estimate the size of the statewide beaver population by combining previous population studies with contemporary beaver distribution. This estimate is a coarse approximation with opportunities for future research to better understand how beaver occupy habitats across Colorado (e.g., recent beaver activity inventories in the White River National Forest detailed in Ramey 2024).

In support of this Strategy, CPW used recent (2021) statewide beaver pond mapping from the COBAM to estimate the population of dam-building beaver in Colorado. This is by nature a conservative evaluation, as bank-dwelling beavers aren't considered at all in this projection.

COBAM identifies 77,776 beaver ponds totalling 47,060 acres (including a 30 m buffer around ponds) in 2021, the most recent year for which beaver ponds have been mapped. We assumed that 65-85% of these ponds were currently occupied by beaver (CPW biologists pers comm.), and that there were 1.4-1.6 beaver per occupied acre of beaver ponds and associated foraging habitat, based on a Colorado-based estimate of 1.5 beaver per acre (MacDonald 1956). This yielded a current estimate of dam-building beavers in Colorado of **53,000 with a range of 43,000 - 64,000.**

CPW recognizes that this estimate is based upon a dearth of recent field data. Future efforts will focus on refining both the occupancy and beavers per acre estimates. This could include community science initiatives to estimate occupancy as well as funding field studies to investigate relationships between fall food cache occurrence and beaver density in Colorado beaver dam colonies. This will be most useful for informing assumptions about mountain, or higher elevation beaver populations, with data on eastern plains and bank-dwelling beavers remaining as an additional need.

A detailed description of the methodology used, limitations, and assumptions made in developing this estimate will be provided in an appendix in the final Beaver Strategy. The actions outlined in this chapter also include data collection needs to further refine the statewide population estimate.

# Monitoring Colorado's Beaver Habitat and Populations Moving Forward

To achieve the goals in this Strategy, it will be critical to refine existing information and obtain new information on:

- **The spatial extent of beaver wetlands**. This will be the baseline metric to gauge progress on the primary Strategy goal, ***"An increasing trend in beaver populations and beaver-occupied wetland habitats in Colorado until ecological or social carrying capacity is reached"*** (see Chapter 1 Introduction). This information will also be used to calculate occupancy rates (see below), and to help estimate the size of the beaver population.
- **The spatial extent of potentially suitable beaver habitat.** This will be used to calculate occupancy rates (i.e., percent of suitable habitat recently occupied, McKenzie et al. 2006) of smaller watersheds. Some potentially suitable habitat may not have been occupied for decades or even centuries. Occupancy rates will be useful as one variable for prioritizing watersheds for future restoration efforts (see Chapter 5, Beaver Restoration Opportunities), for establishing occupancy targets for individual watersheds, and for prioritizing conservation actions. For example, watersheds with high occupancy rates may warrant **habitat protection** efforts, whereas watersheds with low occupancy rates may warrant **habitat restoration and/or beaver reintroduction** efforts.
- **The estimated number of beaver**. This information is needed primarily to calculate a harvest cap for each larger watershed (see Chapter 4, Beaver Harvest Management).

# Goals, Strategies, and Actions

**Goal: Improve knowledge of the extent of beaver wetland habitat and beaver populations in Colorado at multiple scales.**

**Strategy 1: Estimate the spatial extent of beaver wetlands and beaver population size** at the statewide and major watershed scales (HUC4; see Figure 3-2.).

**Actions:**

- Update and refine ongoing statewide beaver wetland mapping using remotely sensed data, and display in the online Colorado Beaver Activity Mapper.

- Refine estimates of the number of individuals per complex and bank-denning beaver using techniques such as fall food cache studies.
- Combine refined beaver habitat mapping and population estimates to reassess statewide beaver population projections every 5-10 years based on new data.

**Strategy 2: Estimate beaver occupancy** (proportion of recently occupied suitable habitat) statewide, and at smaller HUC10 watershed scales.

**Actions:**

- Develop an occupancy monitoring approach with ground-truthing of fall food caches.
- Collaborate with partners and volunteers to implement pilot occupancy monitoring in 2-3 HUC10 watersheds using fall food cache studies.

# Additional Resource Needs

A more diversified funding partnership will be needed for long-term, operational funding for beaver habitat mapping and estimating populations. To date, CNHP has led fundraising efforts and has secured funds from state, federal and foundation sources. CPW should prioritize these efforts within its existing programs where possible and seek new funding streams and partnerships as needed. CPW is at staff capacity, so commitments to prioritize this new work would require an increase in staffing or the deprioritization of some current tasks.

# Chapter 4: Beaver Harvest Management

## Introduction and Chapter Purpose

Following several centuries of unregulated commercial exploitation as part of the fur trade, beaver populations in North America and Colorado began to increase in the 1900s. As numbers grew in the state, opportunities for regulated avocational harvest developed along with the need to address increasing human-beaver conflicts. Colorado Parks and Wildlife's (then Colorado Department of Game and Fish) game wardens in the 1950s were often charged with addressing human-beaver conflicts as a primary job duty. Avocational beaver harvest continues to play a role in reducing conflicts (International Association of Fish and Wildlife Agencies 2005, Association of Fish and Wildlife Agencies Furbearer Conservation Working Group 2019) as well as providing an opportunity for sportspeople to use beaver sustainably for fur, meat, oil, and leather.

This chapter will lay out the current regulations on avocational harvest of beaver in Colorado, which is the only type of human-caused beaver mortality over which CPW has primary jurisdiction. It will review historic harvest data and the significant changes in harvest management brought on through the removal of lethal trapping as a method of take via the passage in 1996 of Amendment 14. It will provide additional information on other sources of human and non-human causes of beaver mortality, along with recommended Strategies and Actions that could be implemented as part of the Beaver Strategy to continue to manage beaver for sustainable avocational harvest.

## Colorado Beaver Avocational Harvest Regulations

Beaver are managed as a hunted furbearer species by CPW. The current beaver avocational season is limited to between October 1 and April 30. There is no bag limit for daily or seasonal possession. Legal methods for avocational take of beaver are limited to hunting methods which are rifle, handgun, shotgun, airgun, handheld bow or crossbow, or live-trapping in a cage or box trap. Live-traps must be checked once per day and any beaver not released from the trap must be dispatched using one of the hunting methods previously described.

Beaver may be hunted from one-half hour before sunrise to one-half hour after sunset. Additionally, on private property, artificial light is allowed at night to hunt beaver with written permission from the landowner or agent. On public land, artificial light is allowed at night to hunt beaver with a permit from the local District or Area Wildlife Manager. Permits are valid for the time and place specified.

There are two licensing options for avocational harvest of beaver. A sportsperson can buy a furbearer license ($36.68 Resident and $101.54 Non-resident in 2025), which allows the take of beaver along with other furbearers during open seasons. Alternatively, those that have purchased a small game license (same fees as furbearer license in 2025), which allows the take of upland birds and waterfowl, may subsequently buy a Furbearer Harvest Permit ($10 Resident or Non-resident in 2025) which expands the harvest opportunities of the license holder to also include beaver and 15 other furbearer species. There is no distinction between hunting or live-trapping methods an avocational sportsperson can use based on license type. Colorado does not have a “trapping” license since harvest from live-traps is relatively low and there is no management need to differentiate between harvest categories.

## Changes to Management and Amendment 14

Beaver harvest levels in Colorado were historically much higher than they are today. In the 1960s, avocational trapping and hunting accounted for an annual harvest of 8,000 to 10,000 beaver, whereas estimates in the last few years suggest avocational harvest is near 1,500 beaver annually.

The most significant recent change in beaver harvest management occurred in 1996-1997 with the passage of Amendment 14 to the Colorado Constitution. Amendment 14, approved by voters in November of 1996, prohibited the use of most types of traps for furbearers, including body-gripping traps for beaver, commonly-known as “conibears”. Prior to the removal of this trapping tool, beaver harvest had been regulated through the use of drainage-specific harvest quotas and beaver trapping permits for public lands. The rationale for these beaver permits was to inform CPW managers about who was trapping and to distribute harvest geographically. Given the impracticality of widespread use of beaver live-traps as the only legal trapping method of beaver, expectations were that harvest would continue to decline after 1996. Live traps for beaver are quite expensive, are very heavy and don’t work well in conditions with frozen water. For these reasons, beaver regulations were changed in 1997 to eliminate drainage quotas and permits statewide, as concerns over beaver over-exploitation no longer existed given the restrictions under Amendment 14 .

# Historic and Current Beaver Harvest Data

Avocational take of Colorado's beaver has declined over the last 70 years (Figure 4-1). Annual per hunter/trapper take was historically in the 10-20 beaver per year range and has now declined to about 2 beaver per year for each hunter/trapper that pursues them.

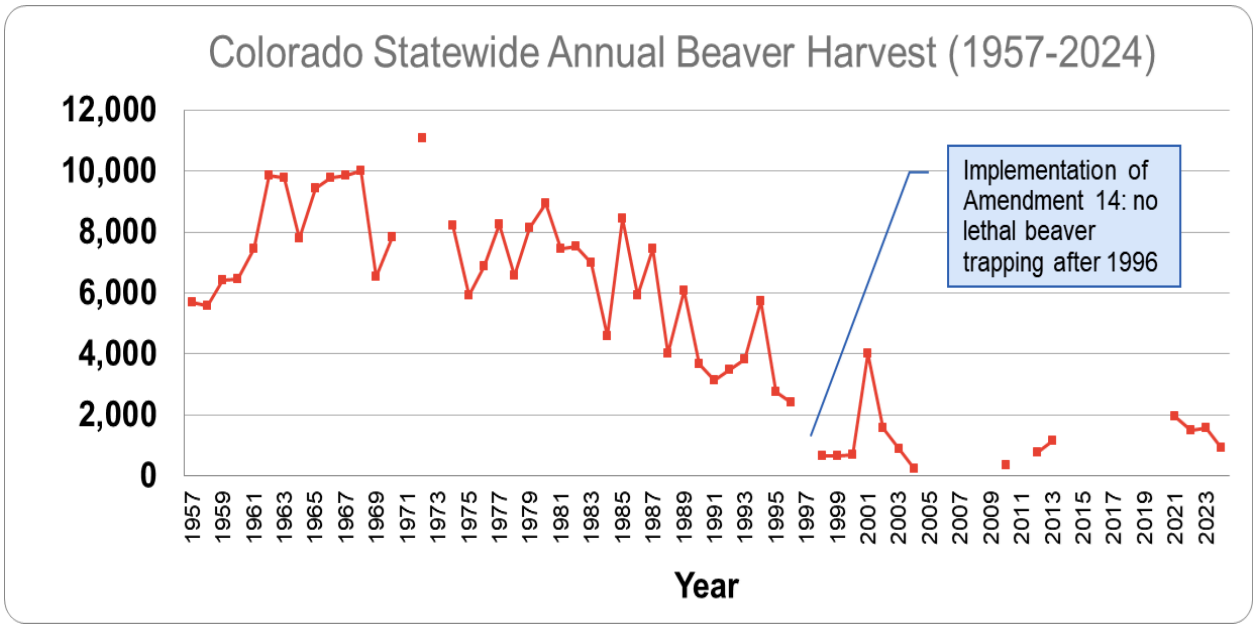



Figure 4-1. Colorado annual beaver harvest 1957-2024. Reports from 1992-1996 indicate "trapping only". Harvest surveys not conducted in 2005-2009, 2011, 2014-2020.

## Beaver Harvest Estimates under the Furbearer Harvest Permit

In 2021, CPW revised the methodology used in the annual sampling of hunters for the Furbearer Harvest survey. This survey has traditionally included questions on beaver harvest which continued to be included under the new sampling design. Every hunter holding either a furbearer harvest permit or furbearer license is included in this survey. During this survey, hunters are contacted via email, text messages, and live-operator phone calls, with up to three follow-up contacts to minimize non-response bias. Response rates since 2021 have ranged from 39 to 53%. In 2023, the survey was refined to quantify beaver harvest based on land ownership (i.e., public vs. private). Figure 4-2 presents the estimated annual statewide avocational beaver harvest derived from these surveys, including the subset of beaver taken on public land in 2023 and 2024. These estimates are thus extrapolated from the data collected. The estimates do not account for beaver taken

as "nuisance" species under Colorado Department of Agriculture (CDA) regulations on private property.

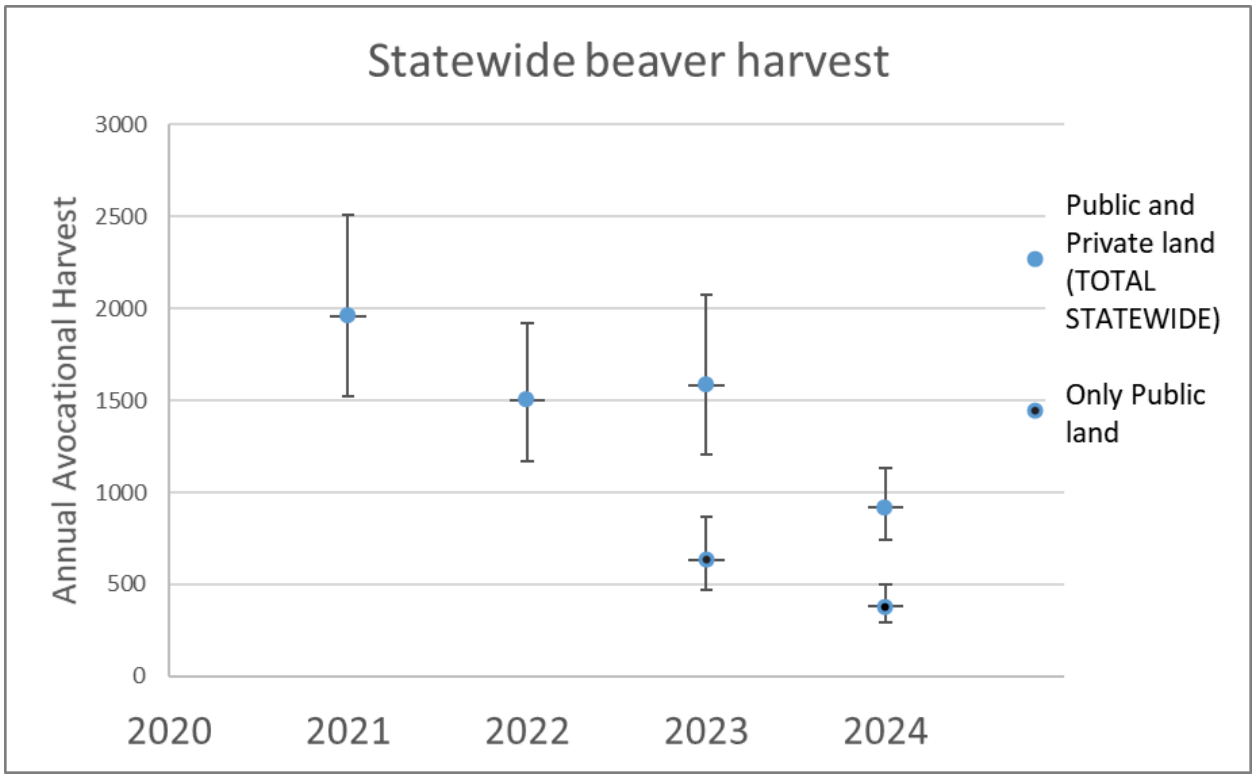



Figure 4-2. Colorado annual avocational beaver harvest based on 2021-2024 Furbearer Harvest Permit sampling to estimate furbearer harvest and associated 95% confidence intervals.

Colorado's estimated avocational beaver harvest was approximately 1600 and 900 animals in 2023 and 2024, respectively (Figure 4-2). Of that statewide total, approximately 630 (39%) and 380 (42%) of harvested beaver were taken on public land in 2023 and 2024, respectively. When scaled against a rough current population projection of 43,000-64,000 dam-building beaver in Colorado, statewide avocational harvest rates are a fraction of sustainable potential.

Annual sustainable harvest rates, driven by the tool of lethal trapping, are frequently reported in the literature as exceeding 20% and often closer to 30% (Bailey 1954, Payne 1984, Novak 1987). Therefore an annual harvest rate of under 20% could be seen as a conservative level not shown to reduce populations (Runge 1999). Colorado's estimated 2-4% statewide avocational harvest rate is much lower than the conservative 20% threshold seen in the literature.

# Other Human Sources of Beaver Mortality and Associated Regulations

Lethal trapping is often cited as the leading human cause of beaver mortality. Because lethal trapping is not a legal avocational pursuit in Colorado and other methods of avocational beaver harvest appear to be very low statewide, it is likely that other human and non-human factors outside of avocational take are greater sources of beaver mortality in Colorado.

While the Beaver Strategy proposes changes to Colorado's avocational harvest regulations or monitoring metrics, the regulatory, statutory, and management authority over individual beaver conflicts with humans falls under several other agencies, including CDA, Colorado Department of Public Health and Environment (CDPHE), and county human health departments.

## Lethal Take of Beaver Causing Damage on Private Land

Title 35, Article 40, Sections 100-207 outline the responsibilities of the CDA's Commissioner regarding "depredating animals," which in this context include beaver. The agency's responsibilities are similarly laid out in CDA Animal Industry Division's rule 8 in the Code of Colorado Regulations (CCR) 1201-12.

Pursuant to Colorado Revised Statutes (CRS) 33-1-106, 33-3-103, 33-3-106, 33-4-101.3, 33-6-107, 33-6-207(3), 33-6-208, 35-40-100.2 through 115, CCR 8 1201-12, and Section 12, Article XVIII of the Colorado Constitution, agricultural producers have the right to control depredating animals, meaning animals that pose a threat to an agricultural product or resource. Landowners may control animals themselves or they may identify a designee. This means that private landowners can lethally take beaver, using legal avocational methods, year-round as necessary to protect private property. There are no reporting requirements or permitting needed for beaver taken under these provisions.

## Exemptions to Amendment 14

A small series of exemptions to Amendment 14 are provided in Article XVIII, 12B of the Colorado Constitution and 8 CCR 1201-12, 3.00 -7.00. These provisions allow for the use of foothold, cable-restraint, and, most applicable to beaver, body-gripping traps under very specific circumstances. Beaver may be lethally trapped when trapping is done in accordance with the provisions of CRS 33-6-204 (General Exemptions); 33-6-205

(Exemption for Departments of Health); 33-6-206 (Nonlethal Methods Exemptions); or 33-6-207 (Exemptions for Protection of Crops and Livestock). Historically, CPW has issued "30-day lethal take" permits to landowners under the Exemptions for Protection of Crops and Livestock provision, with recent reported annual beaver mortality being about 70-90 beaver statewide. Presently, per Amendment 14, landowners are required to notify CPW of their intent to exercise the 30-day trapping exemption but there is no reporting requirement.

## CPW-property Survey on Beaver Conflict and Mortality

In advance of developing this Strategy, the agency conducted an internal survey to gather input from staff involved in managing CPW properties (Appendix A). This survey was emailed to appropriate CPW staff in early April 2025 to better understand who in the agency interacts with beaver and how each CPW property manager handles beaver management responsibilities. Surveys were conducted via Google Forms with one response requested for each Area (managing State Wildlife Areas), Park, or Hatchery. Fifty responses were submitted by the deadline from across 17 Areas, 17 hatcheries, and 16 State Park complexes, giving a fairly broad range of CPW properties to evaluate. Extrapolating from these results, a reasonable estimate is that around 90 beaver are lethally removed annually from CPW properties experiencing human-beaver conflicts.

## Beaver Mortality Associated with Roads and Transportation Infrastructure

Human transportation infrastructure can cause beaver mortality in several ways. One would be via lethal removal used by state transportation departments, and county or local municipal road and bridge departments to address safety issues associated with road flooding and blockage of water passage at road and highway crossings. Secondly, beaver, like all wildlife, can also be hit by vehicles when roads and beaver habitat adjoin. Overall mortality contributions from road deaths in two European studies are cited by Rosell and Campbell-Palmer (2022) as representing 16% -37% of total beaver mortality events, so in some cases, vehicle strikes may be a significant source of mortality. Colorado Department of Transportation (CDOT) collects data on beaver mortalities observed along state highways and has reported a statewide total of fewer than 10 beaver mortalities each of the last 2 years. These data however are very likely an undercount and only represent reports to CDOT maintenance staff or Colorado State Patrol

# Non-human Causes of Beaver Mortality

Research on predation impacts to beaver populations has been mixed with some studies showing impacts at local scales (Baker and Hill 2003) and others showing no effects at larger population scales (Boyle and Owens 2007). In Colorado, predators of beaver include wolves, coyotes, black bears, North American river otters, Canada lynx, bobcats and mountain lions (Dietland Muller-Schwarze 2011, Novak 1987). While currently low in numbers in the state, wolves are identified as a significant predator on beaver in a number of studies (Dietland Muller-Schwarze 2011, Novak 1987, Rosell and Campbell-Palmer 2022). However, even under estimated annual wolf predation rates of 38-42% during the ice-free part of the year, a Minnesota beaver population was able to increase (Gable and Windels 2018), likely bolstered by immigration. Mountain lion predation was the primary cause of mortality for translocated beaver in coastal Oregon (Petro 2013).

Several diseases can cause mortality in beaver, with tularemia being the most impactful. Novak (1987), Dietland Muller-Schwarze (2011), and Rosell and Campbell-Palmer (2022) provide a series of citations from the 1950-1980s, which described tularemia outbreaks as "decimating" and contributing to "substantial mortality" in local beaver populations. Tularemia is a bacterial disease that impacts a beaver's internal organs, almost always fatally. While disease dynamics may still not be fully understood, it can contribute significantly to beaver mortality on a local scale. More information is needed on the role of tularemia in regulating beaver populations in Colorado. While transmission to humans is uncommon, the disease is transmittable by handling or eating an infected beaver, drinking contaminated water, or being bitten by an insect carrying the bacteria.[2]

Numerous environmental factors can also impact beaver survival and mortality, including drowning during spring runoff (particularly for kits), other water fluctuations, starvation during winter and fall, or spring droughts (Henderson 1960, Rutherford 1964, Novak 1987, Johnson-Bice 2019, Rosell and Campbell-Palmer 2022). Stochastic events like a winter storm or even a falling tree (Vieira personal observation 1999, Rosell and Campbell-Palmer 2022) can impact an individual beaver or a colony.

# Tribal Governments and the Brunot Area

*This section is a placeholder pending further input from the Southern Ute Indian Tribe and Ute Mountain Ute Tribe on inclusion of and details of contents for this section.*

[2] This fact sheet prepared by the Minnesota Dept. of Health answers all the common questions about transmission and symptoms: Tularemia Fact Sheet - MN Dept. of Health

# Goals, Strategies, and Actions

**Goal: Manage beaver populations for continued sustainable avocational harvest.**

CPW currently conducts annual furbearer harvest surveys, resulting in beaver hunter numbers and beaver harvest estimates along with estimates of precision. For the last 2 years, these surveys have added resolution of harvest totals by public or private land. However, CPW has no information on the spatial distribution of that annual avocational harvest based on current harvest survey protocols. While beaver population and harvest projections at the statewide scale suggest that beaver harvest rates are minimal and almost an order of magnitude below maximum sustainable rates, it is very likely, but still unknown, if that low rate of harvest also holds true at the major drainage scale (HUC4).

Development of drainage-based annual harvest caps and collection of avocational harvest data with some level of spatial information is recommended for implementation as part of this Strategy. Annual beaver harvest levels would no longer be characterized as unlimited as there would be a maximum harvest cap. An annual evaluation of spatial harvest data against a harvest cap, at an appropriate management scale such as each HUC4 drainage, will allow CPW to maintain robust beaver populations, provide avocational harvest opportunities and bolster occupancy of suitable habitats. The HUC4 drainage scale provides a good size to biologically represent beaver populations while also being appropriate for management evaluations.

An additional line of research is required to learn more about beaver survival rates and specific sources of mortality in Colorado's beaver populations. This information will help inform management actions to mitigate factors limiting beaver population recovery and expansion, particularly in identified restoration opportunity watersheds.

**Strategy 1: Develop sustainable avocational maximum harvest caps** at the watershed scale.

To manage beaver harvest at a more appropriate scale for beaver populations (smaller than statewide), CPW will create avocational beaver harvest caps. These caps will be at the major drainage scale (HUC4) (Figure 3-3) and will represent a conservative maximum on the number of beaver that can be sustainably harvested in a given year. Annual harvest data will be evaluated each year against each HUC4 harvest cap.

**Actions:**

- Using methods described in the population management section and peer-reviewed sustainable beaver harvest rates, CPW will develop HUC4-scale annual maximum harvest caps for beaver.
- CPW staff will perform an annual evaluation of spatial harvest data to assess population status against each drainage's maximum harvest cap.
- If avocational beaver harvest levels surpass maximum harvest caps in any drainage management unit, regulatory steps could be implemented the following year to reduce harvest, beginning with reduced season length.

**Strategy 2: Improve spatial resolution of beaver harvest data.**

Current annual beaver harvest data are obtained from the furbearer harvest survey process. These harvest survey data have no spatial resolution beyond land ownership (public or private). After creating a system for collection of spatial data on avocationally harvested beaver, CPW could require hunters to provide this spatial harvest location information, similar to what is currently done with some other big game species and bobcats.

**Actions:**

- Initiate rulemaking in Chapter W-3 of CPW regulations that would require information, including harvest location, from all avocationally-taken beaver to be reported to CPW (e.g.- mandatory check or mandatory report) by an annual deadline .
- Under this new process, CPW staff would collect information on the date of beaver harvest, avocational harvest method, and location of harvest. These data will be maintained and managed by CPW data staff and used for annual harvest cap evaluations.

**Strategy 3: Annually analyze data collected under Strategy #2 to determine avocational harvest levels on defined beaver restoration opportunity watersheds.**

**Actions:**

- As specific beaver restoration opportunity watersheds (BROWs) are identified (at the HUC10 scale), CPW will evaluate spatial beaver harvest data in those units. It will require 2-3 years of spatial data acquisition as described in Strategy #2 to

understand how harvest levels and regulations might impact beaver populations in restoration opportunity watersheds.

- Consideration of temporary local-scale HUC10 avocational beaver harvest closures (on public land only) for a limited number of restoration opportunity drainages, if harvest levels are found to be impacting restoration efforts.

**Strategy 4: Estimate survival and sources of beaver mortality.**

**Actions:**

- Develop a recruitment, survival and mortality monitoring study approach for 2-3 pilot HUC10 watersheds using the best available techniques for following the fates of individual animals.
- Collaborate with partners and volunteers to implement pilot recruitment, survival and mortality monitoring studies in 2-3 pilot HUC10 watersheds.
- Support research to better understand prevalence and spatial dynamics of tularemia in Colorado, including the role of the disease in regulating beaver populations.
- Encourage other agencies to estimate their annual take of beaver resulting from human-beaver conflicts. CPW has made an intentional effort to lead by example by using an internal staff survey to generate a snapshot estimate of the average annual take of beaver involved in conflicts on CPW properties.

# Regulatory Updates and Public Engagement

Implementing a process for collection of spatial data for avocationally-taken beaver requires approval by the Colorado Parks and Wildlife Commission if it entails changing or making new regulations. The Commission typically uses a two-step rulemaking process with an initial issue or draft stage and a final stage. The public has additional opportunities to comment on proposed regulations at Commission meetings, in addition to the engagement process available during this Strategy development.

# Additional Resource Needs

The addition of staffing capacity, at least seasonally, may be required if CPW implemented a mandatory check process on harvested beaver. Traditionally, these types of checks are conducted by district wildlife managers (DWMs) in the field, by CPW technicians at offices, or by CPW customer service representatives (CSRs) as part of their job duties. The

additional staff time needed to conduct checks on beaver, training needs for staff and development of data collection tools for the beaver inspection will need to be considered. Alternatively, a new mandatory reporting process would also require significant staff capacity investment in program development and data management.

New funding and partnerships are needed for pilot studies of beaver recruitment, survival and sources of mortality. CPW should prioritize these efforts within its existing programs where possible and seek new funding streams and partnerships as needed.

# Chapter 5: Beaver Restoration Opportunities

## Introduction and Chapter Purpose

This chapter outlines the need for beaver restoration in Colorado, along with methods and strategies for identifying and increasing the pace and scale of beaver restoration activities statewide. The chapter concludes with a list of restoration resources and references created for or supporting this Strategy, including tools like the Colorado Beaver Activity Mapper and the beaver Decision Support System, as well as external resources with detailed restoration methods and guidance.

## Context and Trends

Colorado has lost more than 50% of its historical wetland acres since the 1800s (Dahl 1990), including ponds, wet meadows, and willow shrublands created and maintained by beaver activity. In these beaver-maintained wetlands, the absence of beaver over time often results in conversion from wetter to drier hydrologic conditions with reduced support for wetland and riparian-dependent species and wetland functions.

The amount of lost and degraded wetland and stream ecosystems, along with beaver benefits for priority wildlife species, water quality, fire resilience (Fairfax and Whittle 2020; Moravek et al. 2025), and post-fire sediment capture (Dunn et al. 2024) have increased recent interest in partnering with beaver for process-based stream and wetland restoration projects statewide (Figure 5-1).

Several state plans that specifically reference beaver and restoration to support habitat, water quality, water quantity, and climate goals and strategies include:

- The Boreal Toad Conservation Plan (Crockett 2023) includes an action to "re-establish beaver in beaver-unoccupied drainages" as one of the most impactful measures to support boreal toad conservation.
- Colorado's Strategic Plan for Climate-Smart Natural and Working Lands (2023) includes a priority strategy to "support and facilitate, where suitable, beaver recolonization of historically occupied wetland and riparian habitats through coexistence measures and process-based restoration methods".

- Colorado's Water Plan (2023) lists "beaver reintroduction and construction of beaver mimicry structures" as examples that support reconnecting floodplains and nature-based solutions to increase watershed resilience.
- The Nonpoint Source Pollution Management Plan (CDPHE 2022) notes that "Process-based restoration such as partnering with beaver can help prevent and recover from fires and build landscape resiliency under drought and the impacts of climate change. Complexes of beaver dams reconnect floodplains and dissipate stream energy, which decreases erosion and reduces risk to downstream communities, including impacts to infrastructure. Beaver dam analogs, post-assisted log structures, and wetland protection, restoration and creation are relatively inexpensive nature-based solutions to addressing NPS pollutant loading from hydromodification and habitat alteration."
- Colorado's Outdoors Strategy (CPW, DNR [Department of Natural Resources], GOCO [Great Outdoors Colorado] 2025) includes restoration as one of its nine objectives, with an agency action to "Support wetland, riparian, and aquatic health through restoration efforts that incorporate climate-smart and nature-based solutions."
- The 2025 State Wildlife Action Plan includes prospective actions that support stream-wetland corridor restoration, floodplain reconnection, beaver mimicry and beaver relocations.

Figure 5-1. Beaver dam and pond one year after restoration work along Rough & Tumbling Creek involving the construction of multiple Beaver Dam Analogs to entice beavers back into the area. Photo: Sarah Marshall 2023.

# Beaver Restoration

Beaver restoration addresses a reduced statewide beaver population by attempting to increase the amount of occupied beaver habitats and their associated ecological benefits. In this Strategy, ***restoration of beaver will focus on promoting healthy, functional beaver populations and habitats in consideration of available habitat, human needs, and associated species***.

Across Colorado there are thousands of acres of historical beaver habitat that have not been occupied by beaver in more than a decade, and are potential candidates for restoration. Not all suitable habitat can or should be occupied at a given time, given that beaver occupation is dynamic and beaver move up and down stream-wetland corridors over time in response to available food, forage, ponded water and territories. Some previously suitable habitat is also no longer suitable, because ponds have completely filled

with sediment, conditions are too dry, or surrounding land use or management is incompatible with a thriving beaver population.

Two components of beaver habitat considered in evaluating beaver restoration opportunities are ecological and social suitability. **Ecologically suitable habitat**, with a beaver emphasis, includes sufficient water and woody vegetation to support dam and pond construction. Other attributes include abandoned and relic beaver features such as dams, lodges, ponds, and canals. Suitable habitat is not static, and can be enhanced with ecological restoration interventions. **Socially suitable habitat** includes areas with minimal potential for conflicts with human infrastructure (e.g., roads) as well as land and water use, management, and operations. The availability of socially suitable habitat can also be increased through efforts like beaver coexistence, outreach/education, and relationship building.

Ecologically and socially suitable beaver habitat areas that are candidates for beaver restoration are referred to as **beaver restoration opportunity areas** in the Beaver Strategy. **Beaver restoration opportunity watersheds** (using U.S. Geological Survey 10-digit HUC, or HUC10, watershed units commonly used in watershed planning) have a high concentration of beaver restoration opportunity areas.

## Beaver Restoration Activities

Restoring beaver and the habitats they create requires first considering current and historical beaver distribution at various watershed scales, and upstream and downstream of beaver restoration opportunity areas. Beaver need connected, stream-wetland corridors upstream and downstream to safely disperse and otherwise move between suitable habitats. Depending on surrounding land and water use, proactive measures to reduce the risk of beaver conflicts (Chapter 6) should be considered early in the restoration planning process.

Recent research in mountain beaver habitat in Montana suggests that beaver favor relic, or previously occupied beaver habitat features, which were around twice as likely to be re-settled by beaver compared to areas lacking evidence of previous beaver occupation (Ritter et al. 2020). In the absence of relic beaver features, enticing beaver back into historical habitat areas may require activities such as willow and cottonwood planting, constructing beaver-mimicking structures like Beaver Dam Analogs (BDAs; Figure 5-2; Wheaton et al. 2019) to help slow and pond water, and mitigating stressors like eroding road crossings or failed culverts that are contributing to stream channel degradation. Resources like The Beaver Restoration Guidebook (Pollock et al. 2023) and the Low-Tech Process-based Restoration of Riverscapes Design Manual (Wheaton et al. 2019) provide

detailed information on best practices and methods for beaver restoration. Several agencies and groups associated with these manuals also provide field courses on restoration techniques.

Figure 5-2. Recently constructed Beaver Dam Analog (BDA) along Monument Creek, which mimics a natural beaver dam with branches, logs and sediment to slow the flow of water. Photo: Sarah Marshall (2022).

## Finding Suitable Beaver Habitat

Using beaver pond data from 2013-2021 (Marshall et al. 2024), CNHP analyzed factors most strongly associated with beaver pond occurrence and persistence over time, and trained a model that identifies suitable beaver habitat across the mountains of Colorado using recent beaver pond data. Key factors associated with beaver pond complexes across the state included stream and valley slope, as well as proximity to wetlands and to a lesser extent nearby habitat fragmentation, April snowpack (snow water equivalent) in the surrounding watershed, and aspect. The average slope of recent beaver pond clusters in

the Colorado Beaver Activity Mapper was 4.2%, and ranged from nearly flat to occasionally greater than the 12-15% threshold often reported in the literature as the upper limit of suitable beaver habitat (e.g., Rutherford 1964).

Combining historically mapped, recently mapped, and modeled suitable beaver habitat areas yields a map of 1) suitable habitat with recently mapped beaver ponds, 2) previously occupied but less suitable habitat due to factors like reduced stream flow or human-beaver conflicts, and 3) potential suitable but unoccupied beaver habitat areas that can be tracked and re-assessed over time (Figure 5-3).

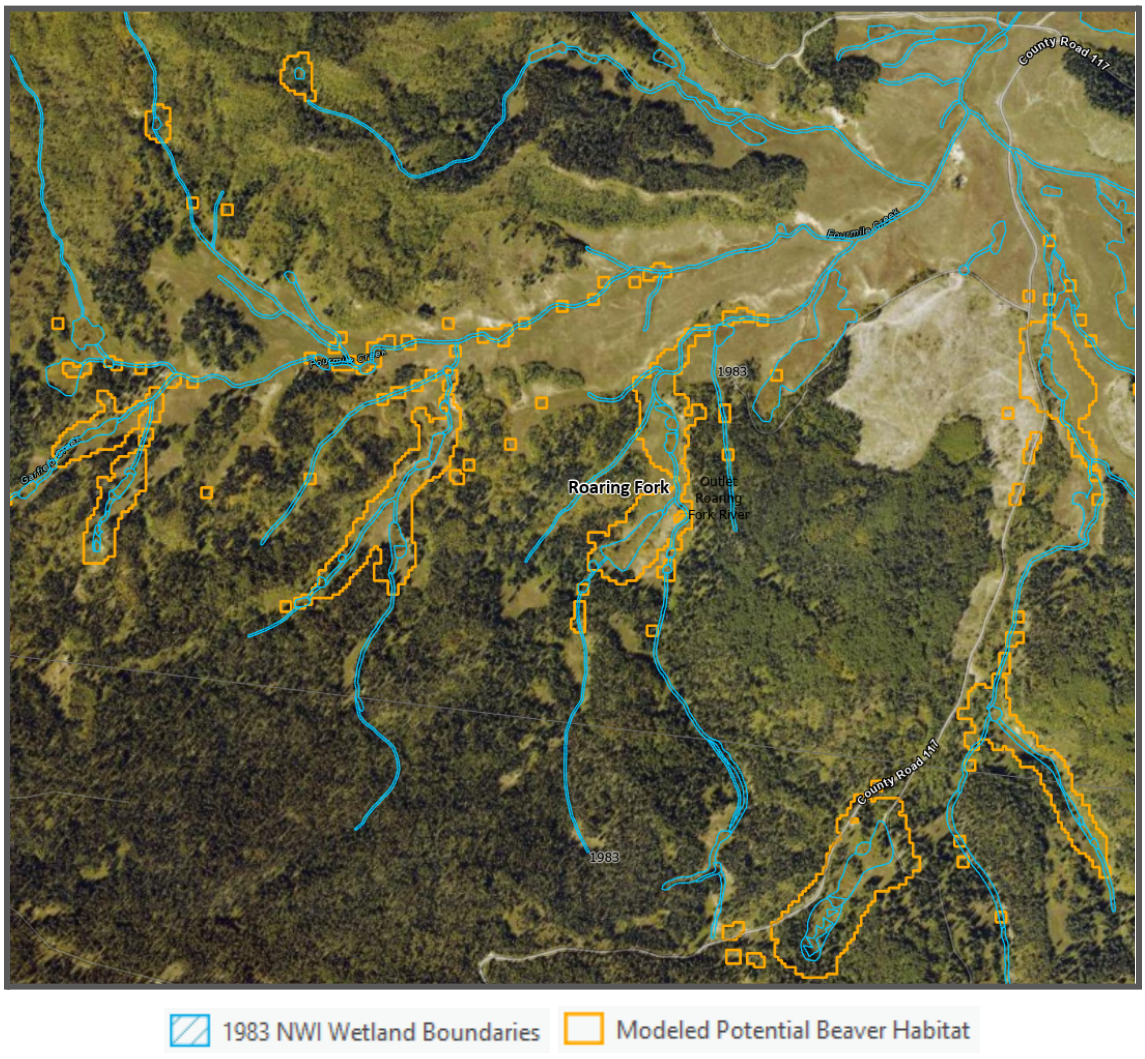



Figure 5-3. Beaver restoration opportunity areas in the Roaring Fork watershed where beaver activity has been limited in the past decade, but beaver could be enticed back into their former habitats using restoration interventions. Historical wetland boundaries mapped using 1983 imagery are shown alongside modeled potential beaver habitat.

# Opportunities for Beaver Habitat Restoration

Restoration prioritization combines data, science, and human values to identify areas where there is a high likelihood that restoration objectives will be achieved over time. In support of this Strategy, CNHP will map beaver restoration opportunity areas using a combination of historical and recent beaver habitat maps, as well as modeled potential habitat areas. CNHP and CPW will then use a combination of the best available science and stakeholder input to identify which opportunity areas have the highest potential for beaver restoration and which areas have lower restoration potential due to reduced chances for beaver occupation over time or high likelihood of human-beaver conflict.

Key factors that will be used to evaluate beaver restoration opportunity areas are listed in Table 5-1, and are separated into core factors (to be included in the initial analysis) and supplemental or future factors (Table 5-2) that may be added to the analysis to further refine a list of candidate sites based on additional available information or restoration objectives. Factors include considerations for sites with high restoration potential, as well as those with low restoration potential or need. Some supplemental factors require additional site knowledge or verification of conditions on the ground.

Table 5-1. Core factors that will be used to evaluate beaver restoration opportunity areas with a) high restoration potential, or b) low restoration potential or need for restoration activities.

| **Core Factors** | **High Restoration Potential** | **Low Restoration Potential or Need** |
|---|---|---|
| Beaver occupation | Evidence of past beaver occupation, but minimal evidence of beaver activity in the last decade | Evidence of recent beaver activity in the last 5-10 years (habitat currently or recently occupied), or area lacking any evidence of past beaver activity |
| Connectivity | Proximity and connection with recently occupied beaver habitat corridors upstream/downstream | Long distances, or substantial barriers between recently occupied beaver habitat upstream or downstream |

| Core Factors | High Restoration Potential | Low Restoration Potential or Need |
|---|---|---|
| Wetland and riparian habitat | Large areas (acres) of wetland/riparian habitat | Small, disconnected areas of wetland/riparian habitat due to land use/management or topographic barriers |
| Woody wetland vegetation | Woody wetland vegetation and/or aspen cover for beaver forage and dam construction | Lack of woody wetland vegetation and/or aspen cover for forage and dam construction |
| Valley width | Gently sloping, broad valley bottom areas | Steep, narrow valley bottom topography |
| Land use/ownership | Mostly within and surrounded by protected or conserved land such as US Forest Service (USFS), Bureau of Land Management (BLM), non-governmental organizations (NGO), etc. | Mostly private land and/or highly fragmented public land |
| Site access | Access for restoration work and equipment via a drivable road (dirt or gravel ok) | Challenging access for restoration work (remote, and/or lacking maintained road access) |
| Infrastructure | Little to no water or transportation infrastructure in the vicinity | Abundant irrigation infrastructure, reservoirs, and/or road crossings in the area, or immediately upstream or downstream |

The acreage of individual beaver restoration opportunity areas at the reach or site scale will be summarized by HUC10 watershed across Colorado to support funders and watershed planners seeking to identify locations to target restoration activities across multiple sites. Beaver restoration opportunity watersheds and areas should be considered

as potential candidates for future restoration and coexistence activities that facilitate beaver returning to historically occupied habitat. These areas may be combined with other watershed or local planning efforts such as stream management, wildfire, and wildlife conservation plans to achieve multiple benefits for beaver alongside other priority wildlife species and humans (Table 5-2).

Table 5-2. Supplemental factors for evaluating beaver restoration potential.

| **Supplemental Factors** | **High Restoration Potential** | **Low Restoration Potential** |
|---|---|---|
| BRAT dam building capacity | High potential dam building capacity for stream segments | Low potential dam building capacity for stream segments |
| Priority species | Overlap with other priority species associated with beaver habitats | No overlap with other priority species associated with beaver habitats |
| Biodiversity | Overlap with priority conservation areas focused on biodiversity | No overlap with priority conservation areas focused on biodiversity |
| Climate change resilience | Climate change resilience, including sufficient current and future projected surface water availability, and benefits for fire and drought mitigation | Minimal climate change resilience, including low likelihood of surface water availability at present, or in the future |
| Other plans/priorities | Overlap with other local or statewide plans and priorities | No overlap with other local or statewide plans and priorities |
| Conservation easements | Within or surrounded by large tracts of protected private land (e.g., conservation easements) | No conservation easements or protected private lands |

# Limitations on Beaver Habitat Restoration

Beaver are resilient animals that often inhabit less than ideal habitats, but restoration ideally targets watersheds and sites that can support shifting beaver habitats over time. Key limiting factors considered in the evaluation of restoration opportunities in this Strategy are outlined in the low restoration potential column of Table 5-1, along with supplemental factors (Table 5-2) that may be used if additional information is available or to address specific local needs. Evaluating and, where possible, addressing these limitations requires preliminary site screening followed by on-the-ground visits to candidate restoration sites.

Utilizing these types of spatial data, it is the intent of beaver restoration opportunity mapping to strategically identify areas that provide the greatest lift for beaver restoration, while minimizing the likelihood of human-beaver conflict. However, within these identified beaver restoration opportunity areas, there may be other wildlife species and habitat management objectives that are incompatible with beaver restoration. It will be essential for anyone using this tool to engage CPW field staff early in the process of identifying and prioritizing restoration opportunities.

An example of such a competing objective includes efforts to restore and protect isolated cutthroat trout populations, which are usually located in headwater streams that are often the focus of beaver restoration. Although in some situations beaver restoration could benefit these populations, in others it could be detrimental. Beaver wetlands can create more favorable habitat for whirling disease, decrease availability of spawning habitat, favor competing non-native trout, and be counterproductive to efforts to eradicate non-native trout. Cutthroat trout conservation provides an example of one of several potentially incompatible wildlife management objectives, underscoring the need to involve CPW field staff in beaver restoration planning.

There is also some uncertainty around the relationship between beaver dams and Colorado water law and administration. The primary issues center on how beaver may alter the hydrology of a stream system in ways that impact the use of water rights. In terms of stream restoration projects to benefit beaver habitat, some projects may qualify as “Minor Stream Restoration Activities" which are exempt from administration within the system of water rights pursuant to Senate Bill 23-270. Restoration proponents and practitioners are encouraged to be familiar with the requirements of SB270, and to engage their river basin’s Division Engineer within the Division of Water Resources early in their planning process.

# Opportunities and Challenges

Key opportunities and challenges related to beaver restoration in Colorado include:

- Colorado's reduction in wetland habitats and beaver populations, detailed in this chapter along with Chapters 2 and 3, present an opportunity to restore thousands of acres of historical beaver habitat across the state.
- Contemporary land use, and water use/water rights present challenges to restoring some historical beaver habitats.
- Holistically evaluating restoration alongside state beaver population trends (Chapter 3), beaver coexistence (Chapter 6), beaver translocation (Chapter 7), and the complex framework of human land and water use across Colorado will help navigate the complex opportunities and challenges associated with beaver restoration.
- Tools, resources, knowledge, and training are needed to support strategic, effective, and consistent beaver restoration work across Colorado.

# Goals, Strategies, and Actions

**Goal: Support a thriving beaver population in Colorado by identifying opportunities and encouraging strategic restoration of ecologically and socially suitable historical, but currently unoccupied, beaver habitats.**

**Strategy 1: Identify the greatest opportunities for beaver restoration across Colorado** to benefit wetland ecosystems and priority wildlife species while minimizing the likelihood of increased human-beaver conflicts.

**Actions:**

- Model and map suitable beaver habitat areas statewide.
- Using factors related to ecological and social suitability, identify a subset of beaver restoration opportunity watersheds that present the greatest ecological benefit while minimizing the potential for human conflict.
- Re-evaluate beaver restoration opportunity watersheds and sites every 5 to 10 years to reflect changes in beaver distribution statewide.

**Strategy 2: Increase beaver occupation of suitable habitat,** with an emphasis on historically occupied habitats that lack evidence of beaver activity in the past decade or more.

**Actions:**

- Work with state, local, and federal agencies, Tribes, public and private land and water managers, non-governmental organizations (NGOs), watershed groups, and others to prioritize and implement beaver restoration activities in watersheds and sites with abundant acreage of suitable but unoccupied beaver habitat.
- Pair beaver translocation with identified and vetted suitable beaver restoration sites when possible (based on criteria in Chapter 7).

**Strategy 3: Create and maintain beaver-focused tools and resources** to support continued strategic beaver restoration and conservation work across Colorado.

**Actions:**

- Maintain and update the Colorado Beaver Activity Mapper (COBAM) with restoration-related beaver mapping layers.
- Develop and maintain a beaver Decision Support System to help restoration practitioners and funders screen beaver restoration opportunity watersheds and sites for implementing beaver-mediated restoration activities.
- Maintain and update the Beaver Habitat Scorecard for beaver restoration practitioners to rapidly assess beaver habitat suitability before and after restoration projects.
- Host links to beaver restoration tools and resources on a centralized toolkit website.
- Explicitly connect beaver restoration with beaver coexistence in outreach, engagement, and review of project proposals to ensure long-term sustainability of beaver restoration efforts and minimize human-beaver conflicts.
- Connect people seeking to restore beaver habitats to beaver tools and resources through outreach and engagement with groups such as watershed coalitions, Wetland Focus Area Committees and the Colorado Watershed Assembly.
- Develop a standard coordination process between CPW and DWR for responding to water right administration issues arising from beaver related restoration activity. This process could also consider appropriate agency coordination when

beaver activity impacts water infrastructure such as measurement devices, diversions, and dam outlets.

## Additional Beaver Restoration Resources

- The **Colorado Beaver Activity Mapper**, which will include future beaver restoration opportunity areas developed in support of the Strategy along with other map layers including multi-year beaver activity areas, the statewide BRAT model, and land management.
- The companion **Beaver Decision Support System** for this Strategy (a Quick Guide to be included as an appendix in the final Beaver Strategy).
- **Beaver Habitat Scorecard**, to be hosted online and included as an appendix in the final Beaver Strategy.
- **Beaver Toolkit**, to be hosted on a future CPW web page.
- **The Beaver Restoration Guidebook** (Pollock et al. 2023): https://www.fws.gov/sites/default/files/documents/The-Beaver-Restoration-Guidebook-v2.02.pdf
- **Low-Tech Process-based Restoration of Riverscapes Design Manual** (Wheaton et al. 2019) https://lowtechpbr.restoration.usu.edu/

# Chapter 6: Living with Beaver — Nonlethal Conflict Resolution

## Introduction and Chapter Purpose

At the heart of every beaver management plan or strategy is the desire to gain the numerous benefits of beaver wetlands while addressing common beaver-human conflicts. In support of that dual purpose, this chapter will: 1) describe common beaver-human conflicts and the nonlethal solutions; 2) provide stepwise guidance for managing beaver-human conflicts; and 3) set forth the overarching coexistence goal and supporting strategies and actions.

In many cases, there are nonlethal solutions to beaver-human conflicts, but there will also be situations where beaver removal may be needed. The most common of these situations being beavers in agricultural ditches. Many helpful "living with beaver" resources have been created by agencies and nonprofits over the past few years. This chapter will cover the basics of common beaver-human problems and solutions and refer readers to these more in-depth resources.

## Context and Trends

Over the past 30 years, many solutions have been developed and tested that allow beaver to continue to occupy habitat while at the same time minimizing or eliminating their impacts on human infrastructure and activities. These "living with beaver" approaches are often referred to as **coexistence** solutions and are gaining popularity around the U.S. as more information becomes available about their effectiveness and as the ecosystem services provided by beaver become better understood. However, awareness of and experience with coexistence solutions varies widely among land, water, and transportation managers.

Coexistence solutions include protecting trees from beaver felling, as well as installing in-stream devices designed to reduce flooding and/or protect infrastructure, broadly referred to as flow devices. Flow devices are generally simple structures consisting of wire fencing, pipes, and/or posts, designed to accommodate natural beaver instincts. Even though they are relatively simple devices, their installation should only be done under the guidance of a trained professional. When devices are installed without sufficient training, they often can fail to function properly, leading to a negative perception of their

effectiveness. Additionally, working in moving water near culverts poses a safety risk that increases for people not trained on how to minimize such risks. The BeaverCorps training from The Beaver Institute is currently the only professional training and certification program in the U.S.[3]

A primary question that arose during the public engagement process was "why would limited resources be allocated to implementing nonlethal vs lethal solutions?" There are three main reasons why coexistence is important to support as part of this Beaver Strategy:

(1) **Coexistence can end a repeated cycle of problems, costs, and work**: Killing or trapping beaver often does not provide a lasting solution. If the habitat remains suitable, which is often the case, new beaver may quickly move in and re-establish occupancy of the area, restarting the cycle of conflict. Properly installed flow devices reduce overall maintenance costs by saving land managers the repeated cost and effort of clearing culverts or removing beaver dams (see further information on this topic below);

(2) **Coexistence can reduce administrative burden from fewer conflict complaints**: When conflicts are managed with durable and readily available nonlethal solutions, wildlife agencies receive fewer recurring complaints from landowners. This allows agency staff to dedicate time and resources to other priorities; and

(3) **Coexistence helps maintain the ecological and ecosystem services benefits that come with beaver presence**: These benefits of beaver have been widely documented by many excellent sources (Pollock et al. 2023; Brazier et al. 2020). When beaver are located in suitable habitat but are causing a problem such as culvert blockage (Figure 6-1), installing a flow device allows them to remain in place and continue providing ecological benefits.

[3] www.beaverinstitute.org/professional-info/beavercorps-program/.


Figure 6-1. Photo provided by Summit County Open Space and Trails staff showing numerous beaver ponds on both sides of Highway 9 near Quandary Pass where a flow device (green circles) was successfully installed by Summit County. The black circle indicates where flooding of the road once occurred prior to the flow device being installed.

It is preferable to resolve human-wildlife conflicts with nonlethal methods when possible. Currently, lethal removal of beaver involved in beaver-human conflict situations is a substantial source of beaver mortality in Colorado. Promoting the availability of coexistence education, training, and support has been identified as a primary means to reduce the loss of beaver involved in such conflicts.

## Cost-Benefits of Nonlethal Solutions vs Lethal Removal

Several studies have shown that coexistence is a long-term cost savings over lethal management approaches. For example, in Billerica, Massachusetts, the installation of 43 pond levelers between 2000-2019 resulted in an annual cost savings of 44% compared to the cost of dam and lethal beaver removal (Callahan et al. 2019). In Virginia, 40 flow devices were installed between 2004 and 2006 to study the costs of nonlethal methods compared to lethal beaver control. A cost-benefit ratio formula utilized by APHIS was used in this Virginia case study to test the differences in the costs to manage beavers and road repairs before and after flow device installation. After installing the flow devices, over $8 was saved for every $1 spent on nonlethal solutions (savings realized from no repeated need for trapping, dam removal/culvert cleaning or road repairs costs) as compared to the cost of lethal management (Boyles and Savitzky 2008).

Another study in Andover, New Hampshire showed that eight flow devices installed between 2007 and 2017 to protect road culverts equated to about a 75% savings over the

costs of trapping/culvert cleaning methods by comparing the cost of trapping/cleaning ($160,000) to the cost of installing and maintaining the flow devices (~$31,300) over 10 years.[4] The study concluded that there would be a $130,000 savings over ten years, which other data has indicated is a reasonable expectation for life-span of flow devices.

The Miistakis Institute at Mount Royal University Calgary Alberta compared the costs of lethal beaver management to address typical flooding issues with coexistence measures. Their coexistence fact sheet cites many examples of local governments saving significant money by switching to coexistence measures.[5] The Institute's Working with Beaver program has also developed a cost calculator to help landowners determine how quickly the installation of a pond leveler will pay for itself with reduced maintenance costs.[6]

## Resolving Typical Beaver-Human Conflicts

What defines a conflict between beaver and humans is subjective and site-specific. Sometimes, landowners may perceive the presence of beaver as a conflict, even if no actual problems have occurred. In many areas, as beaver recolonize habitats where they have been absent for decades, this change can cause negative landowner reactions. Additionally, houses, roads, trails, headgates, and other human infrastructure have been built in floodplains during recent times of reduced beaver presence. As beaver populations increase in some areas and as they recolonize their natural habitat, their activities might come into conflict with humans whose ecological baseline has shifted away from experiencing beaver on their lands.

Appendix B covers the most common beaver problems related to human infrastructure and land use and the associated nonlethal solutions. The information provided is not meant to be a comprehensive guide for how to choose and install the proper flow device (e.g., Figure 6-2), but to illustrate problems and potential solutions to aid in determining if coexistence methods may be an option to pursue in particular situations.

[4] Lisle, S. & Mishcon, V. (2017), Andover, New Hampshire Case Study, How a town saved thousands of dollars on road-maintenance costs and made peace with its beaver.
[5] Miistakis Institute Fact Sheet: Cost-benefit Analysis of Beaver Coexistence Tools.
[6] Miistakis Institute Working with Beaver - Cost Calculator.

Figure 6-2. Photo of a flow pipe installed through a beaver dam by Summit County in 2018. The dam is located just upstream of Highway 9, at Summit County's Monte Cristo Open Space near Quandary Peak. Photo by Summit County Open Space and Trails staff. See Appendix B for more information and photos about this project.

# Examples of Beaver Coexistence Programs in Colorado

## Yampa Valley Beaver Working Group

The collaborative Yampa Valley Beaver Working Group formed in 2024 to manage the resources and health of the Yampa River watershed by protecting and increasing beaver populations and habitat. These goals are achieved through education, outreach, and assisting landowners with nonlethal beaver solutions to common conflicts such as culvert blocking, flooding, and tree loss. The Working Group is led by Friends of the Yampa and the Yampa Valley Sustainability Council with many additional members that include federal, state and local agencies, non-profits and agricultural stakeholders.

The group secured three grants for coexistence education work and to complete on-site beaver coexistence projects. Landowners are required to provide a 25% matching payment for individual projects. Two lead working group staff members are taking the Beaver Institute BeaverCorps training to learn how to assess coexistence opportunities and properly install coexistence solutions. The group's formation and funding has significantly contributed to building the capacity for scaling up beaver coexistence in the Yampa Valley.

### Rio Grande National Forest (RGNF) and the Rio Grande Headwaters Restoration Project (RGHRP)

In 2021, the RGNF and RGHRP, a nonprofit focused on watershed restoration in the greater San Luis Valley area, teamed up to work together on beaver-related restoration of the headwater streams on the RGNF. The work involves several strategies, including coexistence education and implementation, restoration where needed, and nuisance beaver translocation from San Luis Valley agricultural areas to RGNF locations approved by CPW. The RGNF has installed flow devices and exclusion fencing to protect roads and popular recreation sites. An example of a flow device installed in a beaver pond by this partnership to prevent flooding of a RGNF bridge is shown in Appendix B. Coexistence isn't always going to work in all situations stated Connor Born with the RGHRP, and thus "There's always going to be a place for trapping and relocating."[7] Chapter 7 includes information about this partnership's beaver relocation work.

### City and County of Denver

In 2023, the Mile High Flood District and the City and County of Denver collaborated to develop guidelines for beaver management covering the greater Denver area with the goal of being consistent and methodical in their response to beaver presence in urban streams. The plan includes six Beaver Management Zones ranging from "beaver-appropriate, no concerns" to "moderate risk/monitor for issues (risk in regards to flooding or other concerns), to beaver exclusion reaches where they would not be allowed to stay due to high risk of conflicts with human land uses.[8] A decision tree model was developed to help city staff evaluate beaver management based on these zones. Within this decision model, if a problem actually exists, nonlethal solutions are often implemented - many different types of coexistence devices have been installed. However, in the high risk/beaver exclusion zone the likely outcome is removal. The plan was finalized in June 2024 (Murphy 2024).

## Examples of Adopted Best Management Practices

This section provides examples of local government approaches to living with beaver that may be applicable to other communities across Colorado to consider implementing.

[7] Giving troublesome beavers a second chance - Alamosa Citizen (August 31, 2024).
[8] Brian Murphy, River Network and Mary Powell, Mile High Flood District (MHFD) presentation at the May 6, 2023 MHFD Annual Symposium in Denver, CO. Beaver Adaptive Management Plan (youtube.com)

## Town of Vail - Living with Beaver Approach

The Town of Vail takes a coexistence approach to living with beaver whenever possible and only allows dams to be breached on land owned by the town when there is an imminent threat to human property. The town has not allowed the removal or translocation of a beaver on town property in the past decade. Many community members understand the importance of beaver in the ecosystem and the value of coexistence. The town is especially careful not to disturb dams or lodges in the fall. Food sources are more abundant in spring, so their Watershed Health Specialist stated that "he has less heartache about disturbing a dam in the spring than he would in the fall."[9]

## Colorado Springs - Proactive Tree Protection

The Colorado Springs Parks and Recreation Department manages various greenways along Monument Creek and other waterways where beaver are present. Upon identifying concerns related to beaver activity, Parks and Recreation will consult with the City Forestry department regarding the necessary steps, which often include caging native trees or trees that may pose a hazard to the public on nearby trails. This helps prevent beaver from felling native trees while invasive species like Russian olive and Siberian elms remain uncaged. This strategy has yielded positive results in safeguarding desirable trees.[10]

## Town of Frisco - Nonlethal Solution Approach with the Help of Volunteers

Summit County is home to a robust beaver population, and the Town of Frisco commonly manages conflicts with infrastructure by removing beaver and their dams. About five years ago, Public Works began taking a nonlethal approach by working with volunteers from the local Trout Unlimited chapter who had the expertise to install flow devices. The Town does not have an official beaver plan or program, but over the past five years, the Town "has not been trapping and relocating beaver, but instead has been working to coexist happily with the creatures," by installing flow devices where needed (e.g., Figure 6-3).[11]

[9] Telephone interview with Peter Waddas, Town of Vail Watershed Health Specialist, September 23, 2025.
[10] Telephone interview with Matthew Puckett, Colorado Springs City Forester, October 2, 2025.
[11] Spencer, R. (Sept. 17, 2023), Frisco's beaver-deceiver team helps humans 'coexist happily' with Colorado's river rodents | SummitDaily.com; Another great example of volunteers working to help a city Live with Beaver is described in this story from Juneau Alaska: Purdy, D. (July 5, 2019), The Beaver Patrol of Juneau helps maintain balance with wildlife and humans, KTOO News, Juneau, Alaska.

Figure 6-3. Trout Unlimited volunteer Alton Penz wades in the water near the pond leveler he installed into a beaver dam near the Town of Frisco in September 2023. Photo by Ryan Spencer, Summit Daily News.

## Challenges and Opportunities

Raising awareness and gaining acceptance of utilizing nonlethal solutions to common beaver conflicts presents many challenges and opportunities. This section summarizes the two greatest challenges, which provides the basis for crafting strategies to address them.

- **Social acceptance of beaver**. Some of the biggest barriers to beaver returning to historical habitats or staying where they have chosen are both perceived and actual conflicts with private and public landowners, water suppliers/managers, and local and state transportation departments. There are long-standing practices of eliminating beaver, and it will take many years of outreach and support to reduce lethal outcomes.

  A study by the Washington Dept. of Fish and Wildlife found that landowners experiencing conflict with beaver were more likely to agree with lethal control of beaver than landowners not experiencing conflict (Tyson et al. 2022). This study underscores how proactive outreach and education on beaver conflict mitigation is key, particularly related to top concerns like unwanted tree removal and culvert plugging. Hence, this need for proactive outreach and support is reflected in many of the strategies and actions to work towards the overarching coexistence goal.

- **Establishing programs, networks, and permanent funding for coexistence work.** There is currently widespread interest in coexistence, but no statewide program or permanent funding for implementation. CPW cannot address this large need alone,

but can be a leading force. Responses to an internal CPW survey show that a large proportion of CPW properties are experiencing beaver conflicts and some CPW staff are already trying to use nonlethal solutions, with most expressing interest in additional resources (Appendix B/TPP Appendix 2). The strategies and actions accordingly focus on building agency capacity to support coexistence on CPW lands, and the collaboration needed with many partners to help implement key initiatives to elevate coexistence on all lands in Colorado.

# Guidance for Evaluating Beaver Conflicts

This section provides step-wise guidance to evaluate and address potential beaver-human conflicts. It builds upon the 2005 Colorado State Parks Beaver Management Stewardship Prescription and addresses the need for CPW staff guidance as identified by the CPW Beaver Working Group. It is also informed by other published guidance and external feedback on this Beaver Strategy.

The intent of the guidance is to support the use of nonlethal solutions on CPW lands by providing a quick reference for CPW staff, though partners may also find it useful. Nonlethal solutions should be pursued whenever feasible on CPW lands, but certain circumstances may preclude nonlethal resolution.

## Stepwise Process

Existing beaver management plans and programs lay out a stepwise process to guide how to address common beaver problems. Another approach is to create a decision tree model.[12] The Miistakis Institute, together with the Cows & Fish Riparian Management Society, created the most comprehensive Decision Matrix Tool for Beaver Management (a detailed spreadsheet) to help agricultural landowners find solutions to common beaver problems[13] in addition to publishing a comprehensive report (Kinas 2024). Both the matrix tool and the report cover all the beaver management methods listed in this chapter and Appendix B. The Beaver Strategy borrows from existing decision frameworks to provide the stepwise process below, and the associated illustration of a simplified decision tree. The stepwise process and decision tree are intended to be a resource for CPW staff, partners, and the public who are tasked with assessing beaver-human conflicts.

When responding to beaver-human conflicts, a tiered approach as set forth below should be followed.

[12] See for example the decision tree in the City of Portland, Oregon Beaver Management Plan, Version 2.1, pg 14, (2024).
[13] https://cowsandfish.org/wp-content/uploads/Beaver-Matrix-FINAL.pdf.

**Step 1 - Assess if there is actually a problem with beaver presence.**

As beaver populations continue to recover across Colorado and return to streams they historically occupied, their presence may raise concerns without in fact being problematic.

Assess and determine if:

1) no actual problem is present and no action is needed (see Step 2 for common problems);

2) periodic monitoring is needed to determine if future dam building and rising water levels, tree loss, or bank denning could eventually threaten property or infrastructure; or

3) prevention of potential future damage may be needed - proactive steps can be taken as described in Appendix B (e.g., caging trees, installing a decoy dam or flow device, setting back trails farther from the stream).

**Step 2 - Identify actual problem or high risk of future problem that requires action.** Common beaver problems include:

- Blockage of water infrastructure such as a culvert, water diversion point, inlet/outlet, ditch, or dam spillway;
- Dam building that results in flooding of trail, road, picnic area, infrastructure, development, or other land uses;
- Bank denning in an earthen dam or levee that risks weakening this infrastructure;
- Loss of desirable trees.

These are the common problems but there can be other threats to property or other infrastructure not listed above.

**Step 3 - Identify if the problem is in a sustainable beaver location.**

Prior to deciding what action to take, assess if the stream reach or natural water body can sustain beaver presence in order to help prioritize coexistence resources. This step will usually be more relevant for urban and semi-urban areas where dispersing young beaver may not have the best habitat to choose from and will try to use lesser quality areas.

Factors to consider include:

- The location is a natural stream or lake, not a human-built ditch, canal, or pond;
- Vegetation is available for food and dam building/lodging materials and the harvesting of this vegetation by beavers will not be problematic;

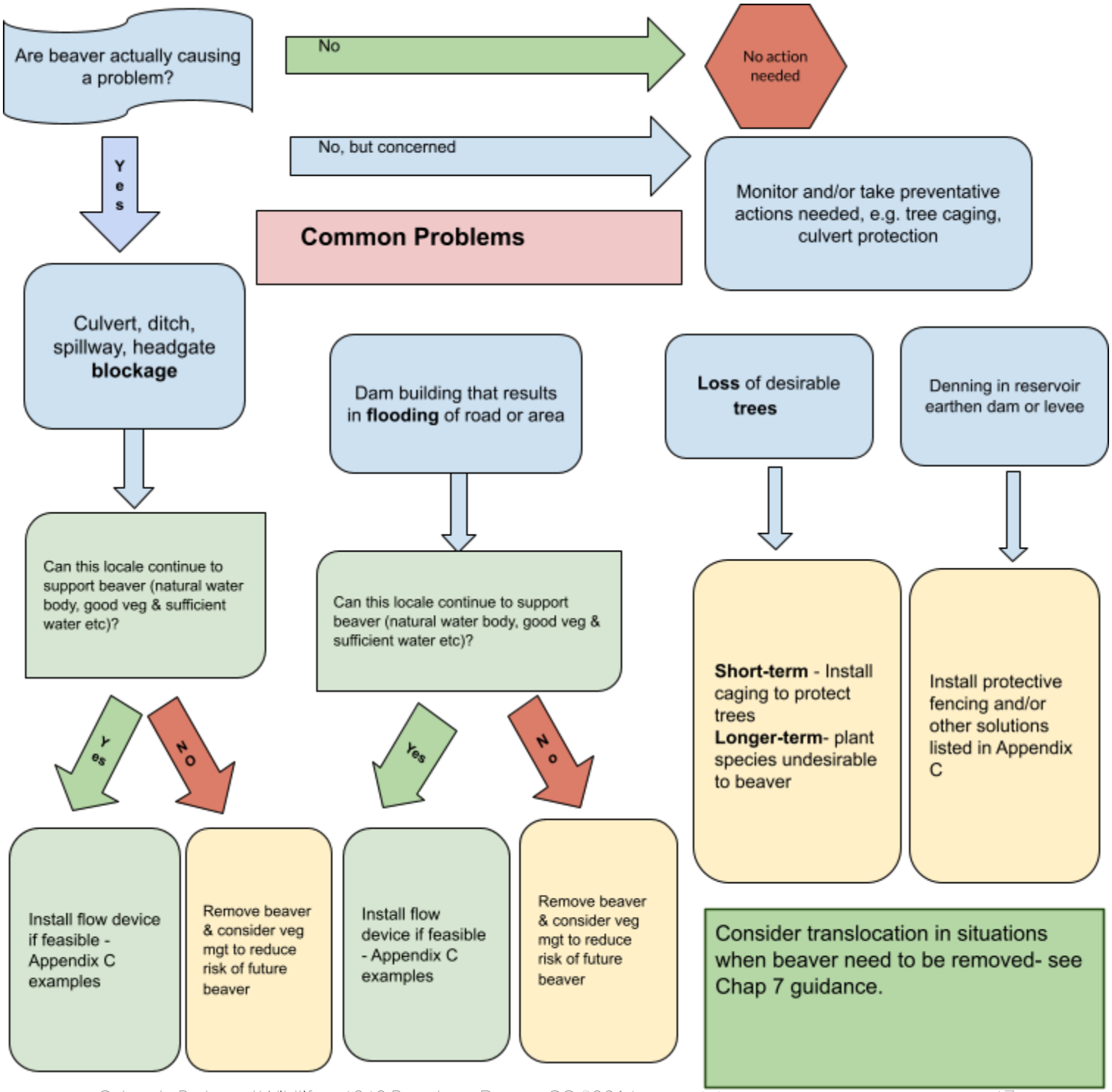
- Floodplain width can accommodate one or more beaver ponds, and there is minimal encroaching infrastructure and/or development;
- Sufficient, reliable water sources are present to maintain a beaver complex.

**Step 4 - Identify the best management approach to the problem based on location and risk**:

- Human infrastructure such as water measurement devices, ditches, canals, or stormwater ponds - in most cases beaver activity will not be acceptable and removal of any dams and beaver will be needed; consider translocation if permitted release sites and holding facilities are available per Chapter 7, especially when there are indications that a family of beaver vs a single beaver are present; if translocation is not feasible, lethal removal.
- If Step #3 concludes the location is a natural water system but not sustainable beaver habitat AND beaver activity poses a risk to human infrastructure, then consider:
    - If dam removal will immediately reduce the damage risk and if habitat is relatively poor, then beaver may move onto another location without the need to trap them.
    - If beaver rebuild the dam, then consider translocation if feasible under the Chapter 7 Translocation guidelines; if not, lethal removal.
    - If steps are needed to manage vegetation or other factors to decrease likelihood of beaver returning to the location.
- If Step #3 concludes the location is a natural water system that can sustain beaver habitat AND a feasible nonlethal solution is available, then take actions to implement the appropriate nonlethal solutions as described in this chapter and Appendix B (e.g., tree caging, culvert exclusion fence, pond leveler, spillway or levee protection).
- Timing of dam removal and translocation - If it is determined that a dam must be removed, if possible, avoid removal from October through March when it will be difficult for beaver to find a new location to build another pond and food cache before winter. The same is true for relocating beaver - follow the Chapter 7 translocation guidelines, which generally allow for beaver translocation June-August depending on elevation and other factors.

- Each situation will require creative assessments of what is appropriate and needed with the goal of pursuing nonlethal solutions when appropriate and feasible. Periodic post-action monitoring and bi-annual maintenance of flow devices will likely be needed in most cases.

## Decision Tree to illustrate the Stepwise Process

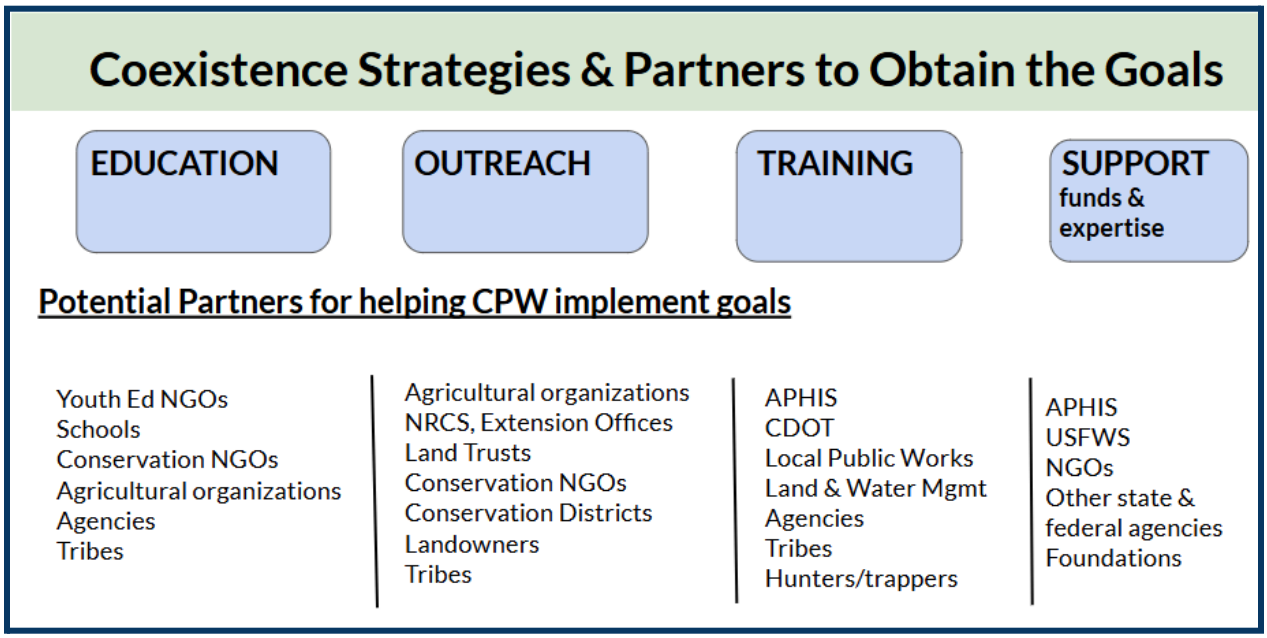


# Goals, Strategies, and Actions

**Goal: Promote the widespread adoption of nonlethal solutions to common beaver conflicts when such solutions are appropriate and feasible.**

Through statewide education and outreach in collaboration with local, state, federal, Tribal and numerous other non-profit and private sector partners, the general public, agency staff, and landowners learn the important keystone role beaver play in restoring and maintaining historic riverine wetlands across the state and all the many ecological and ecosystem services benefits gained. This outreach leads to increased tolerance for beaver presence and nonlethal solutions become well known and adopted as effective industry standard options to solve common beaver problems among land and water management agencies, landowners, local government and state transportation departments.

The outcome of achieving this goal is a **decrease in lethal conflict resolution and an increase in beaver wetlands**, i.e., widespread adoption of nonlethal approaches leads to more beaver being left in place, where appropriate, to continue to provide ecological and ecosystem services benefits.



**Strategy 1: Increase education about the value of beaver and their habitat and the available nonlethal solutions and resources to address common beaver problems.**

**Actions:**

- Within CPW, institutionalize a shared understanding of the value of beaver and their wetlands to habitat, wildlife, and society as a whole.
    - Include general information and printed resources for CPW's Customer Service Representatives.
    - Incorporate training for field staff, incoming DWMs, and Park Managers on the value of beaver, stepwise conflict mitigation procedures, and an overview of coexistence solutions.
    - Provide brief trainings at Terrestrial and Aquatic Branch meetings, as well at State Park resource stewardship meetings.
    - Highlight successful implementation of coexistence measures by CPW staff and partners on CPW managed properties in agency communications to demonstrate effectiveness and increase awareness of nonlethal solutions within the agency.
    - Work with Tribal representatives on incorporating input from the tribes on tribal perspectives for best management practices for beavers.
- Lead and collaborate with partners on developing external education materials.
    - Update CPW's Living with Beaver webpage materials to include the relevant information from the Beaver Strategy on coexistence, including a printable guide for the website that CPW field staff can provide to private and public land managers when conflicts arise. The website will need to be regularly updated.
    - Work with partners to develop co-branded education materials to target different audiences such as youth, landowners, government agencies, water users, and other communities and interests. These materials should be transparent about costs, maintenance needs, and the reality that coexistence may not work for every situation.

**Strategy 2: Collaborate with partners on comprehensive outreach that reaches diverse key audiences.**

**Actions:**

- Work with partners to identify key spokespeople and create opportunities within various communities to distribute living with beaver educational materials and reach key audiences. The specific person(s) may vary by community but could include staff from Natural Resources Conservation Service (NRCS), Conservation Districts, Watershed Councils, and CPW.
- Work with Tribal governments to identify opportunities to incorporate tribal management perspectives into education and outreach materials, as well as coordinate and share educational materials with Tribal member landowners on beaver management resources.
- Work with CWCB to promote and prioritize local beaver coexistence strategy development in watershed planning grants.
- Identify opportunities to coordinate and share educational materials with other State of Colorado agencies that deal with beaver conflicts to promote support for beaver coexistence in state government.
- Establish coexistence demonstration projects on CPW properties that have a combined high degree of beaver conflicts and public visitation. With its many valued State Parks, State Wildlife Areas, and hatcheries often centered around water, CPW has a unique opportunity to lead by example while reaching a large audience with related interpretive installations.
    - Develop site level beaver management plans for state parks, state wildlife areas and hatcheries that have reported high levels of conflict in order to provide greater details on specific beaver management needs, actions and strategies. Site level plans will assist in implementation of the BCMS goals and identify where the best opportunities to establish coexistence demonstration projects are located on a given property.
    - Identify one State Park (consider State Wildlife Areas and hatcheries as well) per region that has indicated a medium to high degree of beaver conflicts, as well as interest in receiving additional beaver management support. Pilot strategic coexistence projects at these properties and include interpretive installations explaining the many benefits of beaver and

effective approaches to dealing with common beaver problems. Support these sites with an operational adaptive management plan.

- Organize periodic partner field trips to pilot project sites to help increase awareness and adoption of nonlethal solutions.
- Monitoring and adaptive management: Implement monitoring to assess the effectiveness of implemented coexistence solutions and to identify when adaptive management actions are appropriate. Track metrics like landowner/manager satisfaction, beaver population trends in the area where devices were installed, where and how human-beaver interactions occur and wetland expansion. Use findings to refine strategies and share successes on various platforms.

**Strategy 3: Expand statewide capacity of CPW and its partners to support the availability and use of coexistence solutions through formal training, to increase available expertise in coexistence methods and support volunteer networks.**

**Actions:**

- Work with partners such as Colorado Department of Transportation, APHIS, and NRCS to organize annual coexistence training workshops (perhaps one for the Front Range and one West Slope) to increase capacity within CPW and partners across the state; coordinate with partners to involve local public works departments and land and water management agencies. The Beaver Institute is currently the only organization that offers professional training and certification.
- Identify and prioritize CPW staff each year to participate in coexistence training based on highest areas of conflict and opportunity for nonlethal solutions, e.g. field staff such as CPW property techs, fish hatcheries, Park Rangers and DWMs. Train other key staff in each region.
- Collaborate with partners to establish a volunteer network in each region to assist with coexistence work to increase capacity and foster community ownership.
    - Opportunities for volunteers can include assisting CPW and partners with beaver education/outreach, beaver coexistence projects, translocation tasks such as daily upkeep/cleaning of beaver holding facilities and beaver transport needs, monitoring for maintenance needs, and citizen science data collection.
    - Community Science Initiatives: Encourage community science projects where local residents can monitor beaver activity, wetland health, or

biodiversity (e.g., bird or amphibian surveys); this builds local pride in beaver-created ecosystems and provides data to support conservation efforts; it could be modeled on CPW's RiverWatch and Raptor Monitoring Volunteer Programs.

- Develop a network of trained coexistence contacts for each geographic region considering that CPW staff alone will not be able to timely respond to all complaints. The list could begin with large regions (e.g., NW, SW, NE, SE) and eventually grow to provide better/faster response by river basin scale (e.g., Yampa, Colorado, Gunnison, San Juan, Rio Grande, Upper and Lower Arkansas and South Platte) and eventually all 18 CPW Wildlife Management Areas.

**Strategy 4: As capacity to support coexistence increases, increase the use of nonlethal solutions to beaver problems by supporting the establishment of cost-share programs for landowners.**

**Actions:**

- Work with partners to establish coexistence cost-share programs that can respond in a timely manner to beaver complaints. Important considerations for cost-share include:
    - Identify sustainable long-term funding.
    - Pool funding through collaboration with watershed coalitions, water suppliers, municipalities, state agencies, and other entities that benefit from the improved water quality and reduced fire risk.
    - Create administrative processes that are minimal/easy and allow nonprofits to apply on behalf of landowners whom they work with such as land trusts.
    - Sliding scale cost-share depending on landowner resources.
    - Cultivate landowner buy-in, management and engagement for projects on their land, rather than having them wholly managed by third parties, NGOs, etc.
- Conduct annual surveys of landowners who received assistance with implementation of coexistence projects to determine the effectiveness of the measures taken along with the collection of other data that will be helpful for future coexistence work.

# Chapter 7: Translocation Policy and Protocol

## Introduction and Chapter Purpose

Beaver restoration may include transplanting beaver from a location where they are involved in conflicts with human infrastructure to a location identified for restoration opportunities. This wildlife management action of moving and releasing animals beyond their home range is referred to as translocation. The purpose of this chapter is to consider strategies that optimize translocation as a tool to support restoration objectives, while considering the multiple potential concerns and opportunities.

## Context and Trends

Translocation is increasingly being used as a tool to bolster beaver restoration efforts. It specifically involves live capture, temporary housing, transport, and release of beaver, all of which require special considerations. Several western states, Tribes, and other organizations have developed beaver translocation programs, which provide valuable insights into how Colorado might more effectively manage translocation, as well as factors that increase translocation success. CPW has regulatory authority over wildlife translocation, has conducted some beaver translocation on CPW properties, and permits public and partner led translocation efforts.

There is room to improve CPW's beaver translocation permitting process with regard to clarity, consistency, and efficiency. When used selectively, translocation can be a valuable tool to support beaver restoration efforts. However, beaver translocation policies should seek to avoid unintended negative ecological consequences, particularly with regard to the spread of wildlife diseases and Aquatic Nuisance Species (ANS).

## History of Beaver Translocation in the United States and Colorado

Some of the first efforts to restore beaver following the deleterious fur trade of the 18th and 19th centuries involved translocation. Referencing an unpublished report, Denney (1952) reported that nineteen states had trapped and transplanted over 10,000 beaver. In 1904, twenty beaver, sourced from Canada and Yellowstone National Park, were released in the state of New York (Radford 1907). The New York beaver population has been

credited for the expeditious recovery and expansion of beaver across New England in the early 1900s. In 1948, the Idaho Department of Fish and Game famously parachuted 76 beaver into a remote wilderness location, where they almost immediately began building dams (Heter 1950). Such efforts were credited for boosting an expeditious rebound of beaver populations across North America, though not to levels preceding the historic fur trade (Pollock et al. 2023).

Beaver translocation also experienced a surge in the early to mid 1900s in Colorado. It was reported that 1,253 beaver were translocated from 1950 to 1951 alone (Denney 1952). Efforts of that time utilized beaver involved in conflict as a source for translocation. In 1951, Colorado followed Idaho's lead, experimentally releasing 12 beaver to four sites by parachuting beaver in wooden crates from a fixed-wing aircraft (Figure 7-1). By 1964, it was noted that beaver appeared to be maintaining robust populations that occupied most available suitable habitat in Colorado, such that translocation was discouraged as a management action, even though a surplus of beaver involved in conflicts remained (Rutherford 1964).

Figure 7-1. A Cessna 170 with the passenger door removed and a beaver parachute drop box ready for flight, during the CO Game and Fish Department experimental parachute beaver release in 1951.

It is likely that subsequent translocations occurred opportunistically and were carried out by Colorado's wildlife management agency (now CPW). DWMs and property technicians likely played the largest role performing translocations within their geographic district of responsibility, with some taking greater interest in beaver management than others.

Beaver translocation regained interest in the 1980s (Pollock et al. 2023). Colorado is home to a nationally recognized citizen beaver advocate who became a professional beaver trapper. Sherri Tippie of Wildlife 2000 is said to have live-trapped and translocated over 1,000 beaver between the years of 1985 and 2010 (Tippie 2010). The majority of these beaver were removed from conflict situations along the Colorado Front Range and held in temporary captivity at her home while she attempted to trap all beaver at a site. She then released beaver mostly as family groups in headwater mountain streams as far as 200 miles from their capture sites, with most releases occurring on private lands (Prendergast 2011). Ms. Tippie's prolific translocation activities helped motivate more formal release site authorization guidance adopted by CPW's NE Region.

## Current Use of Translocation in Beaver Conservation and Management

Beaver translocation has regained momentum as an approach to address complex beaver conservation challenges. With a few exceptions, most beaver translocation efforts in the western U.S. include animals involved in human-beaver conflicts. Thus, translocation also serves as an intervention in a stepwise conflict mitigation process. Often, these conflicts occur in more urbanized areas or along the valley bottoms of large rivers, where beaver are in conflict at the interface of human infrastructure. These beaver, captured from lower elevation areas where they are deemed to be causing problems, are most commonly released into small streams in headwater areas.

There have been varying levels of strategy and planning with regard to exactly where translocated beaver are released. CPW has opportunistically moved beaver involved in conflicts at one State Wildlife Area (SWA) to another SWA where beaver are more welcome, while occasionally permitting other individuals and organizations to move beaver. Some programs outside of Colorado, such as the Methow Okanogan Beaver Project in Washington, have systematically used translocation in a multi-pronged approach to support large-scale restoration across an entire river basin (Pollock et al. 2023). Increasingly, remote sensing tools and spatial models, such as the Beaver Restoration Assessment Tool (BRAT), are being utilized to identify translocation release sites. The Colorado Beaver Activity Mapper (COBAM) and associated map layers could serve as a primary tool for identifying and prioritizing release sites in Colorado.

## Standards for Increasing Translocation Success

The survival and retention of translocated beaver has been variable, emphasizing the importance of release site selection and preparation, as well as beaver care practices

during the translocation process. On the low end, McKinstry and Anderson (2002) found that of 234 beaver released to 154 sites in Wyoming over a six year period, 19% persisted and built dams. Beaver less than 2 years old showed 100% mortality or emigration after six months, while beaver age 3-4 featured the highest rates of survival and retention. The high mortality and emigration rates were attributed to predation and limited cover at release sites, which contained shallow water with no ponds.

Systematic translocation efforts in the Methow Valley, WA, included releasing beaver into pools more than 1 meter deep, as well as providing a temporary lodge and food. Project partners released an average of 4.7 beaver per site, resulting in dam-building beaver colonies at 61% of sites (Pollock et al. 2023). In the Yakima Beaver Project, 62% of 130 translocated beaver moved to unknown locations or died, while 36% were successfully established in 17 colonies within a year of being released. Thirteen beaver made known movements to different areas, with a maximum movement reported to be 40 miles in 47 days (Pollock et al. 2023). Petro (2013) found the survival rate of 38 beaver released into 9 sites across coastal Oregon to be 47% after 16 weeks. The greatest mortality occurred within one week of release and was largely attributed to predation by mountain lions.

It is important to temper expectations for beaver survival and retention at release sites. There are numerous examples of beaver failing to establish at targeted release sites, yet there are also many examples of translocated beaver establishing in stream reaches and restoring valuable wetland habitat. More contemporary findings have provided beneficial insights into factors that can potentially influence translocation success, which can be broadly categorized into release site standards, site preparation, and beaver care during the translocation process. CPW will need to develop best management practices for beaver care during trapping, holding, and transport. Release site and preparation standards are summarized below.

## Release Site Standards and Site Preparation

- **Using remote sensing and spatial modeling tools, the site has been identified as capable of supporting beaver**. The (BRAT) model has been commonly used for this purpose and is foundational to Utah's Beaver Management Plan. However, the BRAT has been applied in Colorado with mixed success. COBAM is recommended for identifying beaver restoration opportunity areas in Colorado, including translocation release sites (see Chapter 5, Restoration).
- **The valley gradient is less than 6% slope and is relatively broad**. Beaver preferentially occupy lower valley gradients where stream energy is lower, their

dams can withstand high flows, and the valley is broad enough for lateral floodplain connection that bolsters riparian vegetation.

- **The site hydrology includes perennially flowing water**.
- **Sufficiently deep (> 1 m) pools and some stream channel complexity are already present**. Such channel complexity can be in the form of meanders, oxbows, logjams, and backwaters, and should include woody vegetation that extends laterally, well beyond the stream channel (Ritter et al. 2023).
- **Ample woody vegetation in the form of willow, aspen, cottonwood, and/or alder is present and in close proximity to the water**. Mac Donald (1956) found that beaver in North Park, CO, were capable of eating 250-300 small trees per year (1500/family/year), and stressed the importance of small diameter trees, including dense willows, close to the water's edge. The older and larger the diameter of trees, the less efficiently they can be used as beaver forage.
- **In the absence of pre-existing channel complexity, deep pools, and/or sufficient woody vegetation, pre-restoration site preparation may be required.** Such restoration may include the construction of Beaver Dam Analogues (BDAs) and other types of Low Tech Process Based Restoration (LTBPR) and/or riparian exclusion fencing to minimize domestic and wild ungulate browse effects. Consider that it may take three to five years for riparian vegetation to re-establish in degraded sites prior to releasing beaver.
- **Artificial lodge structures or releasing near previously abandoned beaver lodges is encouraged**. Findings from The Methow Okanogan Beaver Project suggests that providing lodges constructed from hay bales or logs for immediate cover may enhance short term survival of released beaver.
- **Providing temporary food sources is encouraged and can include fresh cut aspen and willow.**
- **Careful consideration should be given to the proximity of existing beaver colonies.** Beaver should not be released where there is an existing colony, as beaver are territorial. A minimum of 1 km to avoid territorial conflict has been recommended (Corday 2025), but an even greater distance should be considered in Colorado. Beaver in a robust population were shown to disperse an average of 5 miles from their natal colonies and form new colonies in suitable habitats (Sun et al. 2000). If beaver colonies are in such close proximity and the potential for

unimpeded dispersal exists, then restoration should emphasize restoring habitat to encourage natural colonization, rather than the translocation of beaver.

- **Translocate whole colonies or mated pairs of adult beaver when possible**. Moving whole colonies is facilitated by temporarily holding beaver in captivity during trapping, until all beaver at the source site have been captured. However, human-beaver conflicts can often be the result of a young beaver (age 2-3) that has dispersed from its natal colony or a secondarily dispersing adult. In such cases, facilities with the resources to hold beaver in captivity for longer periods of time may be used to pair compatible mates prior to release (Corday 2025).
- **Consider stream network and property ownership context to avoid human-beaver conflicts, especially in consideration of private land and other human infrastructure.** Desktop evaluation using COBAM may be helpful, but on the ground evaluation may be critical with regard to adjacent landowner tolerance. There is no set distance criteria, but translocation efforts should consider that beaver rarely stay where they are released (Pollock et al. 2023). When evaluating a release site, the sites should be viewed in the context of the entire streamscape. Selecting a release site near the headwaters of a stream, with additional available suitable beaver habitat downstream, will help buffer the possibility of beaver creating new conflicts even further downstream.
- **Timing of beaver releases should occur when food resources are most available, with time for beaver to prepare for winter.** The ideal time for translocating beaver will minimally span the summer months. In the spring, care should be taken to avoid disrupting nursing kits and their mother. In the fall, beaver need to be provided time to develop a lodge and food cache before the onset of winter. Relatively high elevation sites may necessitate releases by late summer, while it may be feasible to release beaver later in the fall at lower elevation sites.

## Current Beaver Translocation Practices in Colorado

Translocation has remained an important management tool on CPW's properties, where an estimated average of 30 beaver were live-trapped and translocated annually from 2020-2024 (Appendix A). Over half of these beaver were involved in conflicts on SWAs, where they interfered with CPW irrigation infrastructure, caused water rights administration conflicts downstream, or flooded roads. It has been noted that immediate solutions are needed with waterinfrastructure, making translocation or lethal removal the most compatible option in such circumstances.

Translocation has been used to a lesser degree to address conflicts with hatchery operations on CPW fish hatcheries, and even less so to resolve conflicts on state parks, where conflicts involve road and trail flooding and vegetation loss. Most translocations on CPW lands are handled by DWMs or CPW property technicians, and beaver are often released elsewhere on the property or another SWA within the administrative region.

Translocation has recently gained interest from organized collaboratives across Colorado, including groups like the Boulder Watershed Collective, Yampa Valley Beaver Working Group, and the Rio Grande Headwaters Restoration Project (RGHRP). Organizations that are actively translocating often work with nuisance trappers, including USDA Animal and Plant Health Inspection Service-Wildlife Services (APHIS) and/or private nuisance operators. In 2025, APHIS was involved in the live trapping and translocation of five beaver colonies (Figure 7-2).

The Rio Grande Headwaters Restoration Project (RGHRP) is a non-profit watershed coalition that has collaborated with the Rio Grande National Forest, APHIS, CPW, and private landowners to facilitate beaver translocation. The effort has used a multi-prong approach of LTPBR and beaver translocation in headwaters of the Rio Grande basin, where over 120 stream restoration structures have been constructed and 46 beaver have been translocated (C. Born, personal communication, October 2025).

Figure 7-2. Wildlife Services (APHIS) staff implanting a radio transmitter tag on a translocated beaver (left) and releasing a translocated beaver (right). Photos courtesy of APHIS.

Partner coordination of the RGHRP's beaver translocation work has improved since their work began five years ago. Their recent success in coordinating these efforts has been attributed to strong communication between partners and private landowners. Sites on

RGNF are vetted through the U.S. Forest Service and permitted by CPW, trapping services are contracted with APHIS, beaver are held and quarantined at CPW's Frisco Creek Wildlife Rehabilitation Facility, and private landowners participate as beaver conflicts arise on their properties. CPW's Frisco Creek Wildlife Rehabilitation Center is the only wildlife rehabilitation facility operated by CPW and plays a critical role in supporting this local program (Figure 7-3).

Figure 7-3. A beaver being held at CPW's Frisco Creek wildlife rehabilitation facility

## Current Permitting Process in Colorado

Under CRS 33-6-106: 33-1-106 CPW has the *"Authority to regulate take, possession, and use of wildlife."* This statutory obligation with regard to beaver translocation is further clarified in PWC Regulation 303.A.3 which states, *"Relocation permit applications must be submitted to and approved by the Division prior to relocation. Permit approval or denial shall be based on the following: size of the relocation site; proximity of the site to public lands; habitat suitability and potential to support the relocated species; escape control, including buffer zones and active control if necessary; wildlife health and zoonotic disease concerns; and any other appropriate wildlife management concerns."* PWC Regulation 304.E states that, *"A relocation permit is required to relocate small game and furbearers, in accordance with special conditions listed in #303(A)(3)."*

What constitutes a "relocation permit" for beaver has varied across the four administrative regions of CPW. The Northeast Region utilizes a one page memorandum (Beaver Relocation Guidelines for the Northeast Region) that further stipulates standards for permitting translocations. Beaver translocations are then permitted via the issuance of a letter of authorization that includes stipulations mirroring the beaver relocation guidelines memo, and is signed by the Regional Manager. Outside the Northeast Region,

permitting standardization is variable. In some cases, a permit consists of an email from the AWM or DWM authorizing the translocation.

Translocations are permitted based on the release site, but standards used for evaluating translocation permit proposals have varied as well. For example, the Northeast Region will only individually permit release sites, and does not issue "blanket permits," while approving multiple sites in advance of the translocation season has increased efficiency for the RGHRP project and CPW staff involved in site evaluation. The Northeast Region memo states that beaver may only be relocated between June 1 and September 1, but the Southeast Region issues permits as early as April 1. Unlike several other states, CPW doesn't currently use a standardized site evaluation scorecard to rank potential release sites.

# Risk of Spreading Disease, Aquatic Pathogens, and Aquatic Nuisance Species (ANS)

There is inherent risk involved with translocating wildlife, particularly when disease is part of the landscape (Hartley and Sainsbury 2017). Translocation of beaver may include risk of disease spread across distances that individual beaver would not move naturally. This includes diseases that can spread between beaver, as well as other aquatic pathogens or ANS that could be transferred with beaver translocations. These risks will likely always be pronounced because human-beaver conflicts typically occur in the downstream reaches of watersheds, where disease, pathogens, and ANS are more common. Translocated beaver are often released in upper, more pristine reaches of watersheds.

## Beaver Pathogens

There are several pathogens and diseases that can affect beaver, some of which are zoonotic, meaning they can be spread to other animals, including humans. However, if translocated beaver are screened for clinical signs of illness, then these diseases should be of minimal concern for spreading through translocation because infected animals would present clinical evidence.

According to a recent survey, states that conduct and permit beaver translocations include a range of disease screening. Washington and New Mexico do not require any screening for beaver pathogens and do not test for a set list of beaver pathogens. However, Arizona, California, and Oregon all appear to have screening requirements that include testing for some combination of tularemia, leptospirosis, yersinia, giardia, coccidia, and toxoplasmosis. Screening methods can include serology and fecal examination for

parasites. Multiple day quarantine that includes drying periods is a common method for reducing risk, and parasiticides are commonly administered for parasite treatment. Disease prevalence has been well studied for translocated beaver in Utah, where the disease prevalence in beaver was reported low, but parasitic treatment is recommended (Roug et al. 2022).

## Aquatic Pathogens

A perhaps greater risk includes the potential for beaver to carry viable aquatic pathogens and/or ANS through the translocation process, which could then establish where the beaver are released. Of recent concern is the amphibian chytrid fungus, caused by *Batrachochytium dendrobatidis* (Bd) and *Batrachochytrim salamandrivorans* (Bsal). Bd is well established in North America, while Bsal is not currently established (Olson et al. 2021).

Bd persists in aquatic environments and has caused amphibian declines around the world, with some species being more susceptible than others (Berger et al. 2016). It is the leading cause for the decline in the Southern Rocky Mountain Boreal Toad population in Colorado (Crockett 2023), a Tier 1 Species of Greatest Conservation Need (CPW 2025).

Burgher (2025) found that Bd remained viable for at least 21 days on sections of beaver pelt and that neither drying nor salt treatments were 100% effective at eliminating Bd viability. A 9.5 hour dry period was the most effective treatment, with multiple dry periods being recommended to minimize risk. The study was conducted under conditions ideal for Bd and did not utilize live beaver. More research is needed using live beaver, additional treatment methods, and in situ beaver sampling.

The state of Washington recently restricted movement of beaver from HUC10 watersheds known to be positive for Bd to HUC10 watersheds that have tested negative, or have not been tested. For these restricted Bd positive watersheds, there are additional quarantine requirements for beaver being moved across watershed boundaries.

Understanding of Bd spatial distribution in Colorado is limited, with most Bd testing having occurred at known Boreal Toad breeding sites, located at elevations between 9,000 and 12,000 feet. The prevalence of Bd outside of Boreal Toad breeding sites has not been well studied. However, at elevations below 8,000 feet, the distribution of the invasive American Bullfrog likely serves as a good proxy for Bd, as the species is known to carry and spread Bd. Bullfrogs are widespread in aquatic habitat along the Front Range and Eastern Plains, and have recently expanded along the Colorado River in the Grand Valley (Johnson et al. 2011).

Ranavirus is another amphibian pathogen that has recently caused some localized amphibian die offs in Colorado, but very little is known about the distribution and prevalence of this highly pathogenic amphibian virus. It is also believed to be commonly carried and spread by American Bullfrogs. Nothing is known about the potential for ranavirus to persist on beaver through the translocation process.

A potentially concerning fish pathogen is whirling disease, caused by the parasite *Myxobolus cerebralis*. It has a two-host life cycle that includes the *Tubifex tubifex* aquatic worm and trout, as well as two primary life stages (Beauchamp et al. 2002). Triactinomyxons (TAMs) are the waterborne stage that infect trout. They are somewhat fragile and become non-viable in the environment in days to weeks (El-Matbouli et al. 1999). However, the myxospores shed by infected fish are much more resilient, persisting in the environment and on various substrates for up to a year (Nehring et al. 2015). Myxospores could be transported in fine sediment embedded in beaver feet and fur (Hallet et al. 2015).

After being introduced to Colorado in the 1990s, whirling disease is ubiquitous in the mainstem of every major river basin in Colorado, where it has generally eliminated wild Rainbow Trout populations (Nehring et al. 1998; Figure 7-4). Whirling disease has also spread into some headwater systems, while many others remain negative for the parasite or have not been tested (Nehring et al. 2015). The threat of upstream expansion is of particular concern because most native cutthroat trout conservation populations are isolated in headwater reaches and cutthroat trout are highly susceptible to the disease (Zeigler et al 2019).

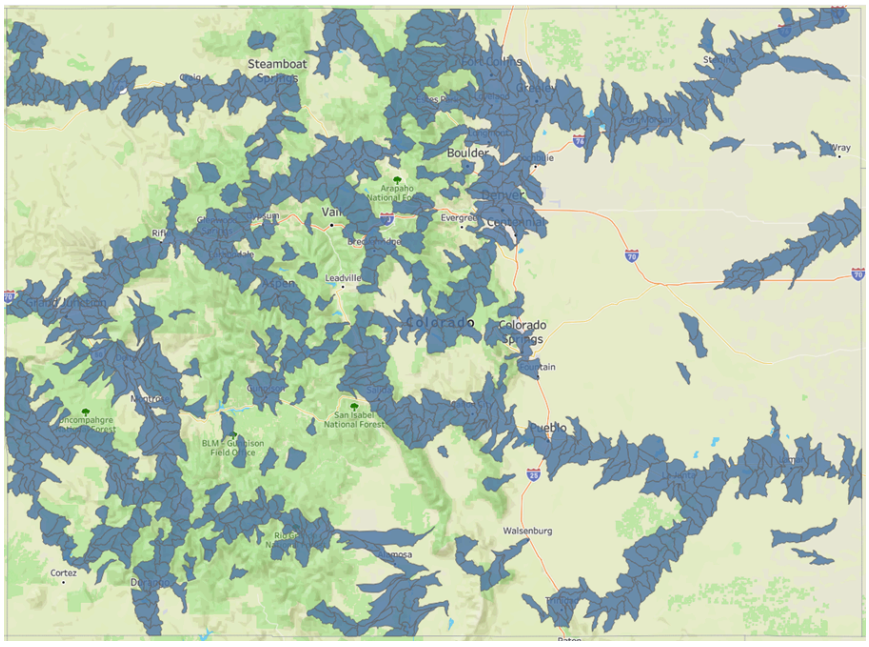


Figure 7-4. HUC12 watersheds that have tested positive for WD, have been stocked with WD positive fish, or are assumed positive based on their downstream proximity to known positive watersheds (blue shading). All other watersheds have not been tested or have tested negative.

Neighboring states have addressed the concern of beaver translocation and whirling disease spread with quarantine requirements and/or restricted watersheds, while some don't have specific criteria for the disease. New Mexico will not translocate from waters with known or suspected whirling disease presence to waters with known or suspected absence, but does not have quarantine requirements (New Mexico Game and Fish 2025). Utah allows transfer of beaver from waters known to be positive for whirling disease to putatively negative waters if their quarantine protocols are followed (Utah Division of Wildlife Resources 2017). Wyoming handles the threat on a case by case basis. Persistence of *M. cerebralis* through the translocation and quarantine process has not been explicitly studied.

### Aquatic Nuisance Species

Aquatic Nuisance Species (ANS) are invasive plants and animals that are transported and released, intentionally or unintentionally, outside of their native range (CPW 2020). The spread of ANS in Colorado's waters is a persistent threat that warrants careful consideration with regard to beaver translocation. Species of highest concern and potential to spread through beaver translocation include New Zealand mudsnails, zebra mussels, quagga mussels, and Eurasian watermillfoil, though the ability of these organisms to persist through the beaver translocation process, as well as treatment methods for beaver, has not been studied. Some states prohibit translocation of beaver from known ANS positive waters, while others address the concern with quarantine procedures.

## Beaver Holding and Quarantine Facilities

Translocation procedures that minimize risk of pathogen spread include the use of quarantine protocols, which are facilitated by structures designed to temporarily hold beaver, or holding facilities. Holding facilities provide the additional benefit of housing beaver during multi-day efforts to trap all beaver at a site and for pairing potential mates captured as single animals from different sites. Moving whole family units or mating pairs contributes to successful establishment at the release site. Holding facilities should meet the following general guidelines:

- Provide an artificial lodge, which can be as simple as a metal watering trough with an opening cut in the side, or constructed from cinder blocks.

- Maintain temperatures between 32 and 84 F (Mac Arthur 1989), and provide constant shade and misting during hotter months.
- Provide water that is ideally 1 meter deep, or at a minimum deep enough for beaver to completely submerge for swimming and bodily functions, with features that enable beaver to enter and exit the water with ease.
- Water should be easy to change on a daily basis with minimal disturbance to beaver, and facility water disposal should not pose a risk of pathogens or ANS to local waterways.
- Enclosures should provide solid screening from adjacent kennels to reduce stress to beaver from seeing or interacting with non-related beaver and people.
- The facility should be easy to clean and disinfect between beaver or beaver groups.
- The entire enclosure should be surrounded by beaver-proof fencing that prevents digging, climbing and chewing their way out and to prevent entry of predators.
- The facility should be located away from vehicle and foot traffic, and held a good distance away from any natural predators. Beaver have well developed olfactory senses, so the presence of predators may cause stress.

Several programs across the west have successfully utilized holding facilities (Corday 2025). Hatchery raceways that are seasonally operated for salmon culturing have been used by the Tulalip Tribes, Methow Okanogan Beaver Project, and Wenatchee Beaver Projects, all in the state of Washington. However, these types are not likely to be a feasible option for Colorado.

More commonly used are the kennel run types (Figure 7-5). These include a 6-kennel facility maintained by IDGF, the Utah Beaver Ecology and Relocation Collaborative (BERC) “beaver bunkhouse” on Utah State University property, Wyoming Wetlands Society’s new (2023) four-kennel holding facility and Wyoming Game and Fish Department’s (WGFD) new (2023) state of the art facility in Cody, WY. The cost to build these facilities ranged from $15,000 to $80,000 (Corday 2025).

Partnerships with zoos have also been utilized to provide holding facilities and support beaver translocation, because they typically have appropriate facilities and are experts in wildlife husbandry, with veterinarians on staff (Corday 2025). Examples of such partnerships include the Oregon Zoo, and Zootah in Logan, Utah. Similar to zoos, wildlife rehabilitation facilities may provide additional opportunities for unique partnerships that facilitate beaver holding in Colorado.

Figure 7-5. Kennel run beaver facility examples. Clockwise from top left: Idaho Game and Fish's beaver holding kennel, the "Beaver Bunkhouse" on Utah State University property, and the Wyoming Wetland Society's facility

WGFD has also effectively used mobile trailer-mounted facilities with improved design (Figure 7-6). These are particularly useful because they are fairly rugged and can be brought to trapping sites, modular with components that can easily be removed and cleaned, and capable of hooking up directly to local plumbing. As a mobile facility they can also conceivably be loaned to partner organizations doing translocation work.

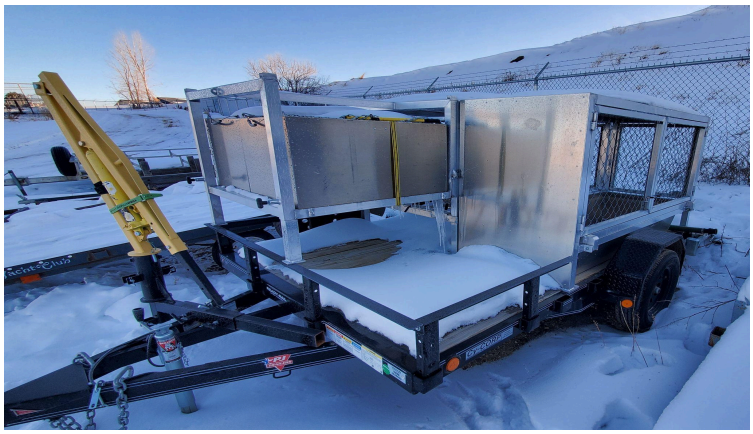


Figure 7-6. Wyoming Game and Fish mobile beaver holding and quarantine trailer.

# Opportunities and Challenges

- Hundreds of human-beaver conflicts occur each year in Colorado. While CPW should promote coexistence first, a small subset of these conflicts could result in beaver being available for translocation to support restoration objectives.
- Effective translocation will require the availability of approved release sites, where translocation is an appropriate management action. The recent development of remote sensing and spatial modeling tools can help with prioritizing sites for further consideration. Contemporary translocation programs as well as a body of scientific literature have provided valuable insight for "boots on the ground" evaluation and prioritization of potential release sites.
- It is not well understood the degree to which translocated beaver may be a source for transmitting aquatic pathogens, ANS, and other diseases of concern, but recent studies suggest this requires further investigation. There are available methods to study and better quantify the risk of transmission, as well as potential treatments. Such research should be prioritized and coordinated with other states dealing with the same concerns.
- Effective translocation will require the availability of quarantine and holding facilities, which enable quarantine procedures that reduce the risk of disease spread and may facilitate whole colony capture and/or mate pairing. Between CPW and a few partner organizations there may already be some facilities that could be improved with minimal investment to better support beaver translocation, but additional resources and investment will also need to be considered.

- Several nuisance operators, including private and government entities, are already operating in Colorado and are adept at using live trapping techniques to capture beaver.
- Timing and the ability to move whole colonies or mated pairs will also be an important factor to consider. Many human-beaver conflicts occur in spring and fall, when conditions may not be best for survival of released beaver. Furthermore, it is common for these conflicts to involve an individual dispersing beaver, which may not be compatible for immediate translocation.
- While beaver are generally regarded as beneficial to aquatic habitats and species, in some cases beaver translocation may be in conflict with other wildlife management objectives. These concerns may be nuanced and are best understood by CPW field staff.

## Goals, Strategies, and Actions

**Goal: Optimize relocation as a tool to support restoration objectives by providing a standard permitting process that maximizes translocation success, while reducing the risk of disease and Aquatic Nuisance Species (ANS) spread.**

**Strategy 1: Develop a standardized and understandable translocation permitting process** that is streamlined, with a focus on efficiently pairing beaver conflicts with available release sites.

**Actions:**

- **Centralize the beaver translocation permit as a license through CPW Special Licensing**. This would facilitate better tracking of translocation activities and standardize the expectations of potential permittees, regardless of where in the state they are working.
    - Require approval from appropriate staff including, the regional Native Aquatic Species Biologist, Area Aquatic Biologist, District Wildlife Manager, Area Wildlife Manager
    - Enable and encourage permitting of multiple release sites under a single permit. Watershed coalitions and other organizations should identify sites for translocation permitting early in their program development.
    - Develop a permit application specific to beaver translocation and require year end reporting to gather detailed data on translocations

    - Once a new permitting process is established, provide web resources that help public and partner organizations understand and navigate the process.

- **Identify a central CPW staff member to coordinate beaver conflicts, holding facilities, nuisance operators (live-trappers), and permitted release sites**.
- **Maintain a database to track all future beaver translocations,** and incorporate historic translocation records as available.
    - Identify a centralized staff member to work with Regional and Area staff to accession all past beaver translocation records, including all available relevant data.
    - Working with CPW Aquatic Research and Terrestrial Species Conservation staff, develop a database to track past and current translocations, including source and release locations.
- **Develop standardized translocation season dates on a sliding scale that varies depending on the elevation of the release site.**

**Strategy 2: Develop translocation procedures that maximize beaver well being and translocation success,** while minimizing the risk of pathogen spread and unintended negative consequences to other wildlife and habitat management objectives.

**Actions:**

- **Develop a standardized release site scorecard** for evaluation of all potential release sites based on ecological and conflict minimization criteria.
- **Require CPW aquatic staff initial review of translocation release site proposals** in the permitting process to provide a nuanced assessment of risk to aquatic species and habitat management objectives.
- **Starting small, build a network of holding facilities,** to support new quarantine requirements and facilitate whole colony capture and mate pairing. Consider an initial goal of one facility per region. These facilities could include CPW operated facilities, as well as facilities owned and operated by other government and non-profit organizations. Identify and provide support for these facilities.
    - Utilize the holding facilities network to collaboratively study and share information on quarantine and beaver care methodology.

- Develop specific requirements for short-term and longer-term facilities, including a minimum requirement of a "vet-client" relationship for facilities.
- Invest in mobile beaver holding trailers, based on designs provided by WGFD. One trailer per region would provide CPW field staff an option for holding and quarantining beaver translocated from CPW properties, and provide a short term solution to meet new beaver quarantine requirements.
- Invest in improvements at CPW's Wildlife Animal Health Lab in Fort Collins. With some minor investment, the lab could support beaver holding and quarantine in the short term. The lab is scheduled to change locations in 2033. Explore the possibility of leveraging this already existing effort to include state-of-the-art facilities for beaver holding.
- Invest in improvements at CPW's Frisco Creek Wildlife Rehabilitation Facility in the SW Region including dedicated beaver runs. The facility is already a critical component in an active beaver translocation program, but both partners and CPW staff have noted some needed improvements to better serve the purpose of beaver holding.
- Support efforts by APHIS to incorporate beaver holding and associated research into their Fort Collins facility in the NE Region.
- Explore and consider programs to support Wildlife Rehabilitator development of beaver holding facilities that meet specific beaver holding requirements. Some wildlife rehabilitation centers could be in a unique position to incorporate or increase beaver holding capacity, with some investment.

- **Require quarantine of any translocated beaver being moved across HUC12 watershed boundaries,** unless being moved downstream within the drainage network. Quarantine should consist of a minimum 72 hour holding period for each beaver, in which water is changed daily, and beaver experience at least two 9 hour dry periods (no access to water) during the quarantine process. Flexibility in this requirement may be appropriate initially, and become more rigid as more holding and quarantine facilities become available. HUC12 represents a relatively small watershed scale and is used for translocation because it is the smallest unit that would generally encompass the home range and natural dispersal distances of beaver. It is also the scale for which aquatic pathogens and aquatic species distribution are reported.

- **Develop and provide standard operating procedures for live-capture, holding, transport, and release of beaver.**
- **Support research to develop a better understanding of pathogen persistence on beaver** and the efficacy of different quarantine treatments.
- **Support research to better understand current spatial distribution of aquatic pathogens** as it relates to risk of spread associated with beaver translocations.
    - Focus Whirling Disease studies in HUC12 watersheds where testing has not occurred and status is unknown. Such information would also help guide other agency priorities, such as cutthroat trout restoration.
    - Support amphibian research that aims to better understand the distribution of Bd and other amphibian pathogens, perhaps prioritizing beaver restoration opportunity watersheds and identified release sites.
- **Prevent translocation of beaver from areas known to be positive for ANS of greatest concern**.

## Additional Resource Needs

The addition of staffing capacity may be required for coordinating beaver translocations, which should be led by staff with knowledge of the nuanced concerns related to aquatic pathogens. There would be a minimal increase in workload for Special Licensing, which would initially consist of developing a license application and incorporating it into current systems. It would then take an estimated one hour of staff time to process a single beaver translocation application. A considerable capital investment would be needed to build holding facilities on the two CPW properties identified above and acquire beaver holding trailers. Additionally, funding to support seasonal staff to help operate facilities may be needed. Translocation database management may already fit well under current staff responsibilities, though some additional workload should be expected.

New funding and partnerships are needed to support the development of additional beaver holding facilities beyond CPW properties, and to support priority research related to aquatic pathogen concerns. CPW should provide funding for this effort, through existing or new programs.

# Chapter 8: Summary of Goals, Strategies, and Actions

Tables 8-1 through 8-5 below present a summarized version of the Beaver Strategy's goals, strategies, actions, resource needs and partners by chapter. Each chapter contains additional detail, including rationale, sub-actions, and other guidance for implementing these recommendations.

Cross-cutting needs for successful Beaver Strategy implementation across all goals include:

- **Funding, capacity, and technical assistance** to support a variety of strategies and actions
- **Collaboration and coordination** within and among CPW, other State partners, and federal, local, Tribal, NGO, and private partners
- **Local and community involvement** to identify and gain support for the most locally relevant priorities and activities
- **Outreach and education** led by a variety of partners, and for a variety of audiences
- **Research and monitoring** to address data gaps, track progress, and support science-informed management

Successful implementation of all these strategies will require collaboration among multiple experts and partners.

**Table 8-1. Chapter 3: Population and Habitat Status and Monitoring**

**Goal:** Improve knowledge of the extent of beaver habitat and beaver populations in Colorado.

| Strategies | Actions |
|---|---|
| Estimate spatial extent of beaver wetlands & population size at statewide & watershed (HUC4) scales | • Update beaver wetland mapping & display in Colorado Beaver Activity Mapper<br>• Refine estimates of individuals per complex & bank-denning beaver<br>• Combine refined mapping and population estimates to reassess beaver population projections every 5-10 years |
| Estimate beaver occupancy – statewide & HUC10 scales | • Develop monitoring approach; ground-truth fall food caches<br>• Implement pilot occupancy monitoring in 2-3 HUC10s |

**Table 8-2. Chapter 4: Beaver Harvest Management**

**Goal:** Manage beaver populations for continued sustainable avocational harvest.

| Strategies | Actions |
|---|---|
| Develop sustainable harvest caps at watershed scale | • Develop HUC4-scale annual avocational harvest caps<br>• Evaluate spatial harvest data annually to assess population status against drainage harvest caps<br>• Implement regulatory steps to reduce harvest when caps are exceeded |
| Improve spatial resolution of harvest data | • Initiate chapter W-3 rulemaking on mandatory checks of avocationally-taken beaver<br>• Collect & maintain data on harvest date, method, location for use in annual evaluations |
| Evaluate avocational harvest levels on beaver restoration opportunity watersheds annually | • Examine spatial harvest data in HUC10 beaver restoration opportunity watersheds<br>• Consider temporary HUC10 harvest closures (public land only) if harvest is impacting restoration efforts |
| Estimate survival and sources of beaver mortality | • Develop recruitment, survival, & mortality monitoring study approach<br>• Implement pilot recruitment, survival, and mortality monitoring studies in 2-3 HUC10s<br>• Research prevalence and spatial dynamics of tularemia in CO, and role of disease in regulating beaver populations<br>• Encourage other agencies to estimate annual beaver take from human-beaver conflicts. |

**Table 8-3. Chapter 5: Beaver Restoration Opportunities**

**Goal:** Support a thriving beaver population by identifying opportunities and encouraging strategic restoration of ecologically and socially suitable historical, but currently unoccupied, beaver habitats.

| Strategies | Actions |
|---|---|
| Identify greatest opportunities for beaver restoration | • Model & map suitable habitat statewide<br>• Identify subset of beaver restoration opportunity watersheds with greatest ecological benefit & minimized human conflict<br>• Re-evaluate restoration opportunity watersheds & sites every 5 years |

| | |
|---|---|
| Increase occupation of unoccupied suitable habitat | • Collaborate with partners to prioritize & implement restoration activities in watersheds with abundant acreage of suitable unoccupied habitat<br>• Pair translocation with vetted restoration sites |
| Create & maintain beaver-focused tools & resources | • Maintain CO Beaver Activity Mapper with restoration-related mapping layers.<br>• Develop & maintain beaver Decision Support System to screen restoration opportunity watersheds & sites.<br>• Maintain Beaver Habitat Scorecard to rapidly assess habitat restoration suitability.<br>• Host links to restoration tools & resources on centralized toolkit website.<br>• Explicitly connect restoration with coexistence in outreach, engagement, & review of project proposals.<br>• Connect people seeking to restore habitat to tools & resources through outreach & engagement.<br>• Develop a standard coordination process between CPW and DWR for responding to water right administration issues arising from beaver related restoration activity. This process could also consider appropriate agency coordination when beaver activity impacts water infrastructure such as measurement devices, diversions, and dam outlets. |

**Table 8-4. Chapter 6: Living with Beaver - Nonlethal Conflict Resolution**

**Goal:** Promote the widespread adoption of nonlethal solutions to common beaver conflicts when such solutions are appropriate and feasible.

| **Strategies** | **Actions** |
|---|---|
| Increase education about the value of beaver & their habitat, and nonlethal solutions & resources to address common beaver problems | • Within CPW, institutionalize a shared understanding of the value of beaver and their wetlands to habitat, wildlife, and society as a whole.<br>• Lead and collaborate with partners on developing external education materials.<br>• Update CPW's Living with Beaver webpage materials to include the relevant information from the Beaver Strategy on coexistence.<br>• Work with partners to develop co-branded education materials to target different audiences. |
| Collaborate with partners on comprehensive outreach that reaches diverse key audiences | • Work with partners to identify key spokespeople and create opportunities within various communities to distribute living with beaver educational materials.<br>• Work with Tribal governments to identify opportunities to incorporate tribal management perspectives into education and outreach materials. |

| | |
|---|---|
| | • Work with CWCB to promote & prioritize beaver coexistence in watershed planning grants.<br>• Identify opportunities to share educational materials with other state agencies to promote coexistence.<br>• Establish coexistence demonstration projects on CPW properties that have a combined high degree of beaver conflicts and public visitation.. |
| Expand statewide capacity to support coexistence solutions through formal training | • Work with partners to organize annual coexistence training workshops to increase capacity within CPW and partners across the state.<br>• Identify and prioritize CPW staff each year to participate in coexistence training.<br>• Collaborate with partners to establish a volunteer network in each region to assist with coexistence work in order to increase capacity and foster community ownership.<br>• Develop a network of trained coexistence contacts for each geographic region considering that CPW staff alone will not be able to timely respond to all complaints. |
| Increase the use of nonlethal solutions to beaver problems through establishment of cost-share programs for landowners | • Work with partners to establish coexistence cost-share programs that can respond in a timely manner to beaver complaints.<br>• Conduct annual surveys of landowners who received assistance to implement coexistence to determine effectiveness of the measures taken among other data that will be helpful for future coexistence work. |

### Table 8-5. Chapter 7: Translocation Policy and Protocol

Goal: Optimize translocation as a tool to support restoration objectives by providing a standard permitting process that maximizes translocation success while reducing the risk of disease and Aquatic Nuisance Species (ANS) spread.

| **Strategies** | **Actions** |
|---|---|
| Develop standardized and understandable translocation permitting process | • Centralize the beaver translocation permit as a license through CPW Special Licensing<br>• ID central CPW staff member to coordinate conflicts, holding facilities, nuisance operators, permitted release sites<br>• Maintain database to track beaver translocations<br>• Develop standardized translocation season dates |

| | |
|---|---|
| Develop translocation procedures that maximize beaver well-being & translocation success | • Develop standardized release site scorecard<br>• Require CPW aquatic staff review of release site proposals<br>• Build network of holding facilities<br>• Require quarantine of beaver moved across HUC12 boundaries<br>• Develop standard operating procedures for live-capture, holding, transport, & release of beaver<br>• Research pathogen persistence on beaver<br>• Research spatial distribution of aquatic pathogens<br>• Prevent translocation of beaver from ANS positive areas |

# Potential Partners

## Public Sector

- State agencies
    - CO Department of Agriculture
    - CO Department of Natural Resources
    - CO Department of Public Health and Environment
    - CO Department of Transportation
    - CO State Land Board
    - CO Water Conservation Board
- Federal agencies
    - U.S. Army Corps of Engineers
    - U.S. Bureau of Land Management
    - U.S. Fish and Wildlife Service
    - U.S. Department of Agriculture
        - Natural Resources Conservation Service
        - U.S. Forest Service
        - Animal and Plant Health Inspection Service, Wildlife Services
    - U.S. National Park Service
- Local governments
    - County governments
    - City and county-level parks & open space

    - City and county-level public works
    - Municipal governments
    - Public water utilities
- Public academic and research institutions (e.g., universities; CO Natural Heritage Program)
- Water conservation districts

## Tribal Governments

- Southern Ute Indian Tribe
- Ute Mountain Ute Tribe

## Private Sector and Non-Governmental Organizations

- Academic and research institutions (private)
- Ditch companies and managers
- Foundations
- Non-profit organizations and collaboratives
    - Agricultural advocacy organizations
    - Beaver advocacy organizations and working groups
    - Environmental education groups
    - Flood districts
    - Land trusts
    - Local government organizations and associations
    - Regional Partnerships and Water Basin Roundtables
    - Sportsperson's advocacy organizations
    - Tribal and Indigenous interest organizations
    - Watershed health and restoration groups
    - Wildlife conservation organizations
    - Wildlife rehabilitation facilities
    - Zoos
- Nuisance operators

- Private landowners
- Water managers
- Water providers

# Literature Cited

Association of Fish and Wildlife Agencies Furbearer Conservation Working Group. 2019. Conservation Brief. The Implication of a Statewide Ban on Trapping: The Massachusetts Experience.

Bailey, R. W. 1954. Status of beaver in West Virginia. J. Wildl. Manage. 18(2): 184-190.

Baker, B.W., H.C. Ducharme, D.C.S. Mitchell, T.R. Stanley, and H.R. Peinetti. 2005. Interaction of beaver and elk herbivory reduces standing crop of willow. Ecological Applications 15(1):110-118.

Beauchamp, K.A., Gay, M., Kelley, G.O., El-Matbouli, M., Kathman, R.D., Nehring, R.B., and Hedrick, R.P. 2002. Prevalence and susceptibility of infection to Myxobolus cerebralis, and genetic differences among populations of Tubifex tubifex. Diseases of Aquatic Organisms 51(2): 113-121.

Beaver Institute. 2024. Low-tech, process-based restoration partnerships, collaborations, communication, and lessons learned. Youtube. 05 February 2025. Available: https://www.youtube.com/watch?v=RSxvZlrnWks.

Beck, J. L., D. C. Dauwalter, D. M. Staley, and S. R. Hirtzel. 2008. Beaver monitoring protocol for Forest Service Region 2. 74pp.

Berger, L., A.A. Roberts, J. Voyles, J.E. Longcore, K.A. Murray, and L.F. Skerratt. 2016. History and recent progress on chytridiomycosis in amphibians. 2016. Fungal Ecology 19:89-99.

Boyle, S. and Owens, S. 2007. North American Beaver (*Castor canadensis*): A Technical Conservation Assessment, prepared for the USFS, Rocky Mtn Region, Species Conservation Project.

Boyles, S. and B. Savitzky. 2008. An analysis of the efficacy and comparative costs of using flow devices to resolve conflicts with North American beaver along roadways in the coastal plain of Virginia. Proceedings 23rd Vertebrate Pest Conf., Published at Univ. of Calif., Davis, pgs 47-52.

Brazier, R. et al. 2020. Beaver: Nature's ecosystem engineers, WIREs Water, Vol. 8(1).

Burgher, J.A.S. 2025. Evaluating the effects of beaver-related restoration on aquatic ecosystems: outcomes and risks of beaver reintroductions. Thesis, Washington State University.

Callahan, M., R. Berube, and I. Tourkantonis. 2019. Billerica Municipal Beaver Management Program. 2000 - 2019 Analysis., Assoc. of MA Wetland Scientists.

Castro, J.M., and C.R. Thorne. 2019. The stream evolution triangle: integrating geology, hydrology and biology. River Research and Applications 35(4):315-326.

Colorado Department of Public Health and Environment (CDPHE). 2022. Colorado's Nonpoint Source Management Plan: 2022. 41 pp. Online at: https://drive.google.com/file/d/1nQxhHkYqSAckOZVyWEc2NKuO6lzcbtCH/view

Colorado Game and Fish Commission. 1941. Colorado Beaver Survey. Pittman-Robertson Project 2-R and 4R.

Colorado Parks and Wildlife. 2020. State of Colorado aquatic nuisance species management plan. ANS Management Plan. 104 pp.

Colorado Parks and Wildlife. 2025. State Wildlife Action Plan. Available: https://engagecpw.org/state-wildlife-action-plan.

Colorado Water Conservation Board (CWCB). 2023. Colorado's Water Plan. 254 pp. Online at: https://dnrweblink.state.co.us/CWCB/0/edoc/219188/Colorado_WaterPlan_2023_Digital.pdf.

Corday, J. 2025. Beaver management planning: a review of existing plans and programs with recommended best management practices. National Wildlife Federation. 85 pp.

Crockett, H. (ed.). 2023. Conservation plan for the boreal toad (Anaxyrus boreas boreas) in the Southern Rocky Mountains. Boreal Toad Conservation Team. 80 p. + Appendices.

Dahl, TE. (1990). Wetlands – Losses in the United States, 1780s to 1980s. U.S. Department of the Interior, U.S. Fish and Wildlife Service Report to Congress. 20 pp. Online at: https://www.fws.gov/sites/default/files/documents/Wetlands-Losses-in-the-United-States-1780s-to-1980s.pdf.

Denney, R.N. 1952. A summary of North American beaver management: 1946-1948. Colorado Game and Fish Department Current Report No. 28. 58 pp.

Dunn, S.B., S.L. Rathburn, and E. Wohl. 2024. Post-fire sediment attenuation in beaver ponds, Rocky Mountains, CO and WY, USA. Earth Surf. Process and Landforms. 49(13):4340-4354.

El-Matbouli, M., T. S. McDowell, D. B. Antonio, K. B. Andree, and R.P. Hedrick. 1999. Effect of water temperature on the development,release and survival of the triactinomyxon stage of *Myxobolus cerebralisin* its aquatic oligochaete host. International Journal of Parasitology 29:627–641.

Fairfax, E. and A. Whittle. 2020. Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western United States. Ecological Applications 30(8):e02225.

Fairfax, E., E. Zhu, N. Clinton, S. Maiman, A. Shaikh, and W. W. Macfarlane. 2023. EEAGER: A neural network model for finding beaver complexes in satellite and aerial imagery. Journal of Geophysical Research: Biogeosciences 128. 16pp.

Gable, T. D., and S. K. Windels. 2018. Kill rates and predation rates of wolves on beaver. The Journal of Wildlife Management 82:466–472.

Gerwing, T.G., C.J. Johnson, and C. Alstrom-Rapaport. 2012. Factors influencing forage selection by the North American beaver (Castor canadensis). Mammalian Biology 78:79-86.

International Association of Fish and Wildlife Agencies. 2005. Trapper Education Manual.

Hallett, S. L., Hartigan, A., and Atkinson, S. D. (2015). Myxozoans on the Move: Dispersal Modes, Exotic Species and Emerging Diseases. In B. Okamura, A. Gruhl, and J. L. Bartholomew (Eds.), Myxozoan Evolution, Ecology and Development (pp. 343–362). Springer International Publishing. https://doi.org/10.1007/978-3-319-14753-6_18.

Hartley, M. and A. Sainsbury. 2017. Methods of disease risk analysis in wildlife translocations for conservation purposes. EcoHealth 14: 516-529.

Hay, K. G. 1955. Development of a beaver census method applicable to mountain terrain in Colorado. M. S. thesis, Colorado A & M College, Fort Collins. 143pp.

Hay, K. G. 1958. Beaver census methods in the Rocky Mountain Region. J. Wildl. Manage. 22(4):395-402.

Henderson, F. R. 1960. Beaver in Kansas. State Biological Survey, University of Kansas.

Heter, E. 1950. Transplanting beaver by airplane and parachute. The Journal of Wildlife Management:143-147.

Johnson-Bice, S. 2019. Factors influencing beaver (*Castor Canadensis*) population fluctuations, and their ecological relationship with salmonids. MS Thesis. University of Minnesota.

Johnson, P.T.J. Johnson, V.J. McKenzie, A.C. Peterson, J.L. Kerby, J. Brown, A.R. Blaustein, and T. Jackson. 2011. Regional decline of an iconic amphibian associated with elevation, land-Use change, and invasive species. Conservation Biology 25(3): 556-566.

Johnston, C.A. and S.K. Windels. 2015. Using beaver works to estimate colony activity in boreal landscapes. The Journal of Wildlife Management 79(7):1072–1080.

Kinas, H., K. O'shaughnessy, and A. McLeod. 2024. Alberta Beaver Beneficial Management Practices, Miistakis Institute, Alberta Canada.

Kohn, B.E. and J.E. Ashbrenner. 1995. Beaver Population Status. Wisconsin Department of Natural Resources. 1995:26.

Laurel, D., and E. Wohl. 2018. The persistence of beaver-induced geomorphic heterogeneity and organic carbon stock in river corridors. Earth Surf. Process, Landforms 44:342-353.

Mac Arthur, R.A. 1989. Energy metabolism and thermoregulation of beaver (*Castor Canadensis*). Canadian Journal of Zoology 67:651-657

Mac Donald, D. 1956. Beaver carrying capacity of certain mountain streams in North Park, Colorado. Thesis, Colorado State University.

Marshall, S.M., D. Bull, M. Lythe, B. Spinner, and M. Chapman. 2024. Beaver Pond Data from the Colorado Beaver Activity Mapper (Version 1). Colorado Natural Heritage Program, Fort Collins, Colorado, U.S.A. [producer and distributor] and Lynker Technologies, Boulder, Colorado [producer].

Marshall, S.M. and G. Smith. 2022. Colorado Beaver Activity Mapper. Online Mapping Tool. Colorado Natural Heritage Program, Colorado State University. Available online: https://csurams.maps.arcgis.com/apps/webappviewer/index.html?id=1051266316f0449f8d657ac3bf9a53ed

Mayer, M., C. Aparicio Estalella, S.K. Windels, and F.N. Rosell. 2020. Landscape structure and population density affect intraspecific aggression in beaver. Ecology and Evolution 10(24):13883-13894.

McColley, S.D., D.B. Tyers, and B.F. Sowell. 2011. Aspen and Willow Restoration Using Beaver on the Northern Yellowstone Winter Range. Restoration Ecology.

McKinstry, M. and S. Anderson. 2002. Survival, Fates, and Success of Transplanted Beaver, *Castor canadensis*, in Wyoming. Canadian Field-Naturalist 116:60-68.

Millman, K. 2022. Beaver management along roads and within the right-of-Way, report and recommendations for the Colorado Department of Transportation. Colorado Department of Transportation, Denver, CO. 67pp.

Moravek, J.A., J. Brashares, M. Girotto, R. Spivak, A. Kerr, A. Molod, S. Feirer, R. Johnson, A. Getirana, E. Fairfax, and A. Ruhí. 2025. Maximizing the potential benefits of beaver restoration for fire resilience and water storage. Ecological Applications 35(7):e70102.

Müller-Schwarze, D. 2011. The beaver: its life and impact, Second Edition (2nd ed.). Cornell University Press.

Murphy, B. 2024. Adaptive Beaver Management Plan, prepared by Anabranch Solutions, Newton, UT, for the Mile High Flood District, Lakewood, CO. 35pp.

Naiman, R.J., J.M. Melillo, and J.E. Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (Castor canadensis). Ecology 67(5):1254-1269.

Naiman R.J., C.A. Johnston, and J.C. Kelley. 1988. Alteration of North American streams by beaver. BioScience 38:753–762.

Nehring, R.B., K..G. Thompson, and S.Hebein. 1998. Impacts of whirling disease on wild trout populations in Colorado. In Transactions of the 63rd North American Wildlife and Natural Resources Conference. Edited by K.G. Wadsworth. Wildlife Management Institute, Washington, D.C. pp. 82-94.

Nehring, R. B., G. J. Schisler, L. Chiaramonte, A. Horton, and B. Poole.2015. Assessment of the long-term viability of the myxospores of Myxobolus cerebralis as determined by production of the actinospores by Tubifex tubifex. Journal of Aquatic Animal Health 27:50–56.

New Mexico Game and Fish. 2025. Beaver in New Mexico: Coexistence and Relocation. Available: https://wildlife.dgf.nm.gov/download/beaver-in-new-mexico-coexistence-and-relocation

Novak, M., J. A. Baker, M. E. Obbard and B. Malloch. 1987. Wild Furbearer Management and Conservation in North America. Toronto: Ontario Ministry of Natural Resources. 1,150 pp.

Olson, D.H., K.H. Haman, M. Gray, R. Harris, T. Thompson, M. Iredale, M. Christman, J. Williams, M.J. Adams, J. Ballard. 2021. Enhanced between-site biosecurity to minimize herpetofaunal disease-causing pathogen transmission. Herpetological Review 52(1):29-39.

Payne, N. F. 1984. Mortality rates of beaver in Newfoundland. Journal of Wildlife Management, 48(1): 117–126.

Petro, V. M. 2013. Evaluating" nuisance" beaver relocation as a tool to increase coho salmon habitat in the Alsea Basin of the central Oregon Coast Range. Thesis, Oregon State University.

Pollock, M.M., G.M. Lewallen, K. Woodruff, C.E. Jordan, and J.M. Castro (Editors). 2023. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 2.02. United States Fish and Wildlife Service, Portland, Oregon. 189 pp. Online at: https://www.fws.gov/media/beaver-restoration-guidebook.

Polvi, L.E., and E. Wohl. 2013. Biotic drivers of steam planform: implications for understanding the past and restoring the future. BioScience 63(6):439-452.

Prendergast, A. 2011. Beaver fever! Sherri Tippie gives a dam about Colorado's beaver population. Westword, September 13, 2011. Available: https://www.westword.com/news/beaver-fever-sherri-tippe-gives-a-dam-about-colorados-beaver-population-5113976/.

Puttock, A. K., A.M. Cunliffe, K. Anderson, and R.E. Brazier. 2015. Aerial photography collected with a multirotor drone reveals impact of Eurasian beaver reintroduction on ecosystem structure. Journal of Unmanned Vehicle Systems 3(3):123-130.

Radford, H. V. 1907. History of the Adirondack beaver. Report of the Forest, Fish and GameCommissioner, Albany, New York.

Ramey, R.C. 2024. Pitkin County Healthy Rivers Program and White River National Forest: Beaver Inventory, 2023-2024. 16pp.

Ritter, TD., C.N. Gower, and L.B. McNew. 2020. Habitat Conditions at Beaver Settlement Sites: Implications for Beaver Restoration Projects. Restoration Ecology, 28(1), 196-205. https://doi.org/10.1111/rec.13032.

Ritter, T., M. McGree, D. Schmetterling, C. Gower, V. Boccadori. 2023. Beaver and their role in riparian restoration in Montana. Montana Wildlife and Parks. 165 pp.

Rocky Mountain News Daily. 1941. Colorado has 48,000 beaver, state game head announces count. 82(326). November 12, 1941. Available: Colorado Historic Newspaper Collection, Colorado State Library.

Rosell, F and R. Campbell-Palmer. 2002. Beaver- ecology, behavior, conservation and management. Oxford University Press.

Roug, A., E. Doden, T. Griffin, J. Young, X. Walden, N. Norman, P. Budy, and A.J. Van Wettere. 2022. Health screening of American Beaver (Castor Canadensis) in Utah, USA. Wildlife Diseases 58(4):902-908.

Runge, M.C. 1999. Design and analysis of a model for adaptive harvest management of beaver (Castor canadensis). Ph.D. diss., Cornell University, Ithaca, New York.

Rutherford, W.H. 1964. The Beaver in Colorado: Its Biology, Ecology, Management and Economics. Technical Publication No. 17. Game Research Division, Colorado Game, Fish and Parks Department.

Rutherford, W. H. 1965. Long-range management plans for game species - beaver. Colorado Department of Game, Fish, and Parks. 5pp.

Seton, J.R. 1929. Lives of Game Animals, Vol. 4, Part 2, Rodents. Doubleday, Doran, Garden City, NY, USA.

State of Colorado. 2023. Colorado's Strategic Plan for Climate-Smart Natural and Working Lands. 47 pp. Online at: https://ag.colorado.gov/conservation/strategic-plan-for-climate-smart-natural-and-working-lands.

Sun, L., D. Muller-Schwarze, and B.A. Schulte. 2000. Dispersal pattern and effective population size of the beaver. Canadian Journal of Zoology. 78: 393-398.

Swope, H. M. 1954. Joint air-ground beaver stream survey. Special report - Colorado Game and Fish Commission. 4pp.

Tippie, S. 2010. Working with beaver for better habitat naturally. Available: https://www.grandcanyontrust.org/sites/default/files/ut_workingBeaver2010.pdf.

U.S. Fish and Wildlife Service (USFWS). 2018. Recovery Plan for Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*), Colorado. Region 6, Lakewood, CO. 148 pp.

Available: https://ecos.fws.gov/docs/recovery_plan/Final_Draftpreblesrecoveryplan_10032018_signed.pdf.

U.S. Fish and Wildlife Service (USFWS). 2023. Recovery Plan for New Mexico Jumping Mouse (*Zapus hudsonius luteus*). U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, NM. 36 pp. Available: https://ecos.fws.gov/docs/recovery_plan/Final%20Recovery%20Plan%20NM%20Meadow%20Jumping%20Mouse%20January%202023.pdf.

Utah Division of Wildlife Resources. 2017. Utah beaver management plan. DWR Publication 17-20. 29 pp.

Vanderhoof, J. 2022. Planning for Beavers Manual: Anticipating Beavers when Designing Restoration Projects, King County WA Dept. of Natural Resources.

Wan, L., E. Fairfax, and K. Maher. 2025. Factors influencing surface water accumulation in beaver pond complexes across the Western United States. Nature Communications Earth and Environment 6:614).

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D., and Shahverdian S.M. (Editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

Ziegler, M.P., K.B. Rogers, J.J. Roberts, A.S. Todd, and K.D. Fausch. 2019. Predicting persistence of Rio Grande Cutthroat Trout populations in an uncertain future. North American Journal of Fisheries Management 39(5): 819-848.

# Appendix A: Summary of a 2025 Human-Beaver Conflict on CPW Lands Survey

## Summary

- Of the 50 State Park complexes, hatcheries, and CPW management areas (representing multiple State Wildlife Areas) that completed the survey 36 reported annual conflicts with beavers
    - 23 reported a low level of conflict (4 incidents or less per year)
    - 7 reported a medium level of conflict (5-12 incidents per year)
    - 6 reported a high level of conflict (greater than 12 incidents per year)
- 19 properties are already using some coexistence methods
    - Of those, all but one indicated they were interested in support for coexistence
    - 4 of 6 high conflict properties are already using some form of coexistence, but also indicated they would like assistance
    - 5 of 7 medium conflict properties are already using some form of coexistence methods, but also indicated interest in support
    - 9 of 23 low conflict properties are already using coexistence; all but one indicated interest in support
- 23 properties reported using lethal control in the past, lethally removing a rough estimate of around 87 beavers per year
    - Areas reporting for all SWAs, where most conflicts are primarily related to irrigation infrastructure, accounted for 61% of lethally removed beavers
- Approximately 26 beavers were translocated annually, 77% of which were moved to resolve conflicts on SWAs

## State Parks

- Ten State Parks reported conflicts: 3 high, 2 medium, 6 low (ranked high to low in order number of conflicts below):

- State Park issues are broadly roads, trails, and vegetation (ranked high to low in order of number of conflicts below:

## Hatcheries

- Nine of 16 surveyed hatcheries reported having beaver conflicts: 1 high, 1 medium, 7 low conflict
- Hatchery issues almost always involve interference with hatchery operation: beavers getting into raceways, lodging in settling ponds making pond management difficult, and interference with water delivery infrastructure
- Hatcheries have sparsely used translocation, compared to SWAs
- Five hatcheries are already using coexistence methods, four of which are interested in additional support to manage human-beaver conflicts
- Overall, nine hatcheries expressed interest in additional support to manage human-beaver conflicts, while two were unsure, and three didn't believe they needed additional support
- Few hatcheries utilized lethal control. The four out of six that did utilize lethal control were also utilizing coexistence

## State Wildlife Areas

- Of the sixteen administrative Areas (representing all Area SWAs) that completed the survey, only one did not report annual human-beaver conflicts: two reported a high degree of conflict, five reported a medium degree of conflict, and nine reported low conflicts
- SWAs mostly resort to "relocation" if using non-lethal approaches, moving approximately 20 beavers per year
- While a majority of Areas use some lethal control across all of their SWAs, many use a combination of lethal and non-lethal control
- Six Areas are utilizing coexistence tools
    - Interestingly, 4 of these Areas are also using lethal control, speaking to the reality that beavers in irrigation infrastructure often need to be dealt with quickly, even when there may be a desire to pursue non-lethal control
- Two Areas specifically mentioned interference to downstream water rights owners being the source of conflict, with one mentioning an order from DWR to remove beaver

# Appendix B: Nonlethal Solutions Examples and Resources

This appendix covers the most common beaver problems and nonlethal solutions with enough information for readers to identify the basics and providing citations to more in-depth resources. Following the Problem/Solution materials, the appendix also includes information from APHIS about their work to employ nonlethal solutions to beaver complaints and a "Living with Beaver" story from a Colorado ranching family.

### Problem: Plugging culverts or other water conveyance infrastructure

By far the most common human-beaver conflict is the plugging of various water infrastructure such as road culverts and water intake structures where the water flow is concentrated. These concentrated flows attract beaver because with minimal effort, such as plugging a small culvert, they can create a large pond of water. Culvert plugging causes water to back up and overtop the culvert, bridges, or other structures, leading to flooding of adjacent lands and roads. Because local and state government transportation departments face these issues on a regular basis, the Colorado Department of Transportation researched and prepared a very helpful report about the most cost effective and successful nonlethal ways to manage beaver road conflicts, which includes all the methods discussed in this section (Millman 2022). In June 2024, CDOT and the Beaver Institute partnered together to offer a road coexistence training webinar that covers all the basics of coexistence solutions to common beaver problems.[14]

### Solution: Culvert protection with exclusion fencing

A common type of beaver coexistence device is building an exclusion fence in front of the culvert to prevent beaver from building dams on and in the culvert. Culvert, river size and site conditions are so variable that each situation must be accessed for the best design, preferably by someone who has training and experience installing such devices. The two main reasons flow devices fail are (1) using low-quality or not heavy-duty materials that don't hold up during strong flows, and (2) the installer had little to no training on choosing the appropriate design and installation.

As mentioned, there are excellent coexistence guides available to explain the basic concepts and which flow device might be appropriate for the situation at hand (Pollock 2023).[15] This decision flow chart for choosing which device is one of the most helpful available, as is the whole coexistence guide created by Jacob Shockey, Project Beaver.[16]

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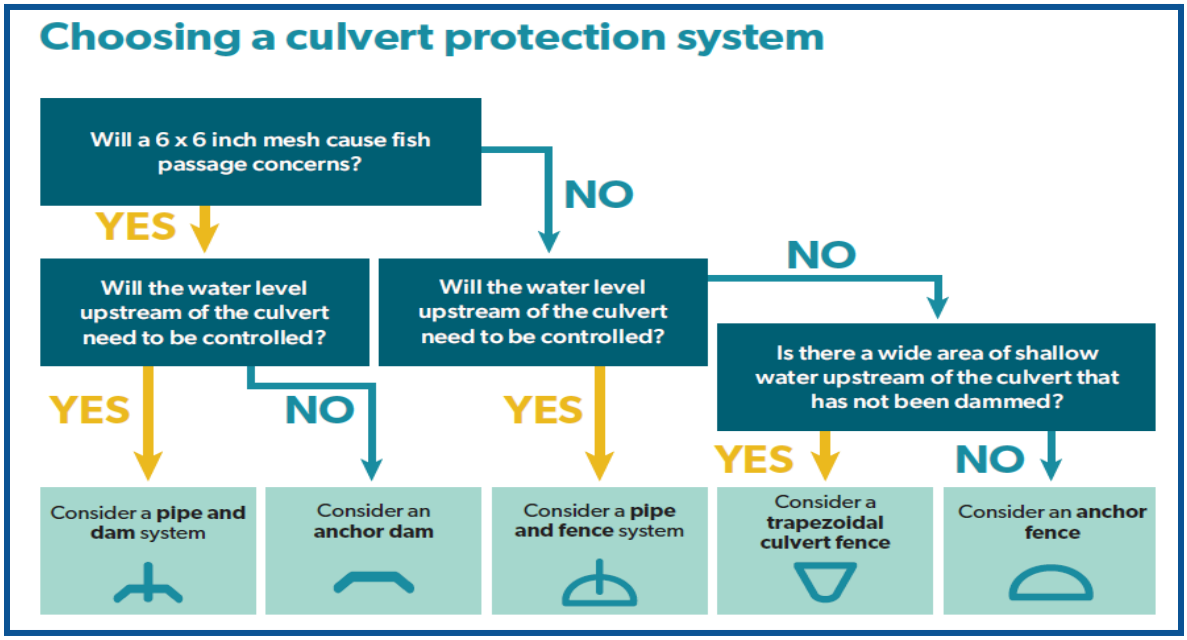
[14] Best Beaver Management Practices for Roads - YouTube (2024).
[15] See also BeaverIntitute-Self-Help-Culverts-Drains.pdf.
[16] Shockey, J. (2022), Best Management Practices for Pond Levelers and Culvert Protection Systems, The Beaver Coalition (now Project Beaver), Jacksonville OR.




Graphic from Best Management Practices for Pond Levelers and Culvert Protection Systems – Project Beaver (Shockey, J. 2022) showing how to choose the right culvert protection design.

**Smaller culverts/limited space** - the keystone triangular fence prevents beaver from directly damming a culvert or similar structure (e.g. a water intake or control gate). They are typically built from heavy duty (4-6 gauge) fencing panels and metal or wooden posts. Each site needs a specifically designed and installed device based on local conditions, including the stream channel topography, water depth and flows. The side panels should be about 12' long to keep enough distance from the culvert. Keystone fences keep the stream at the same flow level and they are the least expensive type of flow device. The cost for building the structure ranges from about $1000 to $2500 depending on materials and labor.


Photo from the Beaver Institute showing culvert exclusion fencing with a small stream and small culvert design with the blue arrow indicating an opening where wildlife can access the culvert to pass safely beneath the road.


Left: Photo by Rory Cowie, Alpine Water Resources, LLC, Silverton, CO, showing a classic triangle keystone design. Right: Photo from Best Management Practices for Resolving Human-Beaver Conflicts in Vermont (2017) showing a smaller triangle design to fit the smaller space available.

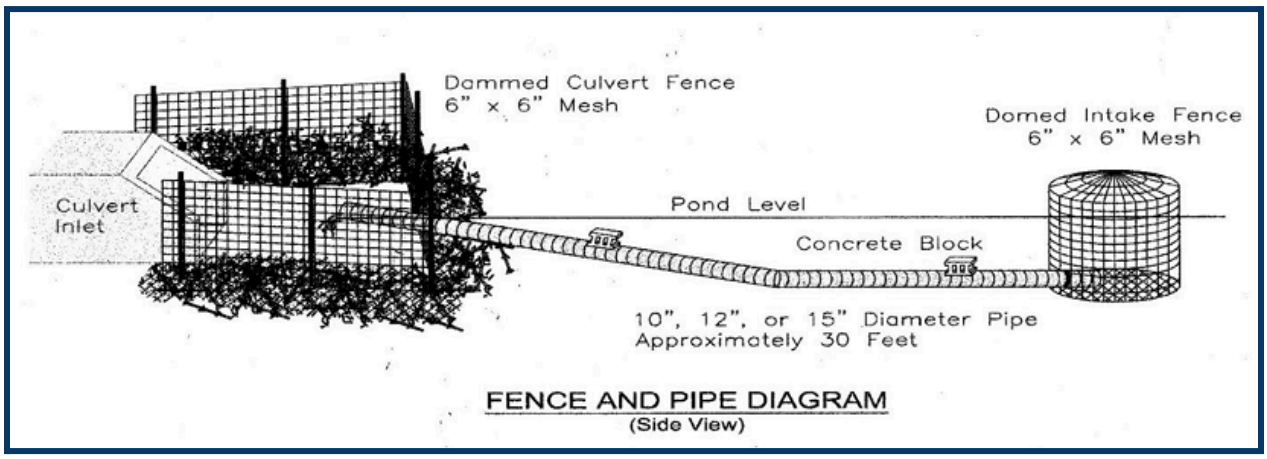
**Larger culverts and/or more space for the structure** - Examples shown below of other exclusion fencing designs when the space and the situation calls for something different than the classic keystone design.


Left: Photo by Rory Cowie, Alpine Water Resources, LLC, Silverton, CO, showing two large concrete culverts protected from beaver damming by an exclusion fence. Right: Photo Best Management Practices for Resolving Human-Beaver Conflicts in Vermont (2017) showing a hexagon shape that has good success deterring beaver.

Photo showing an exclusion fence built similar to a culvert fence to protect a water diversion headgate in Montana. Photo from Clark Fork Coalition presentation: Virtual Field Trip: Non-Lethal Beaver Conflict ResolutionYouTube (2021).

**Solution: Fence and pipe device - when water level upstream of culvert needs managing**

A fence and pipe flow device (Figure XX) is a combination of a fence that excludes the beaver from accessing the culvert, and a pipe/filter system that brings the water inside the culvert fence from deeper in the pond where the beaver will not detect the "leak" in their dam. This setup allows beaver to have a pond but the water level is set by the pipe to be below the road elevation to prevent flooding. The end of the pipe must be in at least 3' deep water to be effective. Fence and pipe devices are typically built from heavy duty (4-6 gauge) fencing panels, posts, and large (8-15" diameter) HDPE pipes. Each site needs a specifically designed and installed device based on local conditions. The average cost to install this structure is about $2000 to $5000.



Drawing of a Fence & Pipe flow device from The Beaver Institute Self Help Guide to Culverts & Drains: BI-Self-Help-Culverts-Drains.pdf

In 2018, the Summit County Open Space and Trails Department installed culvert exclusion fencing and flow pipes to mitigate flooding along Highway 9 and to preserve the healthy beaver complexes located on both sides of the roadway. The County installed two 24-inch corrugated pipes and gabion baskets, which were fully submerged within the ponds. Placement required several months of trial and error to determine the most effective locations; however, once established, the structures have required minimal maintenance, consisting primarily of removing debris and woody material that accumulates around the baskets. Since the installation, no flooding has occurred on Highway 9, and the beaver population has thrived. For landowners interested in implementing similar systems, staff recommend two key items: (1) install the baskets and pipes as deep as possible to avoid creating any water-gurgling sounds, and (2) allow beaver activity and behavior to guide the flow device placement. Ultimately, success comes from working with the beavers, not against them.

Photo of a double flow pipe and culvert exclusion fencing installed in 2018 by Summit County located adjacent to Highway 9 at Summit County's Monte Cristo Open Space near Quandary Peak. Photo by Summit County Open Space and Trails staff.

Photo of the same double flow pipe and culvert exclusion fencing taken in September 2025 showing beaver wetlands located adjacent to Highway 9. Photo by Summit

County Open Space and Trails staff.

### Solution: Spillway exclusion fencing

Spillways from lakes or reservoirs can be another location where beaver build dams and some of the same design elements used for culverts will also work to prevent beaver from being able to block up spillways as shown in the two photo examples below provided by Mike Callahan, with the Beaver Institute and Beaver Solutions, LLC. Callahan stated that he has installed hundreds of these devices on dam spillways with no problems from high flow events such as spring runoff or severe storms. When built properly, the fence actually preserves the spillway capacity for large events because it keeps large floated debris away from the spillway that could otherwise clog it.

The photo below shows a pond leveler pipe through the exclusion fence, which keeps the pond at a safe level. Even if beaver build a dam upon the fence, high flows simply flow up and over the beaver dam, through the fence and through an unblocked spillway. Callahan notes that the fence height should be kept below a height that would cause any damage to the dam if the fence got clogged with debris during a high flow event and the water rose up and over the fence.

Photos from the Beaver Institute showing two different examples of spillway protection: one without the need for a pipe (left) and the other with a flow pipe installed(right). Each situation must be assessed to determine what is needed to maintain a functioning spillway.

### Spillway solution used by CPW's Dam Safety Program to keep beaver from blocking an emergency dam spillway

CPW manages many small reservoirs that have spillways that sometimes get blocked by beaver dams. In 2023, CPW installed a Stoplog Retainer near the top of the spillway which can be set at the desired level of water in the reservoir (shown in graphic below). Storm events that flow over the set level flow through the device and then into a pipe beneath the ground that has a surface outlet at least 100' away from the reservoir dam. If a beaver builds a dam in that location, it will not impact the function of the spillway. CPW Dam Safety Program Manager Eric Eisinger stated that this system is successful in keeping the spillway free of dams. There is minimal maintenance

required, occasionally sticks or debris can get lodged in the intake, just from normal reservoir water action, which can be easily cleared by hand or with rakes.

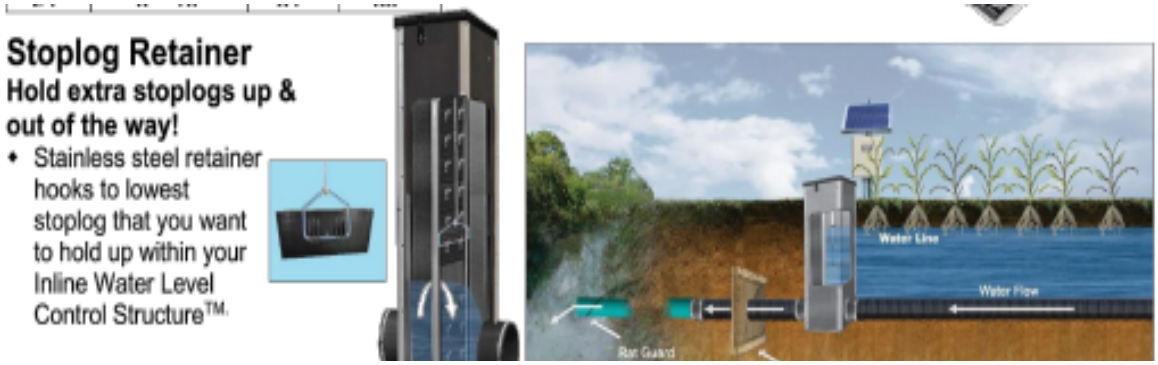



Image provided by CPW Dam Safety Program of a stoplog retainer device used to regulate the flow in a reservoir dam spillway to prevent beaver from building a dam in the spillway.

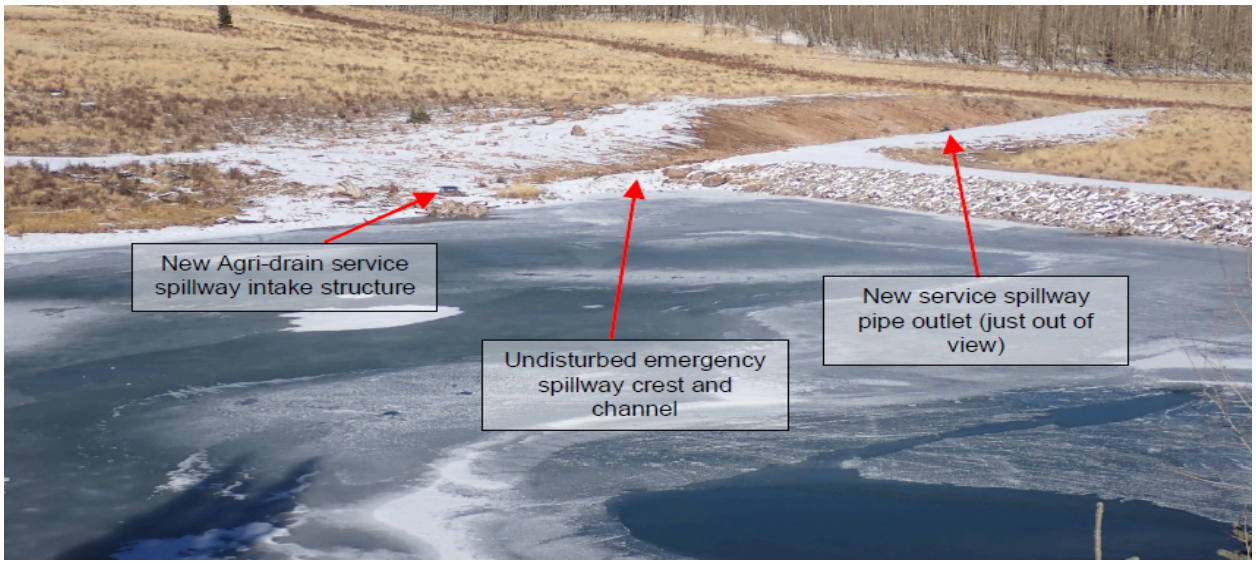



Photo provided by CPW Dam Safety Program showing an installed stoplog retainer device used to regulate the flow from a reservoir in the dam spillway to prevent beaver from building a dam in the spillway.

**Exclusion fencing challenges to consider:**

- **High spring run-off or large woody debris** - In some areas it can make sense to remove part or all of a flow device during periods of high flow. Typically, just the fence panels on the ends of the device will be removed. This allows passage of debris and prevents damage caused by debris clogging the device and causing it to collapse. (Millman 2022). The Beaver Institute BeaverCorps training encourages trainees to look at the hydrograph for the area and understand how much water will flow through; if familiar with the area you're working in, you may already know what the creek looks like in different seasons, and that local knowledge is really important. Consider durability of materials and how you brace them

(heaviest T-posts or 4" wood posts may be needed). One BeaverCorp graduate who works in Colorado recommends designing structures to handle the highest flows rather than using less sturdy materials with the intent to remove the structure prior to spring runoff.

- **Wildlife passage around the exclusion fencing** - Beaver and other wildlife need to be able to continue to use the road culvert to pass beneath the road safely. These photos below from Mike Callahan, Beaver Institute, show the side passage built into the flow device. Callahan has video footage of such passageways being used by beaver and other wildlife.


Photo from the Beaver Institute of a culvert exclusion fence that allows for wildlife passage as shown with the blue arrows.


Photo from the Beaver Institute of a culvert exclusion fence and flow pipes on a large culvert that allows for wildlife passage as shown with the blue arrows.

Photos by Rory Cowie, Alpine Water Resources, LLC, Silverton, CO, showing another example of how to allow for wildlife passage by off-setting the placement of a culvert protection panel.

- **Fish Passage** - The ability of fish to move upstream or downstream through or around beaver flow devices is an important issue depending on the size and species of fish. This has mainly been a concern for salmon species and each of the west coast states have developed or are working on developing permit guidelines for coexistence structures based on those concerns.[17] In areas where fish passage is an issue, there are some modifications to beaver coexistence that can minimize impacts. Fence panels come in a wide variety of sizes, especially the spacing between vertical and horizontal bars. Typically spacing of at least 4"x4" is recommended, but this might not be large enough to allow larger fish species (e.g. salmon and bull trout) to pass through easily. Spacing as large as 6"x 8" can be used in these situations. Larger spacing runs the risk of allowing smaller beaver (e.g. kits or juveniles) to get inside the fencing.

  The specific fish community of interest should be considered when designing devices. If a pond-levelling pipe is also installed with the fencing, the fencing will be the main passage that fish will utilize although there is evidence they will use the pipe as well. In regards to pond-levelers installed into a free-standing beaver dam to lower the water level, evidence indicates that fish will use both the pipe and passage around, through or over the beaver dam. It is important to set the pond leveler out-take at levels that maintain water within the pipe for downstream fish passage and depending on site factors and fish species, the out-take may also need to be set at a level that allows for fish moving upstream.

[17] See for example guidelines from the Oregon Dept of Fish and Wildlife: Beaver Flow Device ODFW Fish Passage Policy Bulletin.pdf (April 2025).

### Problem: Beaver pond is flooding adjacent human development

Another common conflict occurs when human uses within historic floodplain areas, such as agricultural fields, septic systems, roads, trails, and buildings, become threatened by flooding from beaver continuing to extend the surface area of their pond and canal systems. A pond leveler flow device can be an excellent solution to allow the beaver to stay in place but reduce the level of the pond to an acceptable level so as **not to cause flooding of adjacent land uses.**

### Solution: Pond levelers

Pond levelers are most applicable at free-standing beaver dams where the water depth of the pond is greater than three feet. Pond levelers work by creating a "leak" in the beaver dam via the pipe. After installation, beaver will respond to the decreased water level by building on the dam to try and stop the leak, but the water is coming from the intake cage far away so they will not find it and be able to plug it. The final depth of the pond is regulated by the elevation of the pipe when placed through the beaver dam. If the pond water level needs to be lowered more than 1 foot, it needs to be done in stages (so the beaver do not panic and abandon the site), or beaver can be temporarily trapped out while the new water level is established. The pipe can ensure continuous flows not only to address flooding of adjacent land uses, but also to maintain flows to downstream water users. Unlike road culverts, Flexible Pond Leveler pipes do not need to be sized to handle catastrophic storm events because heavy storm runoff will simply flow over the top of the dam. Following the storm, the pipe will return the pond to the normal level. These devices need much more explanation and expertise to install and we encourage folks to consult the more detailed guides such as the Alberta Beaver Beneficial Management Practices and best-management-practices-for-pond-levelers-and-culvert-protection-systems.pdf.

Photos #xx & xx from Rory Cowie, Alpine Water Resources, LLC, Silverton, CO, showing a classic example of when a pond leveler is needed to reduce the water level of a beaver pond located next to Hwy 145 near Rico, CO.

**Pond Leveler Flow Device to Protect Small USFS Bridge - Rio Grande National Forest** (RGNF) - RGNF included beaver as a focal species for aquatic and riparian systems in their 2020 Land Management Plan, thus coexistence is a priority whenever possible on RGNF lands. The RGNF Fish and Wildlife team recently installed a double pipe flow device near the Upper Crossing Guard Station in the Saguache Ranger District. Beaver built a dam directly in front of the small bridge on the road to the guard station that crosses Sheep Creek, which resulted in flooding of the road and bridge. A flow device was installed by cutting a notch into the beaver dam in the Spring of 2024 to lower the level of the pond around the road and bridge. The beavers have responded well to the flow device, maintaining lush riparian habitat along the creek, but allowing the flow device to keep the pond level low enough to no longer interfere with the infrastructure.

Photo provided by the RGNF taken from upon the bridge looking down at the flow device built into a notch of the beaver dam.

Photo provided by the RGNF of the pipe flow device that has been successful in keeping the water level below the bridge and road.

### Problem: Loss of trees

In urban to rural areas, the loss of orchard or ornamental trees from beaver can be problematic for landowners. Beaver are "central-place foragers," which means they use their lodge as a base and typically forage within a small distance, typically less than 100m from the pond margin. They use the trees they take down for both food and building material for dams and lodges. This activity is especially apparent in newly colonized areas as beaver can take down a lot of trees in a short time. Well-established beaver colonies tend to fell fewer trees once established. Tree-felling also increases in the fall as beavers shore up their dams and establish a winter food cache.

### Solution: Tree protection - exclusion fencing

Tree protection options typically consist of 4 to 6' tall wire fencing (12-14 gauge) placed in a circle around the trunk of the tree, leaving a large enough gap for the tree to grow without being girdled. Beaver are poor climbers and they usually cannot get above the fence. In very snowy locations taller fence is needed as beaver can use the snowpack to try and chew above the top of the fence. Tree fencing is a very affordable solution, and dozens of trees can be protected for a few hundred dollars. Fencing can be postless or supported by wood or metal posts, and can be fastened to the ground with landscape stakes to prevent beaver from nudging underneath it. Tree fencing is most applicable for single or small clumps of high-value trees. Several trees can be fenced in a short amount of time, but individual tree fencing is not recommended to protect every tree in a large stand. For large stands of trees, the entire stand can be fenced with a continuous fence supported with posts. Electric fencing can also be used for a more aesthetically pleasing solution, or for high-value situations such as fruit orchards. For more information on this topic, refer to Jakob Shockey's excellent guidebook to protecting crops and trees from beaver.[18]


A tree fencing schematic showing typical guidelines for fencing single trees (photo from defenders.org); Friends of the Yampa photo showing staff installing protective fencing around a cottonwood tree.

### Solution: Gritty sand paint

Another option for tree protection is "sand paint." Sand paint consists of mixing masonry sand in with latex paint, and then painting the tree trunks to a height of 4 to 6 feet. Sand painting is a very affordable solution, and dozens of trees can be protected for a few hundred dollars. Sand painting

[18] Shockey, J. (2024), Best Management Practices for Tree and Crop Protection Version 1.0. Project Beaver, Jacksonville OR. 2024_10+ProjectBeaver_TreeCropBMPs.pdf

works by discouraging the beaver from chewing due to the gritty feel of the sand. Sand paint needs to be reapplied at regular intervals (3-10 years) depending on local conditions. It is not recommended for trees less than 8 inches at breast height as it can impact the growth of young trees. Beaver will choose not to chew gritty trees if there are sufficient trees available that have not been painted, so leave about 30% of the trees in the area unpainted. Sand paint is an effective strategy for large stands of trees where fencing is not feasible or desirable. However, it is not as effective of a deterrent as tree fencing, so beaver may still take down some trees. Both tree fencing and sand paint are often used simultaneously at the same location.

**Sand-Paint Method to Protect Trees from Beavers**

| **Ingredients:** | **Sand to Paint Ratio:** |
|---|---|
| Exterior Latex Paint: Choose a color to match the bark | 5 ounces of sand in 1 quart of paint = |
| Mason or Playground Sand: Grit size = 30 – 70 mm | 20 ounces of sand in 1 gallon of paint = |
| | 140 grams of sand in 1 liter of paint. |

Paint mix information from the Beaver Institute website How To Protect Trees from Beaver Chewing

A year-long trial to protect hundreds of young restoration trees from beaver used a combination of "4 the Birds" (a sticky, transparent nontoxic liquid) and sand. The sticky substances were applied discontinuously about four feet up the trunks of the saplings and then sand was added. This method is not suitable for older trees, where trunk-climbing birds might be harmed.[19] Other potential approaches include replacing their favored vegetation (aspen, willows, young cottonwoods, alder and birch) with less favored vegetation such as spruce, fir and pine trees.

### Problem: Beaver burrowing into levees

Beavers burrowing into levees to create a lodge (instead of building the classic dome-shaped lodge with wood and mud) does not seem to be as common a problem as culvert plugging and flooding. However, the issue was raised by water managers during the Focus Group sessions, and thus we sought information on solutions.

### Solution: Levee protection

Beavers can cause significant damage to levees by burrowing into them to create dens, potentially compromising their structural integrity and flood protection capabilities. While this problem is tougher to address than culvert protection or tree wrapping, several coexistence solutions exist to prevent beaver burrowing into levees:

[19] Information from the Animal Protection New Mexico website: https://apnm.org/what-we-do/promoting-coexistence-with-wildlife/beavers-belong/resolving-beaver-conflicts-humanely/

**Exclusion fencing**

- **Install heavy gauge wire mesh fencing:** Installation of a zinc-galvanized steel mesh fence, at the base of the levee on the side of the river, so that the structure of the embankment will not be affected, is one of the more economical solutions. This fencing should be extended 12" below ground level to prevent beavers from burrowing underneath.[20]
- Using chain-link fencing appears to be the most economical go-to method in Europe where levee burrowing is a more common problem.
- **Consider L-shaped fence sections:** The bottom of the "L" can be laid along the ground and anchored to further discourage burrowing activity. The fence should be tall enough (at least 3-4 feet high) to deter beavers from climbing over.
- **Regularly check and maintain fencing:** Ensure it remains intact and free of gaps or damage that beavers could exploit.

**Bank stabilization and reinforcement**

- **Riprap:** Placing large rocks or riprap on the levee slopes can make it more difficult for beavers to burrow into the embankment, but this approach has gotten mixed results in California and Europe where in some places beaver learned to burrow beneath large rocks to make a den. This might be addressed by laying down RenoMesh first and then riprap.
- **Bentonite mats:** Bentonite geocomposites can be used as a vertical isolation layer within the levee, as their self-sealing properties can help seal any breaks caused by burrowing rodents. It consists of a leak-proof bentonite granulate, sandwiched between two pieces of geotextile. (Kozlowski 2017).

**Habitat modification**

- **Remove preferred food sources:** Eliminating or minimizing the presence of trees and vegetation that beavers favor for food and building materials (e.g., willows, aspens, cottonwoods, birch, alder) near the levee can make the area less appealing for them. Replacing preferred species with those that beavers dislike (e.g., spruce, fir, pine) can also discourage their activity.
- **Remove debris and fallen trees:** Clearing the area of potential dam-building materials can reduce the likelihood of beavers establishing themselves.

## Proactive measures to take when beaver are present

Another approach for landowners, agencies, and stream restoration project managers to consider is taking proactive steps to prevent a problem before it develops if beaver are present or anticipated near infrastructure to reduce the risk of conflicts. King County, WA produced a comprehensive guide for proactive beaver considerations when planning stream restoration

[20] Kozlowski, W. & Balawejder, A. (2017). Protection of Levees against Beavers, IOP Conference Series: Materials Science and Engineering.

projects that is particularly relevant when working in semi-rural to urban areas (Vanderhoof 2022).

**Decoy or Starter Dam -** Decoy or starter dams can be constructed about 15 feet upstream of a culvert in locations where beaver ponding is acceptable to encourage beaver to dam on the structure instead of the culvert. It is a lower-cost approach that may work as a first option before resorting to the other flow devices. They are typically constructed of fencing and posts but can be made with a variety of other materials such as wood, rocks/stones, and branches. The goal is to mimic a small beaver dam and encourage the beaver to continue building in your desired location, not on the culvert. Starter dams can also be installed as proactive protection of culverts in conjunction with stream restoration work that may result in beaver recolonization of the area. Starter dams are a relatively inexpensive option, typically costing $500-$1000 to install.

Photo by Jackie Corday of a starter dam built in 2022 with wood posts and interwoven willow branches on Trail Creek in the Gunnison National Forest in anticipation that beaver might block the culvert. It has been successful in protecting the culvert for over 3 years.

**Habitat modification -** As noted above under levee management, eliminating or minimizing the presence of trees and vegetation that beavers favor for food and building materials (e.g., willows, aspens, cottonwoods, birch, alder) near culverts or other water infrastructure can make the area less appealing for them. Replacing preferred species with those that beavers dislike (e.g., spruce, fir, pine) can also discourage their activity.

**Oversized culvert or bridge** - When planning new stream crossings or replacing existing undersized culverts in areas of beaver presence, oversizing the new culvert or installing a bridge can be an effective proactive approach to reducing the risk of beaver building dams in front of the culvert. An oversized culvert or bridge can carry the entire width of the stream flows without causing constriction of flows that are so attractive to beaver. Oversized culverts should be a minimum of 1.5 times the width of the active channel (Millman 2022).

**Piping sections of irrigation ditches** - If feasible, piping certain sections of irrigation ditches that are continually prone to beaver damming activity can eliminate the problem.

**Designing or re-locating recreational amenities** - Park amenities such as river trails and picnic areas are often located close to a river's edge in the riparian zone. When designing new recreational features consider locating them further back from the river corridor if beaver are within the area or anticipated based upon vegetation, water availability and other beaver factors. If existing trails are threatened by flooding from new beaver activity, consider if feasible re-locating such infrastructure versus installing a flow device that must be maintained.

### Information provided by APHIS about their work to support nonlethal solutions to beaver conflict complaints

USDA U.S. DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service | Wildlife Services | Colorado

Over the years, Wildlife Services' philosophy – as well as the wildlife management profession as a whole – has evolved, along with societal values and perspectives. The USDA Wildlife Services (WS)-Colorado program is committed to finding a balance among a variety of priorities, including wildlife and environmental conservation, human health and safety, economic considerations, and social factors. Since 2022, WS-Colorado has been collaborating with multiple, state, federal, and local partners to promote and implement non-lethal beaver damage management co-existence projects.

When nuisance beaver calls are received, wildlife biologists and specialists offer a variety of integrated wildlife damage management options. Staff have been certified by The Beaver Institute BeaverCorps Program and are available to install or assist with flow device installations throughout Colorado. After performing an initial site assessment to determine which management strategies would be most effective to solve individual damage issues; WS personnel actively work with landowners, CPW, and NGOs to incentivize beaver translocations where feasible.

As part of an ongoing research collaboration with Wildlife Services National Wildlife Research Center, WS can trap and translocate beavers causing damage to locations where beavers are desirable. In 2025 WS translocated five colonies throughout the state and have plans to translocate more colonies in 2026. Several beavers within each translocated colony are tagged and monitored by WS personnel to document the efficacy and outcome of beaver translocations within the state. WS-Colorado is committed to understanding and documenting the short-term and long-term impacts of translocating beavers into a variety of suitable habitats.

In addition to management actions, Wildlife Services supports research through their National Wildlife Research Center in Fort Collins. The Center has a research branch dedicated to understanding beaver ecology, conflict at the human-beaver interface, and developing and evaluating tools for non-lethal beaver damage management.

Nonlethal Beaver Damage Management Services offered by USDA Wildlife Services in Colorado include site assessments, flow device installation, and nonlethal beaver trapping and relocation. Cost share funding may be available; contact WS State Office, 303-328- 9041 for details.


All photos provided by APHIS. Left 2 photos of a pond leveler installed to control water level near a pedestrian bridge. Right top photo of a translocation beaver release project and right bottom photo of a beaver that will be translocated with a tracking device for monitoring.