

Process-Based and Beaver-Related Restoration Resources for Streams and Riparian Wetlands



Process-based restoration of streams and wetlands focuses on restoring the essential natural functions of the landscape. It targets the root causes of habitat change and degradation with the goal of returning to a resilient self-sustaining system. A major goal is to reverse the clock on overly channelized and incised streams, returning to a natural condition of high floodplain connectivity with many branches and impoundments (sometimes referred to as “Stage 0” restoration).

Various techniques, employing both low-tech and mechanical solutions, are increasingly being employed to accomplish stream, valley bottom, and wetland restoration. Nature-based solutions, such as the reintroduction of beavers and beaver mimicry, are also effective strategies to rehabilitate a floodplain. Interventions focus on adding structural complexity to a riverscape to force a diversity of water flow-paths. Increased flow-path complexity creates new geomorphic units, spreads water out, retains water longer, and moderates sediment transportation and deposition with the potential to substantially alter the physical, chemical, and biological characteristics of the surrounding river ecosystem. These restored systems create new, more complex habitat in degraded systems and provide greater benefits to plants, fish, and wildlife.



The goal of this document is to provide a brief overview of process-based and beaver related restoration techniques with links to further scholarship, media, guidebooks, and trainings to more deeply explore topics.

For more information on “stage 0” stream restoration: Cluer and Thorne, [A Stream Evolution Model Integrating Habitat and Ecosystem Benefits \(2014\)](#).

For more information on the principles of process-based restoration: Wheaton et al, Low-tech [Process Based Restoration Guidebook Chapter 2](#).

Types of Process-based and Beaver-Related Restoration

- Beaver restoration activities

- **Restoration to Attract Beaver:** If an area has habitat undesirable to nearby beaver populations, work is conducted to restore the habitat such that it attracts regional beaver naturally to the target area.
- **Beaver Reintroduction:** Once suitable habitats that are lacking beavers are found, beavers are relocated to these new areas and allowed to build dams and alter the area's hydrology.
- **Beaver Co-Existence Devices, Eg.:**
 - **Pond Levelers:** These devices control the maximum water level of a beaver pond to prevent over-flooding where undesirable. Perforated PVC pipes are positioned with caged-off upstream intakes to hide the flow from beavers as water is moved downstream of a beaver dam.¹
 - **Culvert Guards:** There are several styles of culvert guards. Simple grating on the upstream end of a culvert will prevent beavers from damming the inside. Culvert fences or "Beaver Deceivers" create a perimeter around the culvert to prevent the opening from being dammed.²
 - **Tree Protection:** Wrapping mesh wire around the base of trees can prevent them from being cut down by beavers.



Photo Credit: Skip Lisle, Beaver Deceivers International

¹ Source: [US Forest Service](#)

² Source: [US Forest Service](#)

- **Low-tech instream structures, Eg:**
 - **Beaver Dam Analogs (BDAs):** Hand-built bioengineering structures can be designed to mimic the function of natural beaver dams.³ BDAs can accelerate recovery of incised streams and riparian and wet meadow habitats by reducing water velocities, increasing sediment deposition and aggradation, enhancing floodplain connectivity, raising groundwater tables, and increasing habitat complexity. The desired outcome is to initiate restoration of natural processes that self-sustain riparian and wet meadow habitats.
 - **Wicker weirs:** These are small dam structures made from wooden stakes driven into the streambed and woven with wicker materials.⁴
 - **One Rock Dams:** One-rock high dams can be used to raise a rocky streambed.⁵
 - **Media Luna:** In areas with sheet flow, media luna are curved rock and gravel structures designed to disperse water flow to prevent gullyng.⁶
 - **Post-assisted Log Structures (PALS):** Wooden posts can also be used in a riverbed to promote wood accumulation and simulate natural log jams.⁷
- **Valley Floor Resetting:** River and stream bottoms can be infilled to bring the channel up to the level of the floodplain. This technique is associated with "Stage 0" restoration to return floodplains to their pre-channelized forms.⁸



Why Undertake Process-Based and Beaver-related Restoration Work?

A growing body of research and practice is demonstrating that when properly implemented, process-based and beaver-related restoration activities can produce many benefits. Commonly documented benefits of this restoration approach include higher water tables; reconnected and expanded floodplains; more hyporheic exchange; higher summer base flows; expanded wetlands; improved water quality; greater habitat complexity; more diversity and richness in the populations of plants, birds, fish, amphibians, reptiles, and mammals; and overall increased complexity of the riverine ecosystems.

³ Source: [NRCS](#)

⁴ Source: [Bill Zeedyk](#)

⁵ Source: [Bill Zeedyk](#)

⁶ Source: [NRCS](#)

⁷ Source: [Low-Tech Process-Based Restoration of Riverscapes](#)

⁸ Source: [National Park Service](#)

Training and Guidance on Process-Based and Beaver-related Restoration Techniques

A growing literature exists to support professionals and researchers exploring the effectiveness of beaver-related restoration activities.

Restoration Handbooks, Guides, and Textbooks

- [The Beaver Restoration Guidebook](#) (Castro et al)
- [Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 2.02](#) (Wheaton et al)
- [The Low-Tech Process Based Restoration of Riverscapes Pocket Guide](#) (Wheaton et al)
- [Let the Water do the Work: Induced Meandering, an Evolving Method for Restoring Incised Channels](#) (Zeedyk and Clothier)

Training Webinars and Modules

- [NAWM-BLM Beaver-Related Restoration Training Series](#)
- [NAWM Past Beaver-related Restoration Webinars](#)
- [Introductory PBR Workshop Modules](#)
- [Beaver Institute: Beaver Media](#)
- [Beaver Dam Flow Device Training Video](#)
- [AFWA USFS Ranchers and Beaver Restoration Webinar](#)
- [Beaver and Restoration Webinar - Siskiyou Land Trust](#)
- [Urban Beavers: Cleaning Runoff and Restoring Streams -ASLA](#)
- [How Towns Can Manage Conflicts with Beavers Webinar Spring 2023 - VT Fish and Wildlife](#)
- [The Beaver: Ecosystem Restoration Engineer](#) (Learning Tree, 2021)
- [Webinar: Beavers as Active Healers - Beavers and Watershed Restoration - YouTube](#)
- [Permitting Utah Stream Restoration Projects in 2021 - YouTube](#)
- [WADE 2020 Riparian Restoration - Low Tech Process Based Restoration & Bioengineering with Reid Camp - YouTube](#)



Literature and Literature Compilations

- [An Annotated Bibliography of Beaver Literature](#): A 181-page document from Oregon Department of Fish and Wildlife's Beaver Working Group listing citations with abstracts by category
- [Beaver Institute Research Library](#): Searchable library of research articles as well as curated lists by topic
- [Ecosystem Services Provided by Beavers *Castor spp.*](#)
- [Beaver dams attenuate flow: A multi-site study](#) (Graham et al 2020)
- [Using Beaver Dams to Restore Incised Stream Ecosystems](#) (Pollock et al 2014)
- [Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead \(*Oncorhynchus mykiss*\)](#) (Bouwes et al 2016)
- [Using remote sensing to assess the impact of beaver damming on riparian evapotranspiration in an arid landscape](#) (Fairfax & Small 2017)
- [\(PDF\) A process-based approach to restoring depositional river valleys to Stage 0, an anastomosing channel network: RESTORING STREAMS TO STAGE 0 IN UNCONFINED VALLEYS IN THE USA \(researchgate.net\)](#) (Powers et al 2018)
- [Process-based principles for restoring river ecosystems | US Forest Service Research and Development \(usda.gov\)](#) (Beechie et al 2010)
- [Great Expectations: Deconstructing the Process Pathways Underlying Beaver-Related Restoration | BioScience | Oxford Academic \(oup.com\)](#) (Nash et al 2021)
- [\(PDF\) A Stream Evolution Model Integrating Habitat and Ecosystem Benefits \(researchgate.net\)](#) (Cluer & Thorne 2014)

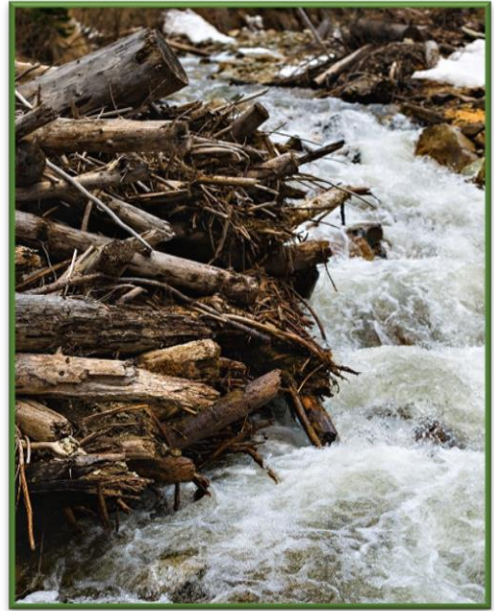
Modeling and Planning Tools

- [Beaver Restoration Assessment Tool](#) (BRAT) – Utah State University
- [BRAT Storymaps](#)
- [Utah Riparian Condition Assessment Toolbox](#)
- [Defenders of Wildlife New Mexico Beaver Habitat Suitability Model](#)
- [Considerations Checklist for Using Low-Tech Structures to Enhance or Restore Riparian and Wet Meadow Habitats](#)
- [Modeling intrinsic potential for beaver \(*Castor canadensis*\) habitat to inform restoration and climate change adaptation](#)



Restoration Organizations and Conferences:

- [The Beaver Institute](#): BI's goal is to resolve beaver-human conflicts in a science-based manner in order to maximize the many benefits that beavers contribute to the environment. They provide technical and financial assistance to private and public landowners experiencing beaver conflicts, train mitigation professionals, support scientific research, and increase the public appreciation of the beaver's critical role in creating climate resilient wetland ecosystems.
- [EcoMetrics](#): EcoMetrics works mostly with land trusts, watershed groups, and other conservation partnerships to promote process-based restoration, beaver expansion, and enlightened land stewardship to Colorado headwaters
- [BeaverCON](#): The BeaverCON conference bring professionals, practitioners, and others dealing with beaver issues and wetland restoration together on the East Coast to share the latest research and best management practices for "Nature's Engineer", the North American beaver
- [Restoring Riverscapes](#): The workshops engage with the practice of riverscape restoration and its universe of opportunities and constraints through engaging, dynamic expert presentations, stories of place, and collaborative engagement sessions.
- [Methow Beaver Project](#): Methow Beaver Project promotes working with Beavers as partners for restoring streams, riparian habitat, and biodiversity while reactivating wetlands, increasing water storage, and fostering community education and involvement to improve the health and resilience of the Methow River watershed.
- [Beavers: Wetlands and Wildlife](#): BWW works to help people learn about the beaver, a keystone species that restores and maintains wetlands, the land's most beneficial ecosystem and provides information about environmentally sound, cost-effective, long-term solutions for problems that arise between humans and beavers.



State and Regional Beaver Working Groups

- [Colorado Beaver Working Group | Defenders of Wildlife](#)
- [Montana Beaver Working Group \(nwf.org\)](#)

Radio and Podcasts

- [I'll Be Dammed on Apple Podcasts](#)
- [Episode 07: Beaver hydrology and management — Water Talk \(watertalkpodcast.com\)](#)
- [Stream Restoring Streams One Beaver Dam at a Time by She Goes Outdoors Podcast | Listen online for free on SoundCloud](#)
- [Episode 26: Stream Restoration by In the Woods \(spotify.com\)](#)

Books

- [Eager: The Surprising, Secret Life of Beavers and Why They Matter](#) (Book)
- [Beaverland: How One Weird Rodent Made America by Leila Philip | Goodreads](#)

Funding Resources

- [USDA RCPP Funding](#) (\$300 million program annually)
- [FEMA Hazard Mitigation Programs](#) (seeking nature-based solutions). Example: \$600m FEMA BRIC program.
 - o FEMA has broadened how they assess Ecosystem Service values, allowing nature-based hazard mitigation approaches to rank higher in their cost-benefit analysis (Biden POTUS Executive Order on January 27, 2021).
- [Funding Restoration Projects \(americanrivers.org\)](#) A directory of funding resources for both broad and specific stream restoration projects

Examples

In addition to learning proper techniques and in-the-field experience, peer-to-peer sharing of restoration successes and lessons learned can be effective learning tools. ASWM has conducted a national dialogue to identify examples of beaver-related restoration for this purpose. To review well-documented examples of these techniques in action, click [here](#).

- [Birch Creek Restoration](#)
- [Burnt Beaver Watershed Restoration](#)
- [Using Beaver Dam Analogues for Fish and Wildlife Recovery on Public and Private Rangelands in Eastern Oregon](#)
- [Experimenting with Beaver Dam Analogues in the Scott River Basin, California](#)
- [Going with the Flow: Beaver-focused Stream Restoration on Western Rangelands](#)
- [Beavers in the Desert? The Potential for Translocated Beavers to Serve as Restoration Tools in Desert Rivers](#)
- [If You Build It, They Will Come: Ranching, Riparian Revegetation, and Beaver Colonization in Elko County, Nevada](#)
- [Smokey the Beaver: Beaver-dammed Riparian Corridors Stay Green during Wildfire throughout the Western United States](#)
- [Advancing Efforts to Restore Beavers for the Benefit of Montana Watersheds 2020 Strategy Meeting Report and Action Plan](#)
- [Beaver power provides year-long water to Idaho ranch](#)

