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RESTORING WESTERN HEADWATER STREAMS WITH LOW-TECH PROCESS-BASED METHODS: A REVIEW OF THE SCIENCE AND CASE STUDY RESULTS, CHALLENGES, AND OPPORTUNITIES

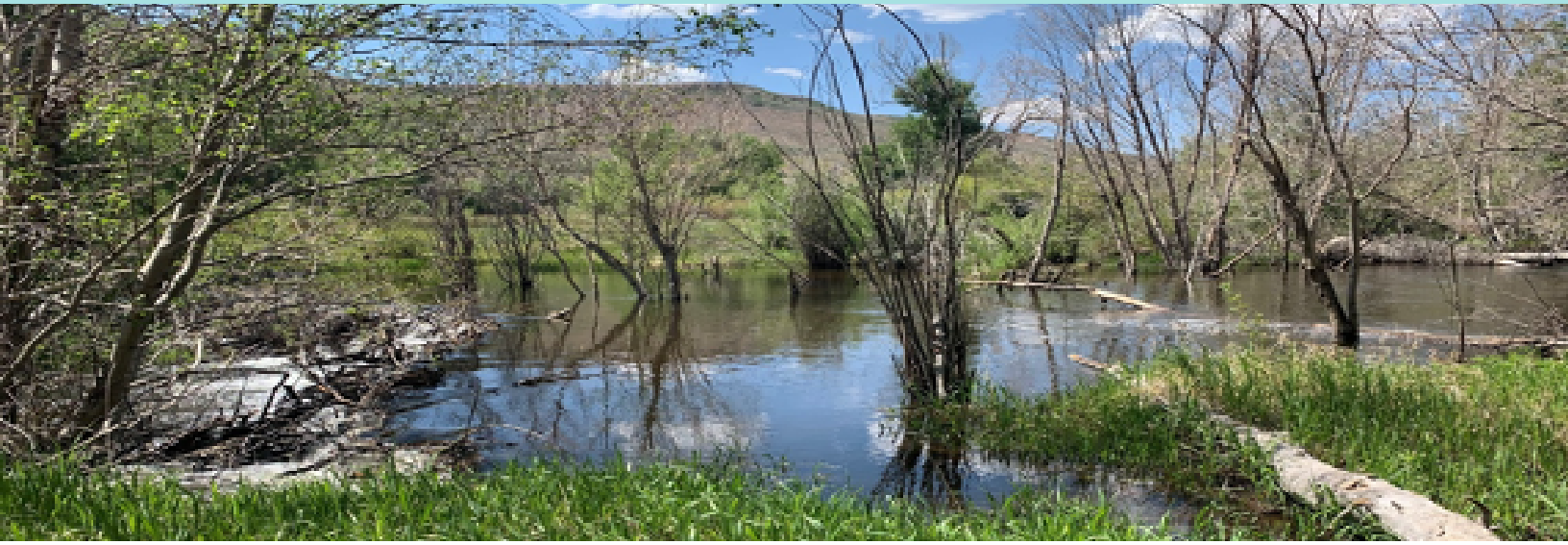


Photo Credit: Beaver Creek LTPBR Project, Gunnison, CO | Jackie Corday

Report Overview

This report, written for American Rivers by Jackie Corday, reviews published research and unpublished case study information on the effects of restoring incised and degraded headwater streams in western states with low-tech process-based restoration methods (LTPBR). LTPBR is a subset of process-based restoration (PBR) that seeks to re-establish natural stream processes by reconnecting incised streams with their floodplains and adjacent wetlands so that more frequent inundation of the floodplain occurs. Projects involve the use of simple, temporary, hand-built wood and rock structures that mimic natural beaver structures, acting as speed bumps that capture sediments to aggrade the stream. LTPBR approaches are substantially less expensive than form-based stream restoration approaches that employ heavy equipment.[1] This approach is appealing in part because low project costs enable implementation at a scale that can respond to the extent of floodplain alteration, which is estimated at 45% of headwaters streams in Colorado.[2] Negative effects of disconnected floodplains include lower groundwater tables, lower summer base flows, warmer water temperatures, and substantial loss of riparian habitat.[3]

A key to the success of LTPBR is having sufficient space for natural fluvial processes to occur. Generally, suitable locations for this type of restoration will be on first- to fourth-order streams with a gradient of less than 6% located on rural public or private lands where there is room for the stream to utilize its full floodplain without causing infrastructure or water use conflicts. These headwater areas were historically occupied by beaver.[4] A goal of many LTPBR projects is for beaver to recolonize the site, maintaining and expanding the LTPBR structures.[5] Grazing management can be an important intervention to enable the growth of sufficient riparian vegetation to provide adequate food and building material for beavers, as well as to address one of the common root causes of stream degradation.[6]

State of the Science - Reported Effects of LTPBR

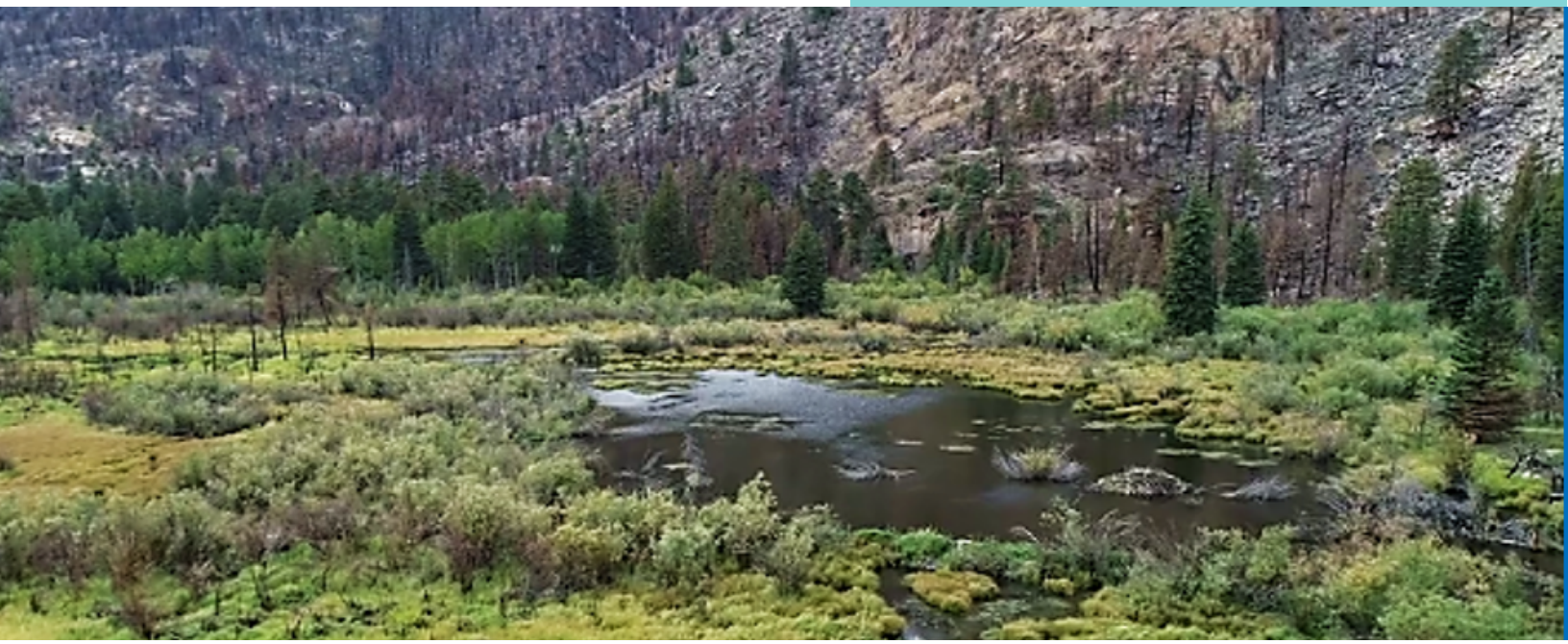
Research surrounding the effects of connected floodplains and beaver complexes is growing. The following effects of LTPBR projects and beavers have been widely documented:

- Drought and flood resilience: Studies indicate that healthy natural stream systems and restored headwater floodplains and wetlands recharge local aquifers. Reconnected floodplains enable infiltration of runoff into soils and wetlands, providing natural storage during spring runoff that can be slowly released to streams during the summer months.[7] There are numerous examples in which beavers increase surface and subsurface water storage. This natural storage was observed to reduce the impact of recent drought on pond levels in a long-term study in Minnesota.[8] Another study found that beaver dams, even failed ones, helped delay downstream flood peaks during a large flood in the Canadian Rocky Mountains.[9]

- Wildfire resilience: A 2020 study of large western US wildfires found that riparian vegetation around beaver complexes had a three times greater rate of survival than around stream segments without beavers.[10]

- Improved habitat: By enhancing wetlands, LTPBR and beaver dams enhance important terrestrial habitat, and have also been shown to enhance fisheries.[11]

> "WE STARTED CONNECTING HOW RESTORATION WORK IN STREAM AREAS AND IMPROVING RIPARIAN ZONES CAN BECOME NATURAL FIRE BREAKS FOR AREAS. AND SO, IT ALIGNED WITH A LOT OF THE WORK WE WERE DOING IN THE COUNTY TO REDUCE FUELS AND CREATE BUFFERS FOR A WILDFIRE. THEN YOU'VE GOT THE ADDED BENEFIT OF A RESTORED STREAM, RESTORING HABITAT, MORE WATER IN THE GROUND, AND KEEPING THE SYSTEM WET. IT'S INCREASING THE WATER TABLE AND ALLOWING VEGETATION TO COME IN NATURALLY. THERE'S JUST SUCH A BENEFIT TO HAVING THE FULL SYSTEM WORKING AS IT SHOULD."
>
> Jess Kirby, Utah Summit County Public Lands Manager, quoted in an article from the Park City News.



Cameron Peak Fire burned everything around this beaver pond in 2020 | Evan Barrientos, Audubon Rockies

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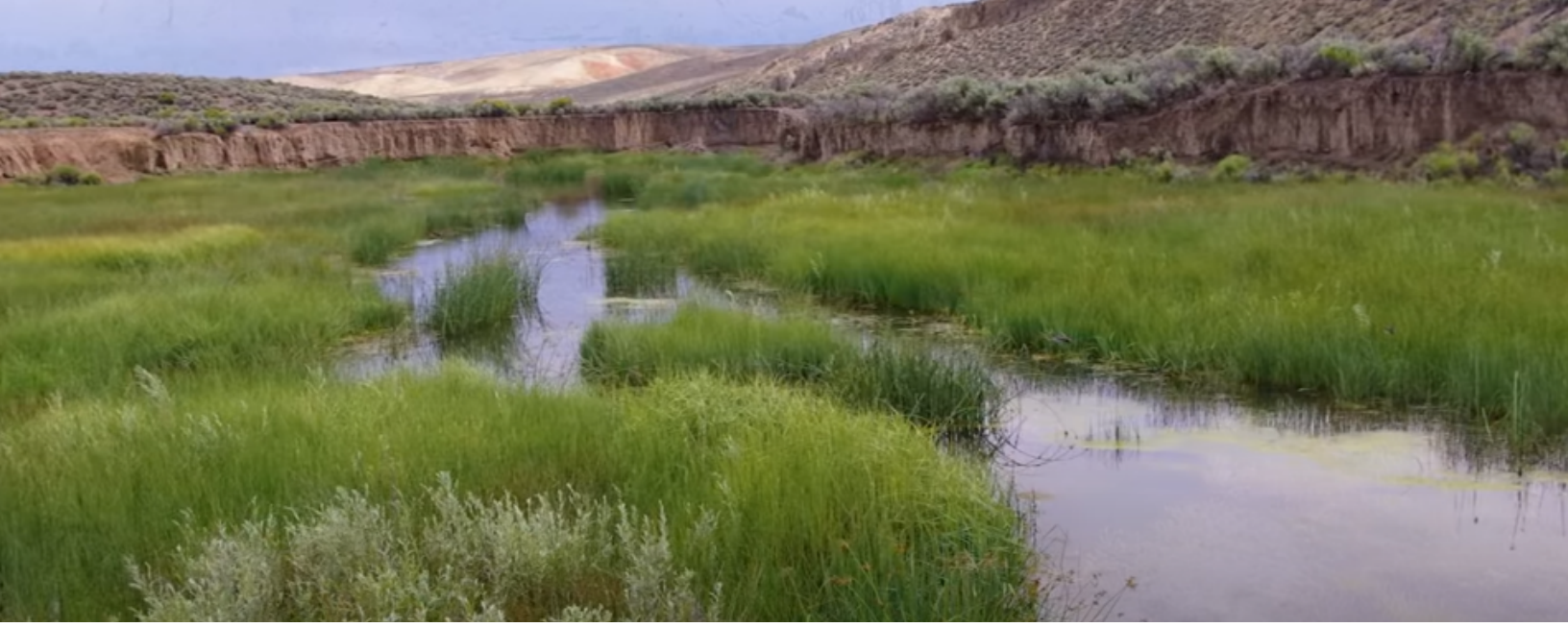

Dixie Creek near Elko, Nevada 30 years after restoration, showing recovered flows and vegetation achieved by grazing management practices | Carol Evans

State of the Science Continued

- Reduced Sedimentation. A study in England monitored 13 beaver ponds built from beavers re-introduced to a controlled 4.5-acre site. They determined that over the four years of monitoring, beaver ponds trapped on average 7.8 tons of sediment, totaling 101.5 tons.[12] The authors concluded beaver ponds may help mitigate the downstream impacts of erosion and nonpoint source pollution.[13]

- Increased water quality. Beaver dams have been shown to retain sediment and nutrients, [14] as well as heavy metals,[15] reducing downstream pollution levels. Additionally, studies have showed beaver complexes can provide cooler water refugia for aquatic species.[16]

- Increased forage. A 2018 study of LTPBR projects in Colorado, Oregon and Nevada showed that the projects increased vegetation productivity and extended it longer into the year. The authors noted that increased soil moisture due to the projects enabled vegetation to keep growing well during periods of low precipitation.[17] A USDA study of LTPBR projects in dryland areas of Oregon, Nevada and Idaho involved extensive interviews of 53 ranchers, the large majority of whom expressed great enthusiasm for beavers returning to their ranches due to the "increased availability of water and better forage" for livestock "that can translate into financial gains."[18]

An Idaho rancher who participated in a LTPBR study said that taking actions to assist the return of beaver to his ranch, "Worked well for everything because, one, it provided water, year-round water all the time, which is a godsend for wildlife, for my cattle, everything. Two, it enhanced the wet meadows that were there, so you had better forage production for cattle, wildlife, everything else."[19]

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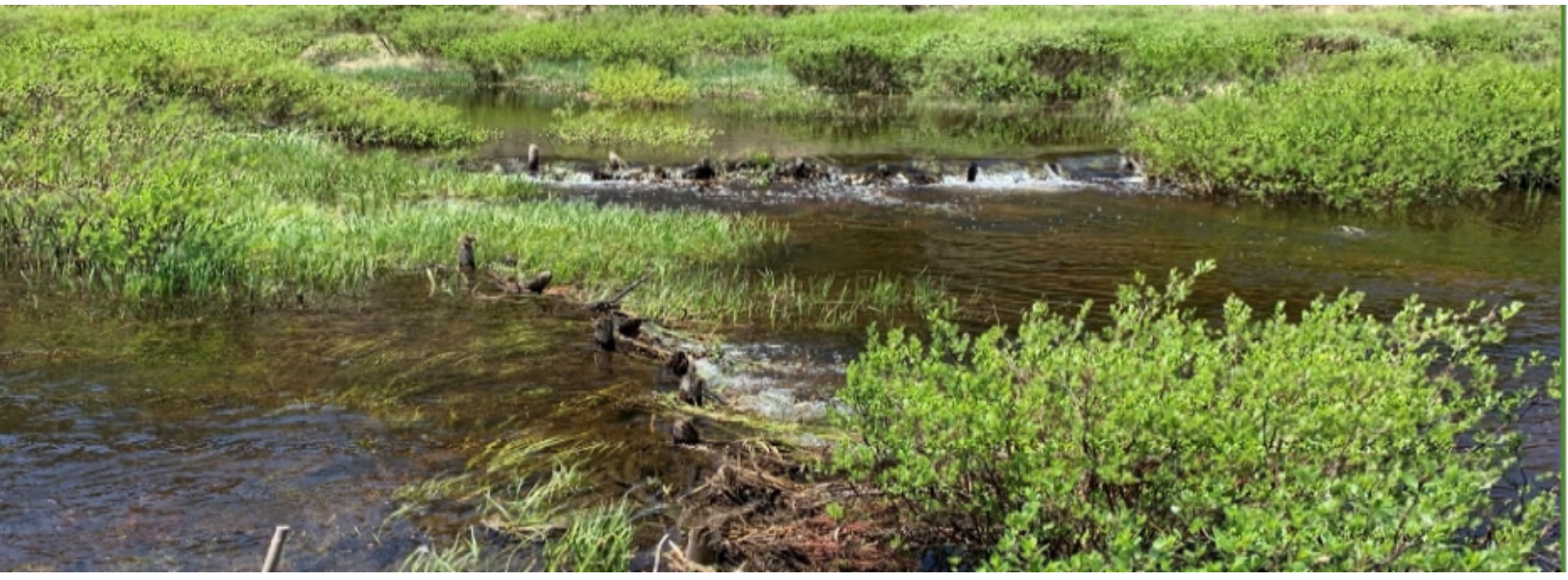
The hydrologic effects of LTPBR projects and beavers, including increased late-season flows and the potential for increased evaporation and water use by additional wetland vegetation, needs additional research. Demonstration projects in different locations and elevations are needed to allow for more scientific understanding of these effects. Existing research on the hydrologic effects has found the following:

- Key factors influencing the degree of LTPBR and beaver impacts on late-season flows include the extent of floodplain inundation and the length of time the inundation is sustained, as well as the porosity of structures.[20]

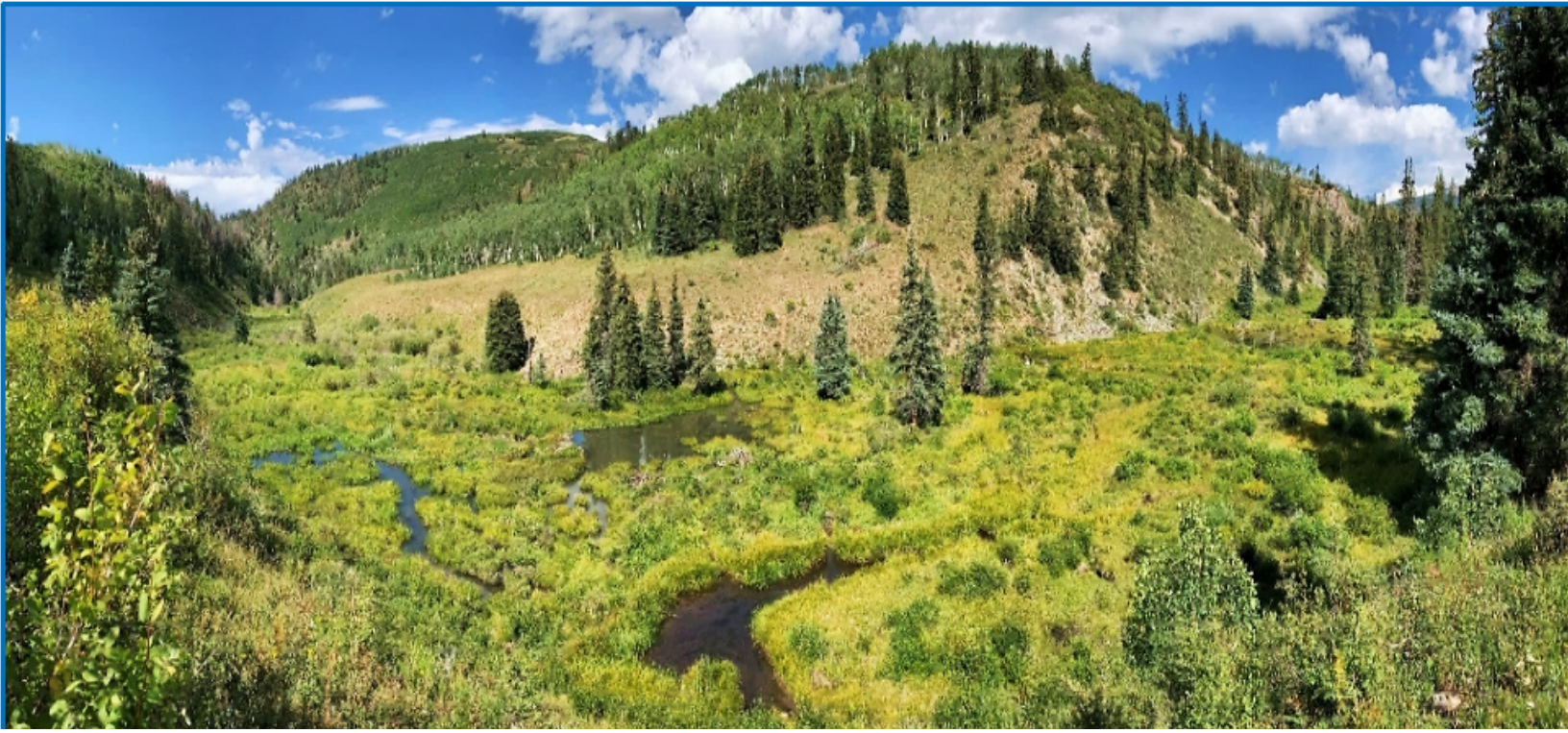
- In regard to the potential for LTPBR to cause higher late-season flows and lower flows when a LTPBR project is first installed, one review found that small LTPBR projects tend not to have observable effects on streamflow, while larger projects (approximately 20 or more structures) can attenuate runoff and increase baseflows.[21]

- Research conducted for this report did not find any documented cases of LTPBR projects that resulted in measurable harm to water rights from increased evaporation due to more surface water and increased evapotranspiration (ET) from riparian vegetation. A 2020 Montana study found that three years after the installation of a LTPBR project, the riparian vegetation had increased by ~25%, which resulted in a 0.7gpm increase in ET per structure.[22] This small amount of decreased flow (0.0015cfs) was well below an amount that could be detected by a stream gage. [23]

There is tremendous opportunity to significantly scale up LTPBR in headwaters stream across Colorado and the West. In the past five years, federal land management agencies have begun moving forward with scaling up stream and wetland restoration on public lands using LTPBR methods. With the passage of the Infrastructure Investment and Jobs Act (2021) and the Inflation Reduction Act (2022), there is unprecedented funding to support ecological restoration, including LTPBR on public and private lands. Despite these opportunities, there are also challenges to utilization of LTPBR at a large landscape scale. These include potential impacts to human infrastructure from beaver dams, such as road and infrastructure flooding. Additionally, concerns about whether or not LTPBR projects may impact downstream water rights can also hinder projects. Consulting with local stakeholders prior to developing an LTPBR project, carefully choosing location and project design, and ensuring compliance with any permitting requirements, can help overcome these challenges and enhance the chances for project success.



BDAs installed in Sept. 2021 on Trail Creek in the Upper Gunnison Basin. This is a great example of a project carefully designed to avoid conflicts with its location high in the headwaters above reservoirs and diversions, and notice how short and porous the BDAs have been designed | Jackie Corday



Beaver complex on Middle Beaver Creek, Uncompahgre National Forest | Jackie Corday

Conclusion

Substantial research and emerging case studies are documenting the need to restore the health of our headwater streams in the face of climate change impacts that have already greatly reduced water availability each year across the West. Research and on the ground projects indicate that LTPBR can be a useful, cost-effective tool for buffering western watersheds from the increasingly extreme droughts, wildfires and rainfall events associated with climate change.

On the ground projects are showing that restored floodplain connection can improve water quality, attenuate storm flows, increase wildfire and drought resilience, and provide benefits of particular interest to the agricultural community – increased quality and quantity of forage, reduced sedimentation of irrigation infrastructure, and in some cases later season water availability. Research also shows that beaver can be our greatest assets for effectively and inexpensively restoring miles of headwater streams where they formerly lived. LTPBR methods have proven successful in assisting the return of beaver to historical ranges once riparian and flow conditions are sufficient for their survival.

Despite the documented benefits and low cost of LTPBR projects, challenges are impeding scaling up these projects. The social barriers to LTPBR and beavers are the largest challenges to solve. These include the potential impacts to human infrastructure from beaver dams, such as road and irrigation infrastructure flooding. This has stimulated the development of numerous solutions for preventing beaver from blocking water conveyances and ensuring sufficient water passage through beaver dams to prevent flooding problems.[24] Additionally, more research is needed to understand the hydrologic effects of LTPBR projects and beaver complexes, including potential benefits to late-season flows and potential water rights impacts that can be avoided or mitigated. Demonstration projects in different types of stream systems and elevations are needed to provide more scientific understanding of these effects. Consulting with local stakeholders prior to developing an LTPBR project, carefully choosing location and project design, and ensuring compliance with any permitting requirements, can help overcome these challenges and enhance the chances for project success.

Recent increases in funding for natural infrastructure through the federal Infrastructure Investment and Jobs Act and Inflation Reduction Act, as well as state-level programs, makes this an opportune moment to develop and implement these projects in conjunction with robust monitoring programs to better understand and maximize their benefit.

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