HEALTHY RIVERSCAPES INITIATIVE: INVESTING IN AQUATIC RESOURCES TO INCREASE CLIMATE RESILIENCE AND BIODIVERSITY OUTCOMES

Recommendations to Bureau of Land Management

A proposal developed by NRDC in collaboration with Professor Wheaton (Utah State University).[1]

INTRODUCTION

As the single largest federal land manager, the Bureau of Land Management has a critical role to play in addressing two inter-related crises—biodiversity collapse and climate change. Key to fighting both challenges is the restoration and protection of freshwater resources – including riverscapes. Riverscapes—the connected floodplain and channel habitats that together make up valley bottoms—are disproportionately important parts of the landscape. While western wetlands have been reduced to just two percent of the land surface, they support around 80 percent of the area's biodiversity. When healthy, riverscapes and their associated wetlands are critical natural infrastructure that support biodiversity, slow the flow of water, attenuate flooding, and act as fire breaks and refugia.

In the continental United States, the Bureau of Land Management (BLM) manages more than 250,000 miles of streams and rivers, roughly 8% of the area's riverscapes and 2% of its perennial riverscapes. Unfortunately, BLM inherited the management of some of the most degraded riverscapes in the country.[2] Between the early 1800s and the end of the century, the systemic removal of beavers, agricultural conversion and development pressures that followed led to streams across the West transitioning from mosaics of wetlands and multi-thread channels to higher energy, single-thread channels that cut down into their floodplains, draining alluvial aquifers and drying out valley bottoms.[3] This history and its legacy have left the agency with a severely degraded resource. Therefore, truly re-capturing the inherent diverse values of

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[2] Courtwright, J, S Miller, S Paulsen, T Olsen, and P Kaufmann, "Stream and River Condition Across the BLM's National System of Public Lands, (presented at the Society for Freshwater Science, Sacramento, CA, May 21 - 26, 2016); and Hess, K, and Holechek, JL, Policy Roots of Land Degradation in the Arid Region of the United States: An Overview," *Environmental Monitoring and Assessment* 37, (1995): 123–141.

[3] Rieman, BE, CL Smith, RJ Naiman, GT Ruggerone, CC Wood, N Huntly, EN Merrill, JR Alldredge, PA Bisson, J Congleton, KD Fausch, C Levings, W Pearcy, D Scarnecchia, and P Smouse, "A Comprehensive Approach for Habitat Restoration in the Columbia Basin," *Fisheries* 40, (2015): 124-135.

riverscapes on BLM land requires an investment in rebuilding healthier, more resilient, and self-sustaining riverscapes with natural processes.

BLM lands are often misunderstood, and their conservation values underestimated. BLM manages many of the riverscapes that were not claimed under the Homestead Act, and not producing commercially viable timber. These happened to be in parts of the watershed that were more vulnerable to degradation from over-grazing, upstream timber harvest, and systematic removal of beaver and wood from these watersheds. The same vulnerabilities that degraded these landscapes makes them prime candidates for a suite of low-tech restoration techniques that prioritize natural processes and increase biodiversity and climate resilience. The fact is, the agency has a ripe opportunity to dramatically increase the health of its landscapes by restoring narrow, often incised stream channels into healthy, functioning riverscapes (Figure 1). Put another way, BLM is in the position to reclaim approximately 70 to 80% of its degraded valley bottoms.[4] By concentrating restoration focus and funding on riverscapes as a category of lands, and particularly those where the most uplift is possible, BLM can return life to the rivers and streams that now look and function like desiccated sponges.

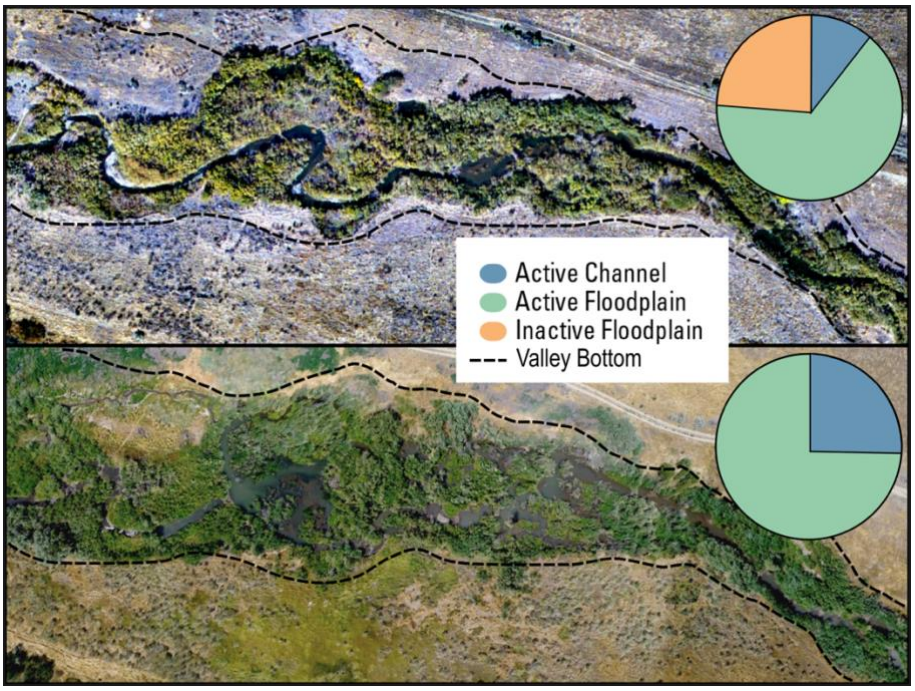

Figure 1. Bridge Creek, a tributary of the John Day River on BLM Lands in Oregon, before a treatment in 2009 (top, 2005) and after (bottom, 2015) a low-tech process-based restoration treatment was used in 2009 to raise the water table; increase base flows, beaver activity, and habitat complexity; decrease stream temperature; and invoke a positive population response to an endangered salmon population.[5] Photo credit: Nick Weber

[4] Note: BLM's riverscapes currently have active channels and floodplains that occupy 1 to 5% (roughly 1 to 5 acres per mile) of their former floodplains (70 to 100 acres per mile).

[5] Bouwes N, N Weber, CE Jordan, WC Saunders, IA Tattam, C Volk, JM Wheaton, and MM Pollock, "Ecosystem Experiment Reveals Benefits of Natural and Simulated Beaver Dams to a Threatened Population of Steelhead (Oncorhynchus mykiss)," *Scientific Reports* 6, 28581 (2016).

REIMAGINING THE ROLE OF RIVERSCAPES ON BLM LANDS

It is time for BLM to reimagine the role its riverscapes can play in increasing climate resilience and protecting biodiversity. To accomplish this, BLM should establish a healthy riverscape initiative that prioritizes investing in low-tech, process-based restoration (LTPBR) to improve the condition of and expand riverscape habitat on BLM managed lands. LTPBR is the practice of using simple, low unit-cost, structural additions (e.g. wood and beaver dams) to riverscapes to mimic functions and initiate specific processes. By investing in such techniques, the BLM can restore degraded stream channels into healthy, functioning riverscapes that will help these landscapes more reliably yield benefits in water quantity, water quality, habitat for terrestrial and aquatic species, recreation, and carbon sequestration, while simultaneously increasing resilience to the increasing frequency and severity of droughts, floods, and fires.

This is a long-term strategy, but one for which there is urgency in initiating and implementing. The most pressing urgency is that posed by the immediate threats and impacts of the climate crisis. Secondly, the clock is ticking on five years of spending for restoration and investments in natural infrastructure and building climate resilience using funding from the Infrastructure Improvement and Jobs Act (IIJA). BLM must use the next five years to establish a compelling and successful track record that helps the public and Congress not have to "imagine" what is possible in riverscapes on BLM lands but see inspiring examples of what can be accomplished where strategic investments are executed in concert with the help of natural processes. This track record can position the agency to make the case for sustained investment in the years that follow the five years of infrastructure funding. In addition to investing in BLM-managed lands, the agency should look for opportunities to partner with tribes, states, private landowners, and its sister federal agencies to accomplish restoration objectives on adjacent lands in watersheds with mixed ownership. Such an approach will leverage BLM's investment and lay the groundwork for creating good paying, private, non-profit and public sector jobs in these rural economies.

Here, we offer our recommendations for how to restore healthy and resilient riverscapes on BLM lands. It will require a shift in how BLM imagines the contribution it can and should be making to the future of water and habitat management, climate resilience, and biodiversity conservation in the West. However, there are simple tractable steps that can be put into motion today with funding from the IIJA.

Path To Achieving Healthy Riverscapes

To increase the scale and impact of riverscape restoration to rival the scope of degradation and need, the BLM should establish a healthy riverscape initiative to steer the agency's restoration direction and investments. Such an initiative would:

- Reimagine what riverscapes on BLM lands can do to help this country address the climate crisis.[6]
- Redefine BLM's definition of and its expectations for what constitutes healthy aquatic habitat on lands it manages in conjunction with the multi-agency collaboration of the Riverscapes Consortium.[7]
- Establish national priorities, frameworks and guidance that support state and field offices and their partners to expand the scope of restoration that is possible on BLM lands.
- Integrate riverscape restoration goals into the following agency priorities: climate adaptation and resilience, grazing management, wildland fire mitigation, sage grouse habitat, flood protection, drought resilience, and the America the Beautiful initiative.
- Complete a comprehensive assessment of riverscape health to inform planning and designs for the restoration of prioritized watersheds.[8]
- Hire restoration experts responsible for supporting state and field offices to develop and implement restoration projects.
- Create regional, interagency restoration coordinator positions to help agency staff and their state, tribal, and local partners co-develop and implement watershed scale restoration that crosses land ownership boundaries.
- Coordinate with leading researchers and restoration experts to coproduce assessment and monitoring tools that align with the latest science on riverscape health and provide the information that BLM and its partners need to prioritize, plan, design, and adaptively manage process-based restoration projects.
- Streamline requirements for permitting and authorizing restoration projects.

Addressing the Root Cause of Degradation

In semiarid landscapes, riparian-wetland and aquatic areas occupy a small portion of the broader landscape (historically 5-15%; today 1-2%), but have a disproportionately beneficial influence on wildlife, vegetation, and water resources. Riparian and wetland areas, lakes, streams, and aquifers on BLM managed lands have the potential to be among the most important, productive, and diverse resources in the West. They provide habitat for myriad species of plants, fish, and wildlife; provide ecosystem services such as drinking water, pollination, and nutrient cycling; attenuate

[6] See Mark Beardsley, "Reimagining What Riverscapes Could Be," (presentation, Introduction to Low-Tech, Process-Based Restoration Module 1:E, online, August 14, 2020).
[7] See Joe Wheaton, "Riverscapes Health Principles," (presentation, Introduction to Low-Tech, Process-Based Restoration Module 1:J, online, August 13, 2020).
[8] See Riverscapes Consortium, "2021 Riverscapes Monitoring Summit," (online, November 2-4, 2021); the Riverscapes Consortium is working to establish a multi-agency Riverscape Health Monitoring Framework from which to base individual protocols.

effects of wildfires, floods, and drought; and are key to the vitality of local economies and communities.

Hydrologic resources in water-scarce regions are highly sensitive to land management and climatic variability. An assessment of stream and river condition across BLM lands found that at least 70% of streams were in a state of moderate or significant departure from biological reference conditions, with the majority of that (47%) being significant. One of the primary drivers of that departure being a reduction in riparian vegetation and canopy cover.[9] In many watersheds, stream channels are incised and disconnected from their floodplains (e.g., Figure 2), which leads to lower water tables, reduced groundwater discharge, reduced soil water storage capacity, and ultimately less drought resiliency.

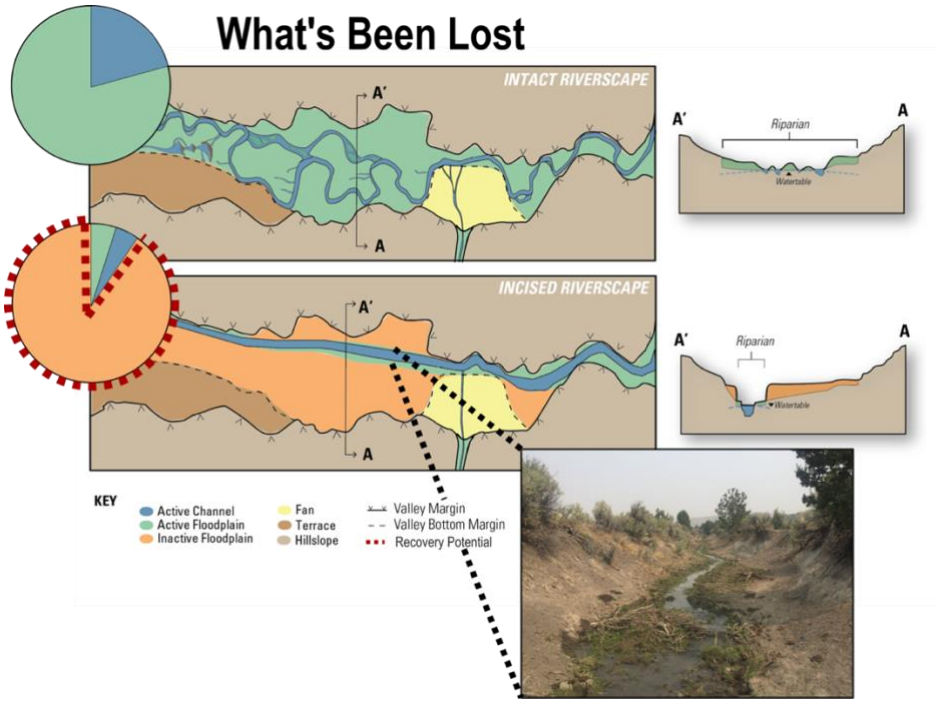

Figure 2. Intact riverscapes are characterized by multi-threaded channels that can access the full expanse of the floodplain (top). These riverscapes provide various ecosystem services which are lost when riverscapes become degraded and incised (bottom). To recover these services, inactive floodplains must become part of the active riverscape again. LTPBR is an effective way to accelerate this recovery. Source: Adapted from Wheaton et al. 2019a.[10]

Starting in the late 1700s and early 1800s, there was a rapid expansion of activities that caused a reduction in wood accumulations, riparian vegetation (especially woody plants), and beaver. These include beaver trapping to supply the fur trade, mining, railroad construction, agricultural development (e.g., crop, pasture, and rangelands), logging, using riverscapes as navigation corridors, channel modification, roads, the introduction of invasive species, livestock grazing, and consequences of climate change.[11] This led to an unprecedented scope, scale, and rate of

[9] Courtright et al., 2016.

[10] Wheaton JM, SN Bennett, N Bouwes, JD Maestas, and SM Shahverdian (Editors), *Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0*, (Logan, UT: Utah State University Restoration Consortium, 2019a).

[11] Rienman et al., 2015.

structural starvation, which continues to affect the health and productivity of riverscapes throughout the West.

Recent BLM-led mapping and modeling efforts provide insight into the scale of riverscape degradation and scope of restoration opportunities. For example, in Montana/Dakotas, over ~92% of all riparian-wetland and aquatic habitats are within the valley bottom, but only ~11% of the valley bottom currently supports riparian-wetland and aquatic habitat (e.g., Figure 2). BLM's results from Montana/Dakotas align with other studies and indicate that most streams are functioning far below their potential. Historically, riparian, wetlands, and aquatic habitat would have made up 90 percent or more of the valley bottoms.

Given the scope of degradation and compounding influence of climate change on ecosystems, the BLM needs to adopt simple, cost-effective (i.e., low-tech) restoration methods that would mimic, promote, and sustain the natural processes that improve riverscape health. Although the BLM has historically prioritized maintaining existing conditions by minimizing or avoiding additional impacts to riparian-wetland and aquatic areas from land use authorizations (e.g., roads, livestock grazing, mining), many systems were already impaired before the BLM was created from historical practices and recovery could take centuries to millennia *without restoration intervention*.

To address this level of degradation, practitioners across the West have turned to cost-effective and relatively simple low-impact restoration approaches designed to mimic, promote, and sustain natural processes (commonly referred to as low-tech, process-based restoration or LTPBR). LTPBR is guided by a basic set of riverscape principles: 1) streams need space; 2) structure forces complexity and builds resilience, 3) the importance of structure varies, and 4) inefficient conveyance of water is healthy (Figure 3, Appendix I). LTPBR prioritizes low gradient, wadable streams that require floodplains and riparian vegetation to function properly but lack the amount and type of structural elements (i.e., wood, boulders, beaver dams, bedrock, vegetation) needed to maintain their health.

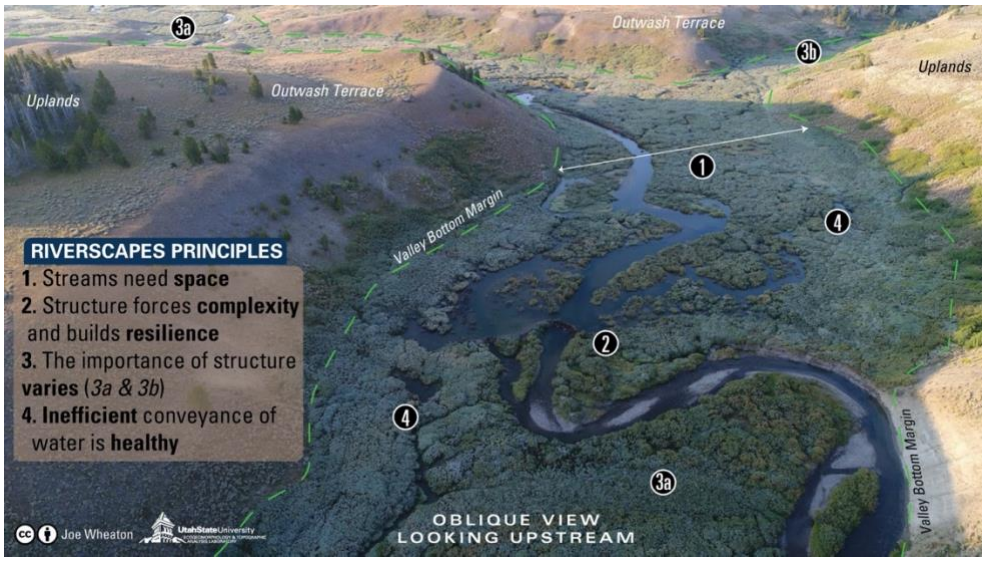

Figure 3. Riverscapes principles inform the planning and design of LTPBR projects through an understanding of what constitutes healthy, functioning riverscapes and therefore what are appropriate targets to aim for. Source: Wheaton et al., 2019a. [12]

[12] Wheaton, et al., 2019a.

The costs of these approaches can vary but are in the range of $50,000 to $150,000 per stream mile depending on stream size, scale of treatment, and accessible building materials. By contrast, traditional stream restoration is roughly $250,00 to $350,000 per mile and river restoration is often more than $1.5 million/mile. This is only twenty to forty percent of the cost for traditional restoration (i.e., use of heavy equipment and rigid designs for stream form and function) because the focus is on restoring the formative processes by reengaging biotic structure, then allowing the system to do the work. Furthermore, outcomes from this low-tech approach tend to exceed what is possible via traditional restoration practices both in terms of ecosystem health and benefits to communities. LTPBR also produces ecosystem services that are more resistant and resilient to the impacts of flood, fire, drought, and climate change (Figure 4).

Figure 4. Illustration of the process of encouraging beaver dam activity with beaver dam analogs (i.e., a man-made structure designed to mimic the form and function of a natural beaver dam) and how this can lead to (on right) self-sustaining conditions. Source: Goldfarb, 2018.[13]

ALIGNING A HEALTHY RIVERSCAPES INITIATIVE WITH EXISTING MANAGEMENT PRIORITIES

Investing in riverscape restoration will result in a myriad of benefits for fish and wildlife; the communities that depend on these lands for water, livelihoods, and recreation; and society writ large. BLM managers can scale up riverscape restoration to address these needs and support existing BLM priorities such as building drought and fire resilience, sustaining sage grouse habitat,

[13] Goldfarb, B, "Beavers, Rebooted: Artificial Beaver Dams Are a Hot Restoration Strategy, but the Projects Aren't Always Welcome," *Science*, 360(6393), 2018: 1058-1061.

and providing grazing lands for permittees. The following sections outline existing BLM resources and priorities that should align with and benefit from reconnected floodplains.

LEVERAGE THE INFRASTRUCTURE INVESTMENT AND JOBS ACT TO SCALE UP BLM'S INVESTMENT IN ITS NATURAL INFRASTRUCTURE

Over the next five years, BLM and its partner agencies will have access to funding from the Infrastructure Investment and Jobs Act (IIJA) to invest in the restoration of BLM's natural infrastructure to achieve outcomes outlined by Congress. The IIJA funding provides BLM with the opportunity to partner with other federal agencies, states, tribes, and local partners to rebuild natural infrastructure to increase climate resilience and support biodiversity outcomes. Not only does leveraging the IIJA help build better natural infrastructure, it also could lay the groundwork for creating good paying, private, non-profit, and public sector jobs in these rural economies. As demonstrated in Figure 5, BLM lands are well positioned for rebuilding riverscape health because they are relatively unburdened by conflicts (e.g., roads, buildings, agricultural lands) compared to private or urban settings.

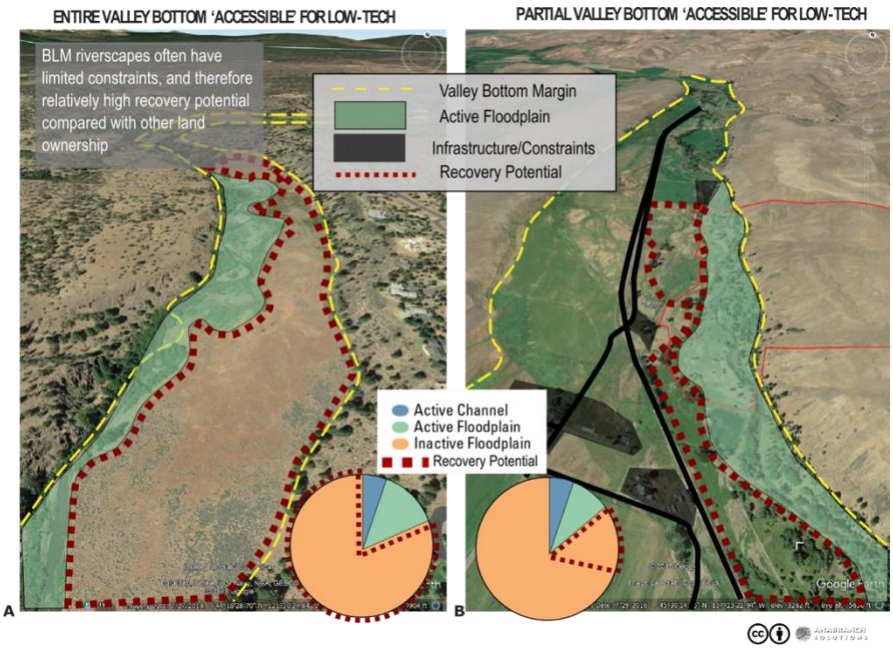

Figure 5. BLM lands (A) are largely unconstrained by development, roads, and other impediments. As such, there is a greater opportunity to restore riverscapes to their full potential compared with those valley bottoms in private ownership (B), urban areas, or indeed the USFS, which has a much higher road density. Source: Adapted from Wheaton, et al., (2019b).[14]

Example: increasing water quality and availability

Healthy riverscapes protect water quality and reduce or eliminate many of the potential impacts of nonpoint source (NPS) pollution. One way this is achieved is by providing a buffer between uplands and adjacent water bodies. These vegetated areas can filter out NPS pollution before it can impact water quality, while also acting as a filtering and processing sink for constituents

[14] Wheaton JM, A Wheaton, J Maestas, S Bennett, N Bouwes, S Shahveridan, R Camp, C Jordan, W Macfarlane, E Portugal, and N Weber, "*Low-Tech Process-Based Restoration of Riverscapes: Pocket Field Guide*," (Logan, UT: Utah State University Restoration Consortium, 2019b).

already mobilized from upstream. They also reduce NPS pollution by shading waterbodies, sustaining healthy erosion/deposition dynamics, enhancing nutrient cycling within the hyporheic zone, and capturing and processing pollutants from upstream sources. In general, riverscape health and water quality are directly related because the proportion of the riverscape that is active floodplain/wetland is directly analogous to what proportion of kidneys are available to do the important work of filtering out waste and extra fluids in humans.

Riverscapes with structural elements (e.g., woody debris, beaver dams, root mats), complex form, abundant riparian vegetation, and frequent hydrologic connections across the valley bottom are capable of naturally storing more water during high flow events and slowly releasing it later in the year. They create large transient surface water stores and even larger sub-surface shallow groundwater stores. This reduces flood peaks and can augment base flows, which often coincides with peak water demand and water-related stresses for aquatic and terrestrial wildlife.

PRIORITIZE RIVERSCAPE RESTORATION TO NATURALLY STORE MORE WATER, INCREASE FIRE RESILIENCE, AND BUILD NATURAL REFUGIA.

A diversity of water residence times in a river system enhances a riverscape's ability to slow flows during wet periods and release stored water as base flow during dry periods, simultaneously mitigating against both flood and drought.[15] This also helps keep water in the soil during periods of prolonged drought to support riparian vegetation and associated wildlife. The wet, saturated soils and braided stream channels present in floodplain-connected riverscapes don't readily burn and can therefore slow fire movement and provide refugia for wildlife.[16] Long stretches of healthy riverscapes could serve as firebreaks, slowing the spread of fire, and giving firefighting teams time to contain them before they get out of control.

[15] Fairfax, E and EE Small, "Using Remote Sensing to Assess the Impact of Beaver Damming on Riparian Evapotranspiration in an Arid Landscape, *Ecohydrology*, 11, 7 (2018).

[16] Fairfax, E and A Whittle, "Smokey the Beaver: Beaver-Dammed Riparian Corridors Stay Green During Wildfire Throughout the Western United States," *Ecological Applications*, 30, 8 (2020); Wohl, E, AE Marshall, J Scamardo, D White, and RR Morrison, "Biogeomorphic Influences on River Corridor Resilience to Wildlife Disturbances in a Mountain Stream of the Southern Rockies, USA." *Science of the Total Environment, 820, 153321 (*2022*);* and Whitcomb, I, "Beaver Dams Help Wildfire-Ravaged Ecosystems Recover Long After Flames Subside," *Scientific American* (February 7, 2022*)*.

Figure 6: Beaver ponds create an emerald refuge within a landscape recently scorched by fire in Idaho. From Wheaton et al. (2019b).[17]

ALIGN RIVERSCAPE RESTORATION WORK TO SUPPORT AQUATIC AND TERRESTRIAL BIODIVERSITY

Even though riverscapes occupy only a small proportion of the total land base (10-15% for perennial streams and 15-30% when including intermittent and ephemeral streams in most watersheds), they are regional hot spots of biodiversity and exhibit high rates of biological productivity. Maintaining or improving riverscape health benefits a wide array of native aquatic and terrestrial species by providing microclimates and shade, complex hydraulics, clean and abundant water, organic litter and wood to aquatic systems, nutrient retention and cycling, wildlife habitat, and food-web support for a wide range of aquatic and terrestrial organisms. When riverscapes are healthy, the riparian-wetland and aquatic habitat zone is larger, more productive and diverse, and better suited to the lifecycle needs of native plants and animals than structurally-starved systems. In fact, many of the species that rely on riverscape habitats evolved to capitalize on the ecosystem attributes and processes created by beaver dam building activity, root mat production, and wood accumulations. Riverscapes are home to an abundance of animal life, including invertebrates, almost all amphibian species and many reptiles, the majority of bird species (particularly in the semiarid West), and many mammal species with semiaquatic habitats.

Example: investing in riverscapes to support sage grouse

An investment in riverscape restoration can offset a deepening risk of water scarcity that is contributing to the sage grouse's decline. Sage grouse evolved not just to live off sagebrush, but to move to wet meadows, springs, and streamside riparian areas in mid to late summer. That's when sage grouse hens and their growing broods head to wet areas to find leafy plants and insects that thrive in wet places. The long-term maintenance of healthy sage grouse populations depends on drought resilient mesic resources that can offset climate driven vulnerability in vegetative productivity. This is why the Working Lands for Wildlife program, and the Sage Grouse Initiative

[17] Wheaton, et al., 2019b.

adopted a "Water is Life" strategy built around restoring and conserving the wet meadows and mesic habitats of riverscapes.[18]

INTEGRATE THE PROTECTION OF RESTORED RIVERSCAPES INTO BLM'S NEW GRAZING REGULATIONS

When BLM initiates a NEPA process to revise its grazing regulations, the agency should identify ways to increase riverscape health through the use of strategic fencing and flexible, high-intensity, short-duration, rotational grazing management. By changing the way cows graze on streams, the plants and beavers can increase so water can reclaim the floodplain, groundwater can be recharged, and wetlands can be maintained for wildlife, fish, and waterfowl—even in years of drought.[19]

Example: shifting grazing management to restore Dixie Creek, NV

Dixie Creek near Elko, NV provides a superb example of BLM working with grazing allotment permittees to alter livestock management (e.g., timing, location, AUMs, duration) to increase ecosystem services like groundwater recharge and overall landscape resiliency. With modest, voluntary adjustments in grazing management and targeted fencing, BLM land managers, ranchers, and sportsmen were able to reconnect Dixie Creek to its floodplain, restore wet meadow habitats, and improve conditions for livestock grazing.[20]

Figure 7. Restored Dixie Creek, near Elko, NV. BLM land managers, ranchers, and sportsmen and women worked together to shift grazing on Dixie Creek to benefit ecosystem services and the interests of all parties. Eventually beavers returned to support natural processes and create wetlands that remained wet throughout the 2021 drought. Photo credit: Little Wild.

[18] See Sage Grouse Conservation Initiative, "Water is Life: Introducing SGI's Mesic Habitat Conservation Strategy," April 5, 2017.
[19] See coverage of rancher-led efforts to create healthier riverscapes: Brianna Randall, "Beaver Power Provides Year-Round Water to Idaho Ranch," *Beef Magazine*, February 20, 2020; and Steve Steubner, "Restoring Beaver: Rancher Jay Wilde Realizes Long Time Dream of Bringing Beaver Back to Birch Creek," Life on the Range.
[20] See Hannah Nikonow, "Creating Miracles in the Desert: Restoring Dixie Creek Film," Partners in the Sage, October 27, 2021; and Silverman, NL, BW Allred, JP Dollelly, TB Chapman, JD Maestes, JM Wheaton, J White, and DE Naugle, "Low-Tech Riparian and Wet Meadow Restoration Increases Vegetation Productivity and Resilience Across Semiarid Rangelands," *Restoration Ecology*, 27, 2 (2019): 269-278.

APPENDIX I: RIVERSCAPE AND RESTORATION PRINCIPLES

Riverscapes Principles inform planning and design through an understanding of what constitutes healthy, functioning riverscapes and therefore what are appropriate targets and analogues to aim for.[21] They include:

- *Streams need space*. Healthy streams are dynamic, regularly shifting position within their valley bottom, reworking and interacting with their floodplain. Allowing streams to adjust within their valley bottom is essential for maintaining functioning riverscapes.
- *Structure forces complexity and builds resilience***.** Structural elements, such as beaver dams and large woody debris, force changes in flow patterns that produce physically diverse habitats. Physically diverse habitats are more resilient to disturbances than simplified, homogeneous habitats**.**
- *The importance of structure varies***.** The relative importance and abundance of structural elements varies based on reach type, valley setting, flow regime and watershed context. Recognizing what type of stream you are dealing with (i.e., what other streams it is similar to) helps develop realistic expectations about what that stream should or could look (form) and behave (process) like.
- *Inefficient conveyance of water is often healthy.* Hydrologic inefficiency is the hallmark of a healthy system. More diverse residence times for water can attenuate potentially damaging floods, fill up valley bottom sponges, and slowly release that water later elevating baseflow and producing critical ecosystem services.

Restoration Principles relate to specific restoration actions and give us clues as to how to develop designs to promote processes that lead to recovery and resilience. These principles are rooted in the notion that we are not designing and building the solution, but rather we are simply initiating and promoting natural processes with structural additions as efficiently as possible to maximize the miles of riverscape we can improve. The principles outlined below place restoration actions in the right context to maximize effectiveness in promoting better riverscape health.

- *It's okay to be messy.* When structure is added back to streams, it is meant to mimic and promote the processes of wood accumulation and beaver dam activity. Structures are fed to the system like a meal and should resemble natural structures (log jams, beaver dams, fallen trees) in naturally 'messy' systems. Structures do not have to be perfectly built to yield desirable outcomes. Focus less on the form and more on the processes the structures will promote.
- *There is strength in numbers.* A large number of smaller structures working in concert with each other can achieve much more than a few isolated, over-built, highly-secured structures. Using a lot of smaller structures provides redundancy and reduces the

[21] Wheaton, et al., 2019a.

importance of any one structure. It generally takes many structures, designed in a complex, to promote the processes of wood accumulation and beaver dam activity that lead to the desired outcomes.

- *Use natural building materials.* Natural materials should be used because structures are simply intended to initiate process recovery and go away over time. Locally sourced materials are preferable because they simplify logistics and keep costs down.
- *Let the system do the work.* Giving the riverscape and/or beaver the tools (structure) to promote natural processes to heal itself with stream power and ecosystem engineering, as opposed to diesel power, promotes efficiency that allows restoration to scale to the scope of degradation.
- *Defer decision making to the system.* Wherever possible, let the system make critical design decisions by simply providing the tools and space it needs to adjust. Deferring decision making to the system downplays the significance of uncertainty due to limited knowledge. For example, choosing a floodplain elevation to grade to based on limited hydrology information can be a complex and uncertain endeavor, but deferring to the hydrology of that system to build its own floodplain grade reduces the importance of uncertainty due to limited knowledge.
- *Self-sustaining systems are the solution.* Low-tech restoration actions in and of themselves are not the solution. Rather they are just intended to initiate processes and nudge the system towards the ultimate goal of building a resilient, self-sustaining riverscape.

APPENDIX II: POSITIONING BLM TO LAUNCH A RIVERSCAPE RESTORATION INITIATIVE

Although the IIJA may represent the single largest infusion of restoration dollars to BLM in its history, it is not enough to reverse 200 years of impacts and degradation on the at least 200,000 miles of riverscapes BLM stewards with major restoration needs and potential. The need, just for riverscape restoration, is closer to $10 to $20 billion on BLM land alone. It is fundamental for BLM to recognize that a riverscape restoration initiative is a long-term investment in improving and being proud stewards of BLM's riverscapes well beyond the five-year timeframe of the IIJA. However, the IIJA provides a major opportunity to launch this initiative and use it to demonstrate what is possible when funding is focused on helping restore entire systems.

BLM should not confuse this short-term opportunity as a means to dribble out resources uniformly across BLM to support good intents but limited impacts. We suggest that the initiative should be launched with strategic focus in specific watersheds in BLM offices that are ready to go. Specifically, BLM could target its restoration spending through IIJA in areas most likely to demonstrate what restoration "scaled up" to address the scope of problem looks like. These projects should become regional sources of inspiration and possibility for what an investment in natural infrastructure can bring and how it becomes a positive community and economic force through creation (and later sustaining) of well paying, restoration jobs in the local communities being served.

Scaling up riverscape restoration is achievable through coordinated action at six levels:

1. Establish Agency-Wide Vision and Goals
2. Invest in BLM & Partner Capacity
3. Advance Planning and NEPA Compliance
4. Coordinate with Federal, State, Tribal, and Local Partners
5. Increase State and Field Office Implementation
6. Create Decision Support and Monitoring Tools

1. Establish Agency-Wide Vision and Goals

- Prioritize riverscape restoration across BLM-managed lands. (Headquarters)
- Integrate riverscape restoration goals into the following agency priorities: climate adaptation and resilience, grazing, wildland fire mitigation, sage grouse habitat, flood protection, drought resilience, and the America the Beautiful initiative. (Headquarters)

2. Invest in BLM & Partner Capacity

- Create a riverscape restoration service team to assist field offices in the planning, design, and implementation of restoration projects. (National Operations Center)

- Hire a national riverscape restoration lead to guide the development of policies and monitoring protocols that will advance the agency's restoration strategy and support state and field offices with project implementation. (National Operations Center)
- Require all national and state Aquatic Resources Program leads, as well as support staff at the National Operations Center (Assessment and Monitoring Division) to attend a workshop on the Principles of Riverscape Health and related Principles of Riverscape Restoration (see Appendix I). Utilize the trainings to integrate BLM staff with other federal, state, tribal, and academic partners.[22] (Headquarters)
- Develop and offer internal trainings and workshops that incorporate the Principles of Riverscape Health (see Appendix I) to facilitate a paradigm shift across BLM. (National Operations Center & National Training Center)
- Hire state and regional restoration coordinators (permanent, full time within BLM or via agreements with partners) to facilitate the ongoing process of project prioritization, planning and design, implementation, monitoring, and adaptive management. (State and Field Offices)
- Establish cooperative agreements with local and regional partners that have the knowledge, skills, and capacity to work with BLM state and field office as well as other stakeholders to complete on-the-ground LTPBR projects. (State and Field Offices)

3. Advance Planning and NEPA Compliance

- Write an instruction memorandum that directs the National Operations Center and state offices to support field offices and their partners to restore as many miles/acres of riverscape as possible. Direct the field offices to restore as many miles/acres of riverscape as possible. (Headquarters, National Operations Center, State Offices, District Offices, Field Offices)
- Support state offices to develop programmatic NEPA, and where appropriate, utilize BLM's categorical exclusion authority. When riverscape restoration work has been adequately piloted across BLM-managed lands, conduct agency-wide programmatic NEPA. (Headquarters)
- Commission a scientific advisory panel of riverscape researchers (e.g., Riverscapes Consortium) and practitioners to support BLM Resource Advisory Councils to update Standards and Guidelines for Rangeland Health in accordance with recent advances in riverscape science. The outdated standards and guidelines have many direct and indirect impacts on all aspects of the agency's riverscape management strategies (e.g., monitoring protocols, restoration actions, allocation of staff and funding).[23] (Headquarters)

[22] Note: NRCS National Technology Center has already invested in such training programs and offers these trainings to local partnerships, which helps concurrently build the capacity of NRCS staff and that of partners while at the same time building the relationships needed to accomplish the work on the ground. Partner capacity can sometimes be easier to invest in, leverage and mobilize quickly, rather than reinventing from the ground-up.

[23] Note: Existing criteria for evaluations of riverscape health are rooted in the BLM's original (1990s era) Proper Functioning Condition Assessment Protocols (TR 1737-15). Since then, advances in riverscape science have led to a complete re-thinking of the way our riverscapes should look and function. However, the BLM is still mandated to use outdated and incomplete assumptions for reference conditions as criteria for evaluating riverscape health and the success of BLM's management actions. Lack of adherence

4. Coordinate with Federal, State, Tribal, and Local Partners

- Coordinate with other agencies (e.g., NRCS, USFS, USFWS, BLM, DOD) to invest in the Riverscapes Consortium to produce decision support tools that benefit the restoration community to identify and prioritize restoration, while streamlining the planning, design, and implementation of projects across ownership boundaries.[24] (National Operations Center)
- Contribute BLM learnings to the Restoration Consortium to develop a Riverscape Health Monitoring Framework that will be used across agencies and other partners.[25] BLM should continue to provide leadership to this effort and ultimately adopt a Riverscape Health focused monitoring protocol aligned with other agencies to compare progress and measure outcomes across various federal land ownerships. (National Operations Center)
- Coordinate with U.S. Army Corps of Engineers (USACE) to develop efficient and effective data collection methods for achieving the information needs of both Nationwide Permit 27 and adaptive riverscape restoration.[26] (Headquarters)
- Coordinate with USACE to add BLM to list of federal agencies with whom watershed groups, conservation districts, and other non-federal partners can develop binding conservation agreements to obtain Nationwide Permit 27 coverage on BLM administered lands.[27] (Headquarters)
- Coordinate with state wildlife agencies, trapping associations, zoos, and other stakeholders to support establishment of state-run or contracted facilities for beavers trapped in human-beaver conflict zones, so they can be subsequently translocated to areas where the probability for natural dispersal is low, the potential for human-beaver conflict is low, and the need for beaver dam building activity to promote and/or sustain restoration is high.[28] (State Offices)
- Work with state wildlife agencies to develop MOUs and related policies that balance the desire to avoid human-beaver conflicts with the BLM's need to restore healthy, productive, and resilient riverscape ecosystems. This should include policies for temporary trapping

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to the best available science causes the BLM to systematically under-estimate the potential of these systems, overestimate their current health, and overlook the loss of riparian-wetland and aquatic features across the majority of most valley bottoms (i.e., 85-90% conversion to uplands).

[24] See Riverscapes Consortium.

[25] Note: Dr. Scott Miller (Director of National Aquatic Monitoring Center) and Alden Shallcross (Hydrologist, Montana/Dakotas) contributed their expertise to the multi-stakeholder Riverscapes Monitoring Summit held online Nov 2-4, 2021.

[26] Note: Currently, wetland delineations required by some USACE offices cost more than physical implementation of the projects and can take an extensive amount of time to conduct. This increases the cost of restoration while also reducing the scope of restoration that is possible. BLM and other federal agencies should work with USACE to clearly define the range of LTPBR projects that can fit within the scope of Nationwide Permit 27: Aquatic Habitat Restoration, Enhancement, and Establishment Activities.

[27] Note: USACE overlooked BLM when developing this list for the Nationwide Permit 27 finalized on December 27, 2021 (86 Fed. Reg. 73522). As such, BLM's non-federal partners are unable to utilize the streamlined process for authorizations for externally generated restoration projects on BLM lands. USACE is planning a comprehensive rulemaking in 2022 to reexamine all Nationwide Permits issued in 2021 which will provide BLM the opportunity to request to be included on the list of federal agencies that can support external partners implementing projects under Nationwide Permit 27.

[28] See Dave Helzer, "Pilot Beaver Translocation Program and Holding Facility," Environmental Services City of Portland, February 2020. Oregon BLM partnered with the Oregon Beaver Working Group to pilot a holding facility to support a beaver translocation program. Beavers were released on BLM managed lands in the Western Cascades.

closures to achieve resource objectives, the use of "living with beaver" conflict reduction strategies, and a process for allowing translocation of beaver from human-beaver conflict zones to restoration zones. (State Offices)

5. Increase State and Field Office Implementation

- Identify the 3-5 BLM state offices best positioned to serve as large-scale demonstrations for initial, deep BLM investment using IIJA funding. This approach will allow BLM to demonstrate what is possible when areas are prioritized for investment. The next 4-5 years is too short to demonstrate sustained, resilience. However, for places that already have groundwork laid (e.g., NEPA started or cleared, a track record, partner support), it is realistic to move the needle on improving riverscape health at the scale of whole watersheds (e.g., HUC 8s). Moreover, investing in and leveraging natural processes will demonstrate what local, community-led, and low-tech projects can achieve in a short time and will be a source of inspiration to other BLM offices. While there may be other efforts within BLM that we are unaware of, several state offices are ready for this investment. (Headquarters & State Offices—See Appendix III)
- Direct and support BLM pilot states to restore as many miles/acres of riverscape as possible within 10 to 20 HUC 8 watersheds (note: there are 2,300 HUC 8s in the US and BLM co-manages roughly 250 of them). This strategic approach should prioritize offices ready to lead and capable of quick turn arounds and results, with a specific emphasis on selecting areas where: (a) conditions are right for LTPBR, (b) ecological and hydrological benefits are high, and (c) partner interest and stakeholder engagement is high. (Headquarters)
- Hire regional restoration coordinators for each BLM district office to (a) prioritize and implement projects, develop planning and design reports, monitor, and conduct adaptive management; (b) engage and support external partners (e.g., tribes, watershed groups, conservation districts, state water and wildlife agencies, NGOs) to advance restoration across ownership boundaries; and (c) leverage partner talent, community relationships, and financial resources to achieve common restoration objectives.[29] (District Offices)
- In the states that have already invested in riverscape health data/models,[30] BLM should (a) coordinate with partners to review existing data/models at the state and district levels; (b) prioritize watershed(s) for restoration; and (c) identify project locations that are unlikely to make progress towards the achievement of land health standards or RMP objectives through natural processes, alone. (State Offices)
- In the states that have not yet invested in Riverscape Health data/models, BLM should: (a) identify federal, state, tribal, and local partners interested in working together to develop the tools necessary to guide future restoration opportunities, (b) co-produce with identified partners the data/models necessary to prioritize and implement riverscape restoration, and (c) proceed with the steps outlined above. (State Offices)

[29] Note: BLM should consider the Sage Grouse Initiative's strategy that co-funds restoration coordinator positions across USDA and DOI.

[30] See Riverscapes Consortium; riverscape health data and models include: Beaver Restoration Assessment Tool, Riparian Condition Assessment Tool, Geomorphic Condition Assessment Tool, Valley Bottom Extraction Tool, Riparian-wetland mapping.

6. CREATE DECISION SUPPORT & MONITORING TOOLS

- Co-produce decision support tools that help BLM and its partners identify and prioritize restoration opportunities, while streamlining the planning, design, and implementation of projects across ownership boundaries. (National Operations Center)
- Revise or replace existing Inventory, Assessment, and Monitoring Protocols to incorporate the latest science on riverscape health. (Headquarters & National Operations Center)
- Measure project implementation and effectiveness to adaptively manage individual projects, while ensuring that staff are effectively applying the principles of riverscape restoration (see Appendix I) to improve the health of as many miles and acres of riverscape as possible. The capacity for a riverscape to provide ecosystem services increases with scale (stream length and riparian extent), morphological diversity, and hydroperiod. As such, BLM's metrics should be tailored to the associated process and attributes. (Field Offices)

APPENDIX III: BLM STATE AND FIELD OFFICES READY FOR INVESTMENT

Many BLM state and field offices have been using LTPBR approaches and are poised to scale up investment in the restoration approach. Many of these state and field offices can benefit from decision support tools that have been developed or are under development in the Montana/Dakotas State Office.

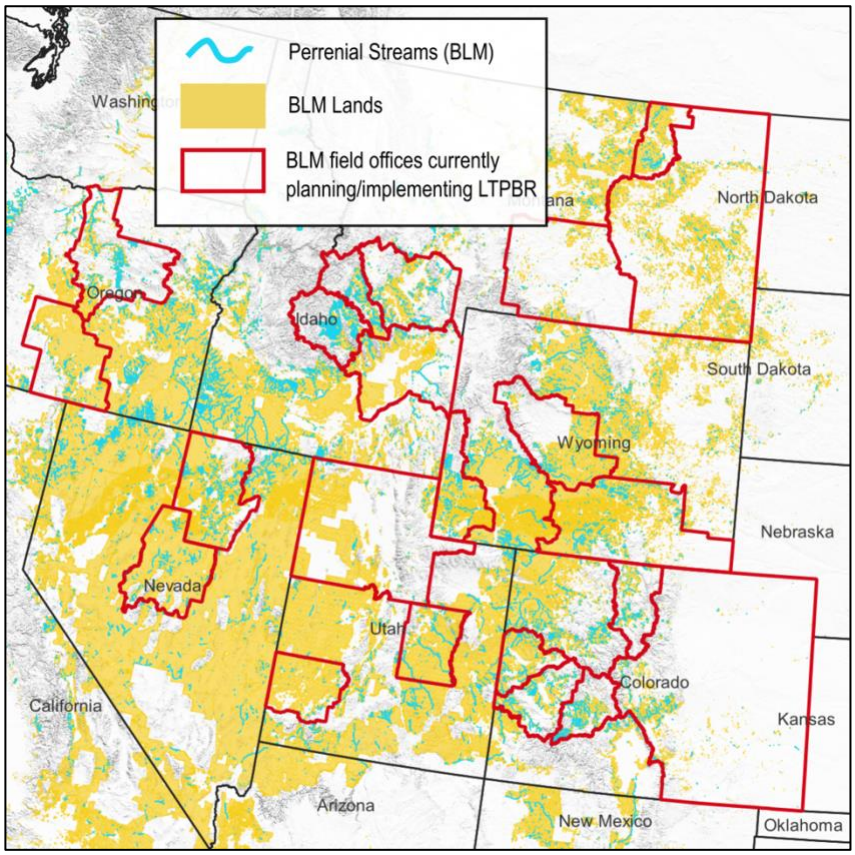

Figure 8. BLM field offices that are planning and/or have carried out LTPBR projects in association with various partners. [31]

Colorado

Colorado BLM began planning and implementing LTPBR projects in 2012, beginning with low-tech work restoring wet meadows in the Upper Gunnison.[32] By 2019, the LTPBR work expanded into broader riverscape restoration in five field offices (Gunnison, Kremmling, Uncompahgre, Grand Junction, and Royal Gorge). One focus in Colorado has been on creating the conditions that will support the return of beaver activity to riverscapes. As such, beaver dam analogs and woody material structures are the primary LTPBR treatments being used, along with grazing management and vegetation treatments. Another focus has been on fluvial wetlands and wet meadows, where

[31] Note: The authors of this proposal are most familiar with LTPBR work on BLM lands in Idaho, Montana, Utah, and Colorado and have some awareness and involvement in past and current work in Oregon, Washington, and Wyoming. There may be field offices engaged in LTPBR work that are not represented on this map. BLM should prioritize implementation in state and field offices that are ready for investment while it builds capacity across the agency.

[32] See JD Maestas, S Conner, B Zeedyk, B Neely, R Rondeau, N Seward, T Chapman, L With, and R Murph, "Hand-Built Structures for Restoring Degraded Meadows in Sagebrush Rangelands: Examples and Lessons Learned From the Upper Gunnison River Basin, Colorado," (Denver, CO: USDA-Natural Resource Conservation Service, 2018).

sod-based structures, grazing management, and revegetation are the key strategies. Twelve to 20 projects are currently being planned and permitted for implementation in 2022-2025. BLM is in the early stages of a statewide LTPBR programmatic EA and it has entered into a cooperative agreement with Colorado Open Lands to facilitate LTPBR site prioritization, NEPA and other compliance, local contracting, and implementation. The primary goal of this program is to involve local BLM staff, partners, and practitioners on LTPBR projects to begin spreading knowledge, appreciation, and skills within the greater BLM restoration community from which this work can grow and expand across Colorado. Other projects are being coordinated by local land trusts and other conservation organizations. *Agency and local partners: Colorado Parks and Wildlife, Colorado Open Lands, EcoMetrics, Central Colorado Conservancy, County governments, Colorado Water Conservation Board, National Fish and Wildlife Foundation, NRCS, USFS, Southwest Conservation Corps, Colorado Mesa University, Colorado State University, High Country Conservation Advocates, Upper Gunnison River Water Conservancy District, ranchers, lessees, landowners.*

Figure 10. The Kremmling Field Office (CO) installed 60 beaver dam analogs and other LTPBR structures in Reeder Creek in September 2021 to mimic, promote, and sustain beavers and the natural processes that this keystone species performs in healthy riverscapes. This work expands on decades of riparian improvement brought about by managed grazing. The project brought together private practitioners, staff from several BLM offices, and other NGO partners to work on the treatments while learning about the benefits of LTPBR and beaver restoration. The photos were taken before and immediately after treatment. Photo credit: Mark Beardsley, EcoMetrics.

Idaho

The Idaho Department of Fish and Game has been advancing the use of LTPBR throughout the state and helped fund the Idaho Beaver Restoration Assessment Tool. Three BLM field offices have increasingly engaged in these efforts. The Salmon Field Office completed a project on Hawley Creek in 2019.[33] The Upper Snake Field Office is currently working on a programmatic restoration EA, which should streamline the implementation of future projects. Furthermore, the Challis Field Office is working with the Shoshone Bannock Tribe, which recently commissioned a broad-level

[33] See Lucy Littlejohn et al., "It Takes a Community: Lemhi Basin Stream Restoration," Partners in the Sage, April 3, 2020.

restoration plan, with opportunities for BLM engagement. *Agency and local partners: Shoshone Bannock Tribe, USFS, NRCS, NOAA Fisheries, USACE, Bonneville Power Administration, Idaho Department of Fish and Game, Idaho Department of Water Resources, Idaho Governor's Office of Species Conservation, The Nature Conservancy, Trout Unlimited, Henry Fork Foundation, Salmon Valley Stewardship.*

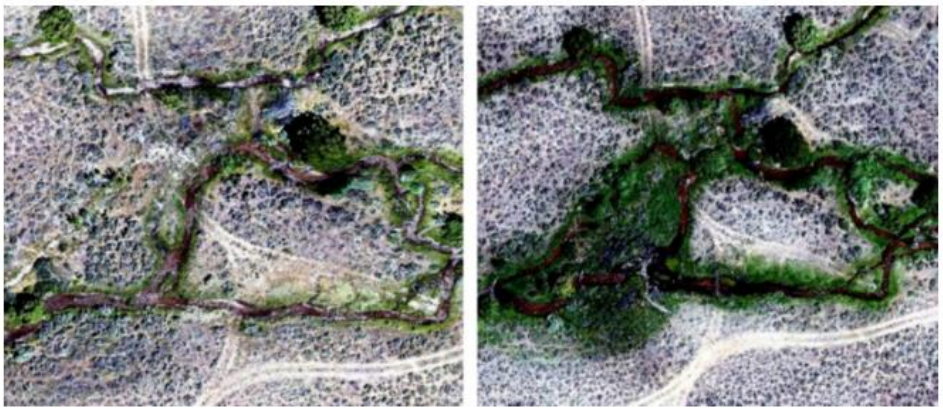

Figure 9. Hawley Creek in July 2016 (left) prior to beaver dam analog construction and again in 2019 (right) after perennial flow restoration and beaver dam installation. Monitoring shows the beaver dam analogs have improved riparian, wetland, mesic, and aquatic habitats for ESA-listed fishes, and BLM sensitive westslope cutthroat trout and greater sage grouse. Sage grouse hens with broods are frequently seen in the new mesic-riparian habitats. Kingfishers, great blue herons, common nighthawks, and a variety of ducks are utilizing the habitat created by the beaver dam analogs. Photo credit: Partners in the Sage.

Montana/Dakotas

BLM Montana/Dakotas completed nine riverscape restoration projects between 2019 and 2021. The office won the 2019 National Riparian Challenge Award by the American Fishery Society for their use of LTPBR in Southwest Montana. Given the success of these initial projects, new partnerships have formed and efforts to expand the scope of restoration are rapidly increasing. To support this effort, the state office is on track to finalize the Montana/Dakotas Low-Tech, Process Based Riverscape Restoration Programmatic EA in Spring 2022. The Proposed Action would utilize beaver dam analogs, post assisted log structures, headcut control, vegetation management, and beaver mitigation strategies to advance riverscape restoration on suitable lands across the three-state geography. The state office has also developed cooperative agreements with the Montana Watershed Coordination Council and the National Wildlife Federation to increase internal and external capacity for restoration, as well as Utah State University and the Montana Natural Heritage Program to develop tools and models that help BLM and its partners identify shared restoration objectives and streamline the project planning and design process. *Agency and local partners: NRCS, Montana Fish Wildlife and Parks, Montana Natural Heritage Program, Montana Watershed Coordinating Council, National Wildlife Federation, Utah State University, Montana Trappers Association, Winnet ACES, Sun River Watershed Group, Pheasants Forever, Beaverhead Conservation District, Ruby Watershed Council, private landowners.*

Oregon/Washington

Oregon/Washington BLM has an active aquatics program and many partners who help maintain or improve habitats for fish. Several of their staff have participated in riverscape restoration workshops and have expressed an interest in the development of programmatic NEPA to facilitate the use of LTPBR methods. The project that gave low-tech process-based restoration credibility and put LTPBR on the map was based on BLM land in Central Oregon on Bridge Creek (see Figure 1) and was made possible by improvements in grazing management put in place by the BLM. *Agency and local partners: NRCS, BPA, USFS, USFWS, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Trout Unlimited, Pheasants Forever.*

Utah

In Utah, BLM has partnered with various entities including the Utah Watershed Restoration Initiative and the Utah Division of Wildlife Resources to implement LTPBR projects across the state. Projects focused on reversing incision using beaver dam analogs and beaver reintroduction were successfully completed in the Grouse Creek watershed in the northwestern part of the state. In Central Utah, various projects designed to improve habitat for endangered desert fishes using low-tech restoration structures were completed in the Price and San Rafael River watersheds. Similarly, LTPBR methods were used to restore small streams in the Beaver River watershed of south-central Utah to improve habitat for native Bonneville cutthroat trout. In Southern Utah, stream degradation is being treated using LTPBR projects in Ranch Canyon and Bear Creek. *Agency and local partners: USFS, NRCS, Utah Department of Water Resources, Utah Division of Wildlife Resources, Utah Watershed Restoration Initiative, Utah State University, hunting and angling groups.*

Wyoming

Several Wyoming field offices have been working with partners to implement LTPBR projects. The Rawlins Field Office is partnering with Trout Unlimited and other stakeholders to restore Upper Muddy Creek, a high-profile fisheries resource in the Colorado Basin. In 2021, the Lander Field Office completed an LTPBR project on Deep Creek, a tributary of the Sweetwater River.[34] BLM and its partners constructed restoration structures by hand to brace the stream channel and armor headcuts. *Agency and local partners: NRCS, USFWS, Wyoming Game and Fish Department, Wyoming Department of Environmental Quality, Intermountain West Joint Venture, Pheasants Forever, The Nature Conservancy, Trout Unlimited, a local permittee.*

[34] See Bureau of Land Management, Lander Field Office. "Low-Tech Restoration Has High Impact on Wildlife and Working Lands," November 15, 2021.