Restoring Rivers

AN INDIGENOUS-LED TOOLKIT FOR PROCESS-BASED RESTORATION

BURNS PAIUTE TRIBE

The development of this toolkit was a collaborative project of the Upper Snake River Tribes Foundation (USRT) and its member Tribes: the Burns Paiute Tribe, the Fort McDermitt Paiute and Shoshone Tribe, the Shoshone-Bannock Tribes, the Shoshone-Paiute Tribes, Adaptation International, and Watershed Solutions Inc.

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To access the digital version, visit: http://uppersnakerivertribes.org/projects/Restoring-Rivers.

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Glossary

ADAPTATION: "Processing culturally relevant information and practices while implementing a suite of actions to better prepare for and adjust to new conditions while maintaining cultural protection to reduce risk, utilize new opportunities, and enhance resilience" (Dalton et al., 2018).

ADAPTIVE MANAGEMENT: "A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables" (Intergovernmental Panel on Climate Change [IPCC], 2022).

BEAVER DAM ANALOGS (BDAs): Human-made structures that mimic the function of natural beaver dams to restore and enhance stream and wetland habitats.

CARBON SEQUESTRATION: The process of removing carbon from the atmosphere and storing it in a carbon sink, a fixed molecule in soil, oceans, or plants.

CARBON SINK: "Any process, activity, or mechanism that removes carbon from the atmosphere. A carbon sink may also refer to a physical location, defined area, or geological or biological element of Earth's system (e.g., the ocean, a country, biomass) that stores acquired carbon from the atmosphere for a specified period of time" (Grade et al., 2023).

CLIMATE BASELINE: A reference point, usually a period of time, used to assess changes in climate conditions and to evaluate the impact of climate change initiatives.

CLIMATE PROJECTIONS: "The simulated response of the climate system (e.g., temperature, precipitation, etc.) to a scenario of future emissions or concentrations of greenhouse gases and aerosols, generally derived using global climate models" (Dalton et al., 2018).

COMMUNITY ENGAGEMENT: "The facilitation of purposeful reflection and discussion among tribal community members about topics of common concern and decision-making" (Dalton et al., 2018).

COMPLIANCE: An organization's or individual's adherence to environmental laws, regulations, and standards that are designed to protect the environment and minimize harmful impacts on ecosystems.

FLOODPLAIN: "Flat area adjoining a river channel constructed by the river in the present climate, and that overbank flows inundate during bankfull discharge (ordinary high water) events" (Wheaton et al., 2019).

FLUVIAL PROCESSES: The dynamic, physical, ecological forces that create and maintain streams through time.

GEOMORPHOLOGY: The physical features of the surface of the Earth and their relation to its geological structures.

HUC8: Hydrologic Unit Code 8-digit refers to a watershed classification used by the United States Geological Survey (USGS) in the Hydrologic Unit System. HUC8s generally reflect sub-basin geographies containing multiple watersheds and are used in environmental planning, watershed management, and federal or state programs for organizing water data.

LOW-TECH PROCESS-BASED RESTORATION (LTPBR): "A practice of using simple, low-unit-cost structural additions to riverscapes to mimic functions and promote specific processes. Hallmarks of this approach include an explicit focus on promoting geomorphic and fluvial processes, a conscious effort to use cost-effective, low-tech treatments (e.g., hand-built, natural materials, non-engineered, short-term design life-spans) because of the need to efficiently scale-up application, and 'Letting the system do the work', which defers critical decision making to riverscapes and beavers" (Wheaton et al., 2019).

PROCESS-BASED RESTORATION (PBR): "Aims to reestablish normative rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems" (e.g., rates of erosion and deposition, channel migration, growth and succession of riparian vegetation) (Beechie et al., 2010).

RIPARIAN: Areas of land located along the edges of rivers, streams, lakes, and other water bodies, such as streambanks, riverbanks, and floodplains. These zones are distinct from surrounding uplands due to their soils and vegetation, which are influenced by the presence of water.

RIPARIAN CORRIDOR: The area of land adjacent to a river, stream, or other body of water, characterized by unique vegetation adapted to wet conditions and important to maintaining ecosystem health.

RIVERSCAPE: The interconnected floodplain and channel habitats that form streams and riverine landscapes, collectively making up the valley bottom. This term reflects a holistic view of the large-scale patterns and processes within fluvial systems (Wheaton et al., 2019).

RESILIENCE: "The capacity of a community to withstand, survive, and thrive by applying adaptation actions that maintain and adhere to essential cultural functions, identities, and structures while co-existing with and managing for changing conditions. Indigenous resilience may include protecting, preserving, and enhancing Tribal resources, cultural and traditional knowledge and practices, identity, and sovereignty in the face of climate and other changes" (Dalton et al., 2018).

RUNOFF: "The flow of water over the surface or through the subsurface, which typically originates from the part of liquid precipitation and/or snow/ice melt that does not evaporate, transpire, or refreeze and returns to water bodies" (IPCC, 2022).

UPPER SNAKE RIVER TRIBES (THE TRIBES): The Shoshone-Bannock Tribes of Fort Hall, The Burns Paiute Tribe, The Shoshone-Paiute Tribes of Duck Valley Indian Reservation, and the Fort McDermitt Paiute and Shoshone Tribe.

VULNERABILITY: "The degree to which a key concern is susceptible to adverse effects of climate change as determined by climate exposure, sensitivity, and adaptive capacity" (Dalton et al., 2018).

WATERSHED: An area of land where all the water drains to a common outlet, such as a river, lake, or ocean.

WETLANDS: Soils that are inundated or saturated by water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated conditions (Grade et al., 2023).

Duck Valley Reservation. Photo taken July 15, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

ABSTRACT

The rivers, streams, and riparian areas of the Upper Snake River Basin have sustained the peoples of the Burns Paiute Tribe, Fort McDermitt Paiute and Shoshone Tribe, Shoshone-Bannock Tribes of the Fort Hall Reservation, and Shoshone-Paiute Tribes of the Duck Valley Reservation since time immemorial. These lands and waters have long provided food, medicines, materials, and places for trade, ceremony, and cultural connection. Colonization, land conversion, dams, and other forms of development have disrupted these systems, and today they face additional pressures from climate change, including shifting streamflow patterns, rising temperatures, and increasing disturbance.

This toolkit was created to support the riparian restoration efforts of the Upper Snake River Tribes Foundation (USRT) and its member Tribes. It is intended as a practical and living resource for Tribal staff, community members, restoration practitioners, and partners. Rooted in Indigenous Knowledge and ecological science, it provides context on climate trends and habitat stressors, introduces process-based restoration approaches, and offers tools for planning, funding, and implementing projects.

At the heart of this guide is Process-Based Restoration (PBR), and in particular, Low-Tech Process-Based Restoration (LTPBR). These approaches work with natural processes such as floodplain reconnection, sediment transport, and beaver activity to restore the functions that sustain healthy riparian systems. They emphasize cost-effective, scalable methods that can be adapted to local conditions and carried out in ways that align with Tribal values and priorities. The guide also introduces Zeedyk structures as a complementary technique for wet meadows and incised systems, where simple structures can slow water, reduce erosion, and support floodplain re-wetting alongside LTPBR approaches.

The toolkit also highlights the cultural importance of riparian restoration. Restoring these ecosystems is not only about repairing habitats, but also about revitalizing traditional foods, medicines, and practices, reinforcing Tribal sovereignty, and supporting intergenerational knowledge transfer.

By combining Indigenous Knowledge and ecological science, this toolkit offers a pathway for restoration that is both culturally grounded and ecologically resilient. It is designed to inform decisions, spark collaboration, and guide actions that restore balance to rivers, lands, and communities across the Upper Snake River Basin.

INTRODUCTION

This toolkit is designed to provide an opportunity to:

- Ground restoration planning in the ecological, cultural, and historical context of the Upper Snake River region, centering the Tribes who have stewarded these lands since time immemorial;
- Understand the ongoing changes and associated challenges to riparian areas in the region, including climate change;
- Explain the philosophy behind long-term process-based restoration and its value in building riparian resilience.

This guide is designed to support riparian restoration in the Upper Snake River Basin. It is intended as a practical, living resource for Tribal managers—whether they are stewarding lands on the reservation, on ancestral territories, or on purchased and controlled lands—to revitalize riparian areas in ways that align with Indigenous values, Indigenous Knowledge, and ecological science. Rooted in the place-based histories and priorities of USRT, and its four member Tribes (Burns Paiute Tribe, Fort McDermitt Paiute and Shoshone Tribe, Shoshone-Bannock Tribes of the Fort Hall Reservation, and Shoshone-Paiute Tribes of the Duck Valley Reservation), the guide brings together information on climate change, habitat stressors, and riparian restoration strategies to help advance healing of both the land and the lifeways it sustains.

From time immemorial, the Snake River and its tributaries have been vital to the lifeways of the Bannock, Shoshone, and Paiute peoples (the Tribes). These rivers and their surrounding riparian zones provide fish, plants, medicines, and materials necessary for food, shelter, tools, and ceremony. These areas were also places of trade, migration, and spiritual connection. Colonization and settler development, including construction of dams for hydropower, industrial agricultural irrigation, flood control structures, pollution, and land conversion, have disrupted these systems and the Tribal relationships they support. Today, riparian areas face threats from climate change, including changing streamflows, warming temperatures, and increasing disturbance. These challenges call for restoration approaches that are not only ecologically effective but also culturally grounded and community-led.

This guide introduces Process-Based Restoration (PBR) and Low-Tech Process-Based Restoration (LTPBR) as a key path forward. These methods aim to restore the natural processes that build and maintain healthy riparian ecosystems over time, such as sediment movement, floodplain connectivity, and beaver activity. LTPBR emphasizes cost-effective, scalable techniques that work with natural systems rather than against them. Within this framework, the guide also highlights complementary

Riparian vegetation is thick along the steep and channelized banks of the Owyhee River running through the lower portion of the Duck Valley Reservation near Chinatown. Photo taken October 8, 2025 (credit: Sascha Petersen, Adaptation International).

low-tech tools, including Zeedyk structures, which are particularly well suited for restoring wet meadows, springs, and incised or ephemeral systems where traditional instream approaches may not be appropriate. These approaches respect Indigenous Knowledge systems and the inherent rights of Tribal Nations to lead restoration efforts.

Throughout the guide, there are tools to help identify restoration goals, develop site-specific plans, engage Tribal members and community partners, navigate compliance processes, and ensure long-term maintenance and functionality of these projects. This resource is designed to support stream and riparian restoration work guided by actionable knowledge and cultural integrity. As with any restoration effort, this work must be adaptive and collaborative, rooted in shared values and reciprocal care for the land and waters.

Importantly, this guide was developed with Tribal data sovereignty in mind. All information, stories, and cultural context shared herein belong to the Tribes and are to be used in a manner that respects their leadership, authority, and vision for the future.

How to use the Toolkit

The information in this guide is designed to be flexible, practical, and rooted in Indigenous Knowledge and ecological science. This toolkit is for Tribes and is intended to center Tribal perspectives, priorities, and knowledge, while also supporting others in learning from and working respectfully with Tribal communities. Whether your community is just beginning to explore riparian restoration or already leading projects on the ground, this guide can provide support at every stage of the process, from understanding the ecology of riparian areas to planning, funding, implementing, and sustaining

Understand the approach to riparian restoration in the Upper Snake River Basin with respect for Tribal Sovereignty, traditional lifeways, and local climate realities.

- Introduction
- Background
- Current and Future Climate
- Riparian Habitat Stressors

Let the river do the work. Riparian restoration is a long-term relationship that requires patience, creativity, and ongoing collaboration. Even the best-designed Low-Tech Process-Based Restoration strategies may not take hold on the first attempt– structures may wash out, flows may shift, and unexpected climate or watershed events may influence the site. This isn't failure; it's part of working with dynamic systems. Sustaining restoration means committing to monitoring, maintenance, and responsive adaptation.

- Revisit Previous Steps and Adjust
- Build out Additional Restoration as Needed

restoration efforts. This toolkit is not necessarily intended to be read cover to cover. Instead, think of it as a toolbox where each section can be used independently, depending on needs, goals, and stage of the project. This guide is meant to grow and adapt as a living resource alongside the work of the Tribes and their partners. It should be used to inform decisions, spark conversations, and guide restoration with intention and care.

Plan for success by starting with a project vision, then characterizing the specific site conditions and most suitable process based restoration techniques.

- Restoration as a Path Forward
- Developing a Restoration Plan
- Reservation Specific Plans (Appendix C)

Carry out your plan responsibly and effectively by grounding work in community, securing funding, following legal and compliance procedures, and completing restoration.

- Implementation
- Follow Through

Restoring the Lifeways of the Tribes

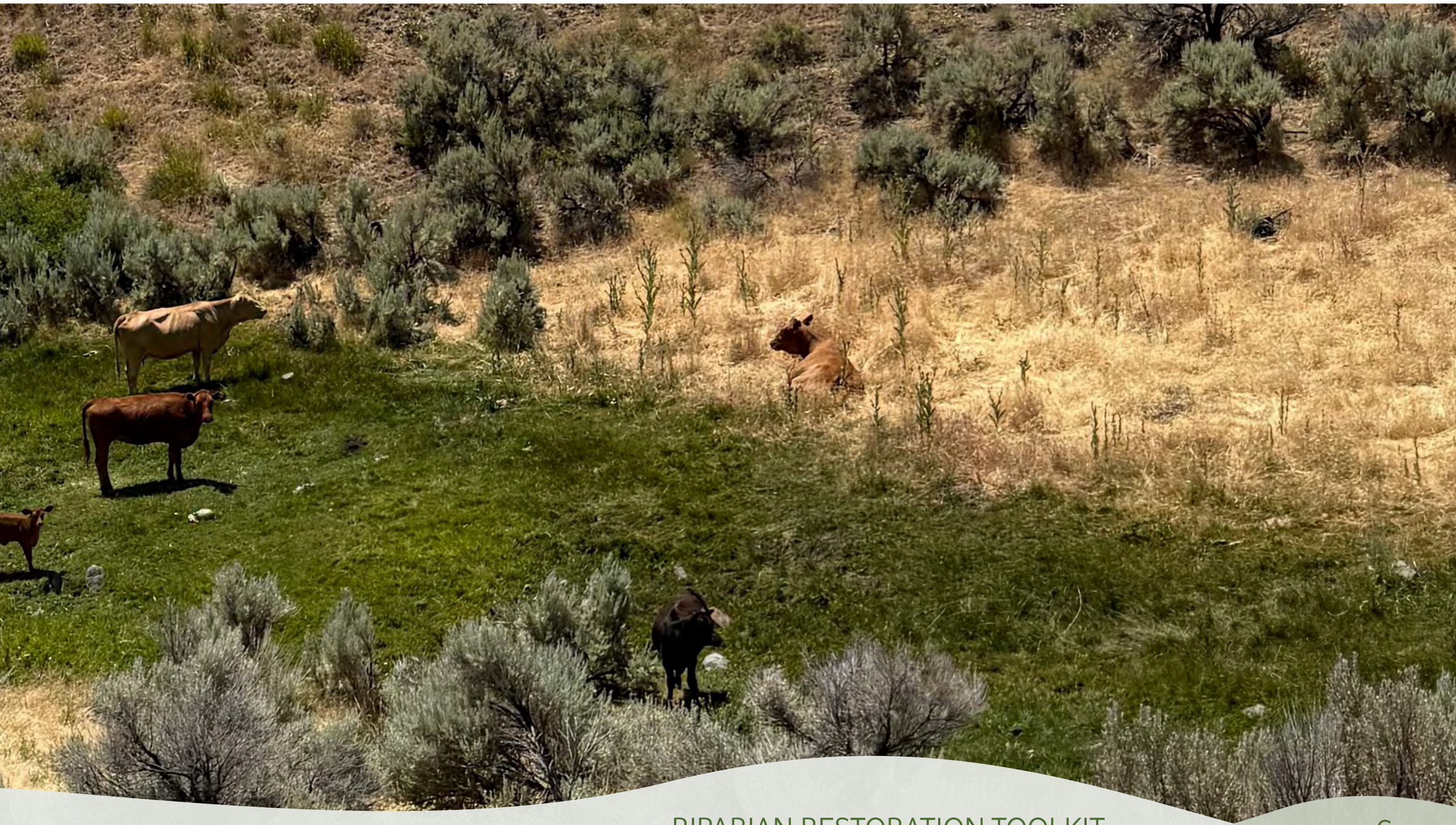
The Tribes have deep cultural and spiritual connections to fish and riparian habitats, which are essential for their subsistence, medicinal plants and traditional practices. The waterways of the Snake River region have sustained the Tribes since time immemorial, providing not only food and materials for daily life but also serving as sites for ceremonies, storytelling, and intergenerational knowledge sharing. Historically, Tribes moved for harvests and lived in areas with abundant rivers, lakes, and wetlands, where they relied on fish (such as salmon, trout, lamprey, and sturgeon) and other native species—some of which are categorized today as “non-game fish”— as a primary food source. These species marked seasonal transitions and reinforced enduring relationships with the lands and waters of the region.

Riparian zones have also historically been rich sources of traditional plants such as willows, camas, and tule, used for basketry, subsistence, and medicine. Other traditionally and culturally important species that depend on riparian areas include frogs, beavers, and sage grouse. In more recent times, domesticated cattle production has become a culturally important land use for many Tribes and is an important consideration in riparian restoration and management.

Fort McDermitt, one of many springs within the reservation. A cattle enclosure could help in reducing damage from grazing activity. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

However, with the expansion of settler populations, industrial and agricultural development, and the alteration of waterways, much of the Tribes' access to these vital habitats has been lost. Dams, water diversion, and pollution severely disrupted fish populations and the surrounding ecosystems. As a result, the Snake River Tribes have seen a decline in the availability of traditional foods, erosion of cultural practices tied to fishing, and the loss of a key part of their heritage. Today, many Tribal members continue to fight for the restoration of these habitats and the preservation of their cultural identity.

The use of Indigenous Knowledge in restoration is essential for Tribal communities to navigate socio-ecological changes, enhance the sustainability of their livelihoods, and promotes resilience. Indigenous Knowledge provides insights into ecosystem dynamics and their interactions with societal norms and resource-use patterns (Haq et al., 2023). Valuing Indigenous Knowledge in the restoration process will allow land managers to incorporate culturally significant species into restoration targets and use traditional management practices that enhance ecological resilience. Tribally led and culturally relevant riparian restoration efforts can promote self-determination while safeguarding the livelihoods, cultural heritage, and biodiversity critical to the Tribes in the Upper Snake River Basin. Centering Indigenous Knowledge and leadership in restoration efforts not only strengthens ecological function but also supports cultural healing, intergenerational knowledge transfer, and the resilience of Tribal communities for generations to come.



Fort Hall Reservation. Photo taken October 15, 2024 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

Conceptual Methodology

Riparian and stream restoration are most successful when rooted in an understanding of place — both ecological and cultural. This guide approaches restoration not as a fixed formula but as a process of reactivating natural functions in the specific watersheds that sustain Tribal lifeways. The riparian areas of each reservation, and even along each stream, look and behave differently because of their unique geomorphology, climate, and land use history. Restoration, therefore, must be responsive to these differences.

By focusing on the fluvial processes rather than focusing on the channel shape and geometry (channel form), this guide encourages restoration actions that enable and heal underlying ecological processes rather than only addressing symptoms of degradation (sediment loads, flash flooding, etc.). To be successful, restoration requires a relationship of care, listening to what the land and waters need, and restoring in ways that are aligned with place-based values and knowledge.

Data governance is also essential in these collaborations. The CARE Principles for Indigenous Data Governance (Collective benefit, Authority to control, Responsibility, and Ethics) provide a model for ethically stewarding Indigenous Knowledge, in contrast to extractive data practices that have long dominated environmental science (Jennings et al., 2023). Indigenous Data Sovereignty–the right of Indigenous peoples to govern the collection, ownership, and application of their data–is a foundational aspect of restoration partnerships (Cannon et al., 2024). Respecting Data Sovereignty requires intentional dialogue, clear agreements on data use, and support for Indigenous-led research.

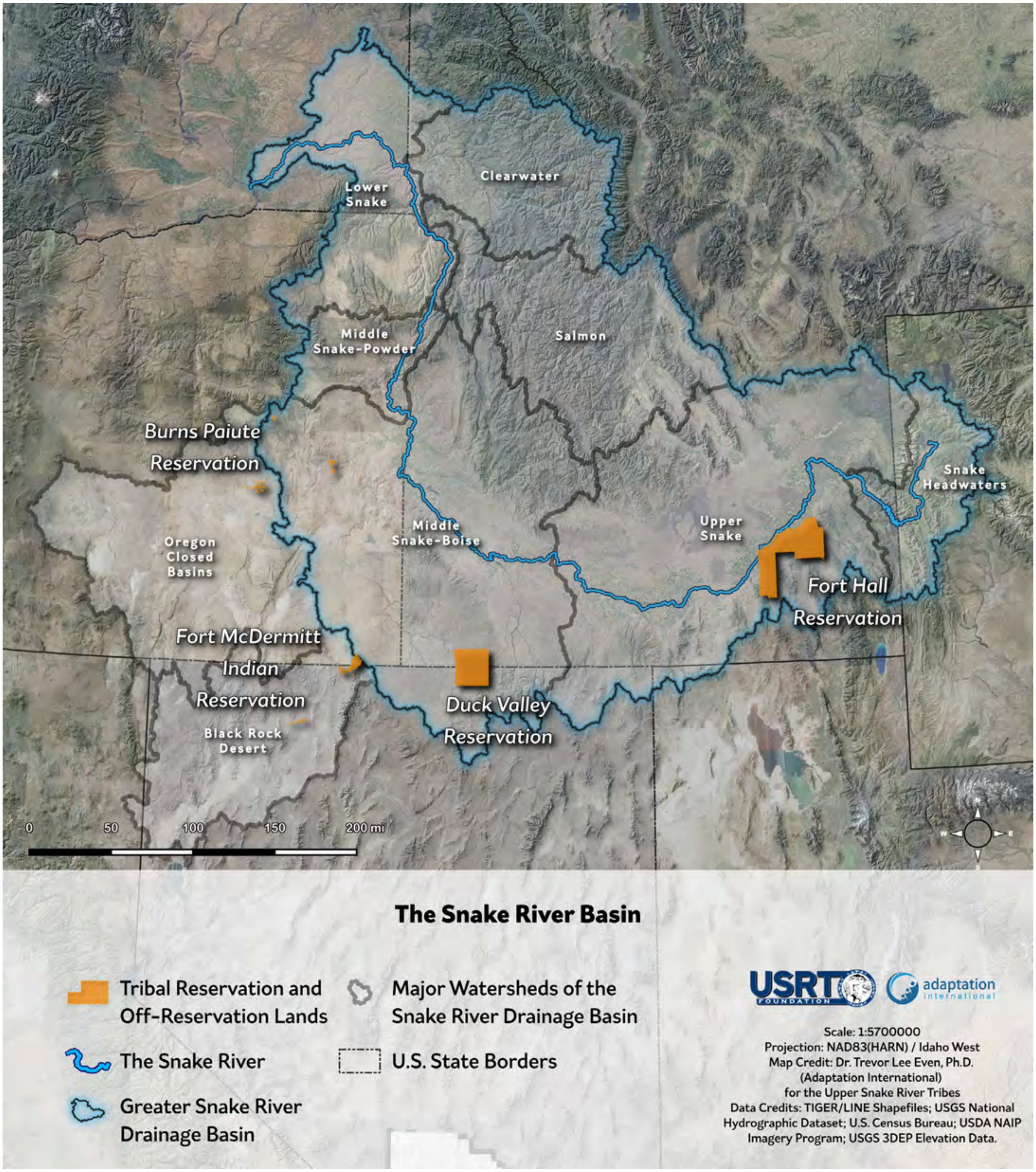
The inclusion of Indigenous and local knowledge in global assessments like the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has shown that diverse knowledge systems enrich understanding of ecosystem change, biocultural indicators, and sustainable pathways. The IPBES Global Assessment offers important lessons: successful integration of these knowledges requires early and sustained engagement, clear frameworks that respect different knowledge systems, and the identification of shared goals across spatial and temporal scales (McElwee et al., 2020).

BACKGROUND

The Upper Snake River Tribes Foundation

The reservations of the Upper Snake River Tribes are distributed across the states of Idaho, Nevada, and Oregon, with traditional homelands encompassing a much larger area. While each of the four reservations has some distinct climatic and ecological features, they are all broadly characterized by lowland semi-arid zones, heavily human-modified landscapes primarily due to agriculture and ranching, and a distinct cold semi-arid climate, where moderately wet, cold winters give way to hot, dry summers.

Generally, annual precipitation on each reservation ranges from 8 to 14 inches per year and is subject to significant year-to-year variability between wet and dry years. Because of this, each of the four reservations and the river systems rely heavily on snow and rainfall in both nearby and distant watersheds, both within and outside of Tribal reservation territory.



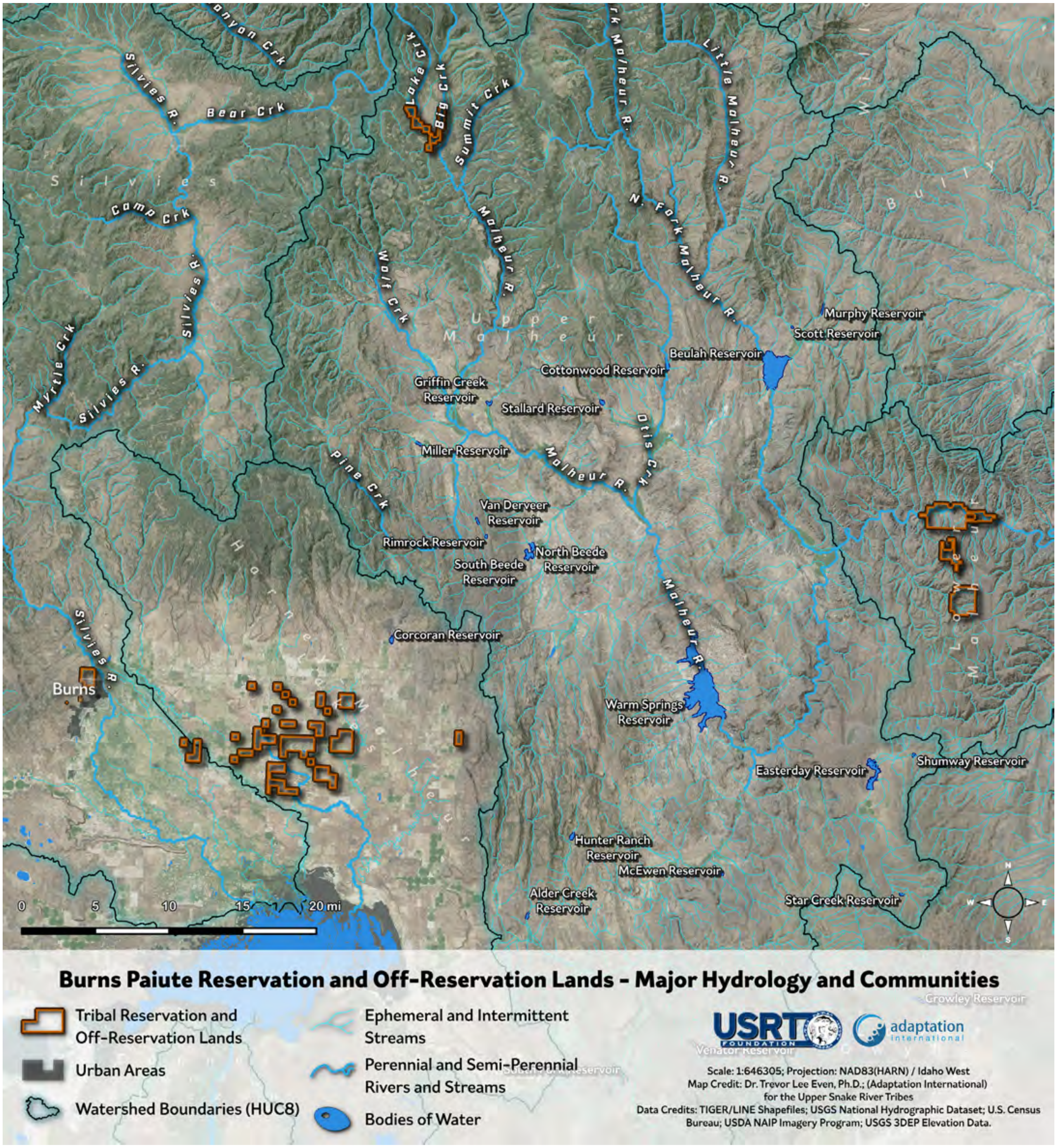
The Upper Snake River watersheds (outlined in black with blue highlights) and the locations of the reservations for the four Upper Snake River Tribes (shown in orange), along with the Snake River (blue).

Big Creek in Logan Valley. Burns Paiute land. Vegetation of sedges, rushes, willows and conifers in the background. Photo taken August 13, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

BURNS PAIUTE TRIBE

The Burns Paiute Reservation in Harney County, Oregon, spans 775 acres, with 816 additional acres held in trust. The Tribe also manages several off-reservation properties, including Logan Valley (1,760 acres in the Upper Malheur River headwaters), Jonesboro Ranch (6,385 acres near Juntura, Oregon), and the Beech Creek Property (2,392 acres in the upper John Day River watershed north of Mount Vernon, Oregon), which together encompass high-value riparian, wetland, and sagebrush steppe habitats. The Tribe additionally manages extensive federal and state grazing allotments associated with these lands.

Tribal citizens are primarily descended from the Wadatika (Wada Root eaters) Band of Northern Paiutes and remnants of six other eastern Oregon Paiute bands. Their ancestral territory spans the Cascade Mountains, the Columbia River, the Great Basin, and the High Plains/Plateau of western Idaho. Historically, they established camps near lakes, streams, and rivers for access to water and food. Recent challenges on the reservation include less water availability and expansion of invasive plant species, which threaten the ecological and cultural integrity of the area. They utilized plants like willow, tule, and sagebrush for making baskets, sandals, fishing nets, and traps. Riparian plants are not only important for their physical sustenance but also hold spiritual and cultural significance, playing a vital role in the Burns Paiute Tribe's connection to their ancestral lands and heritage.



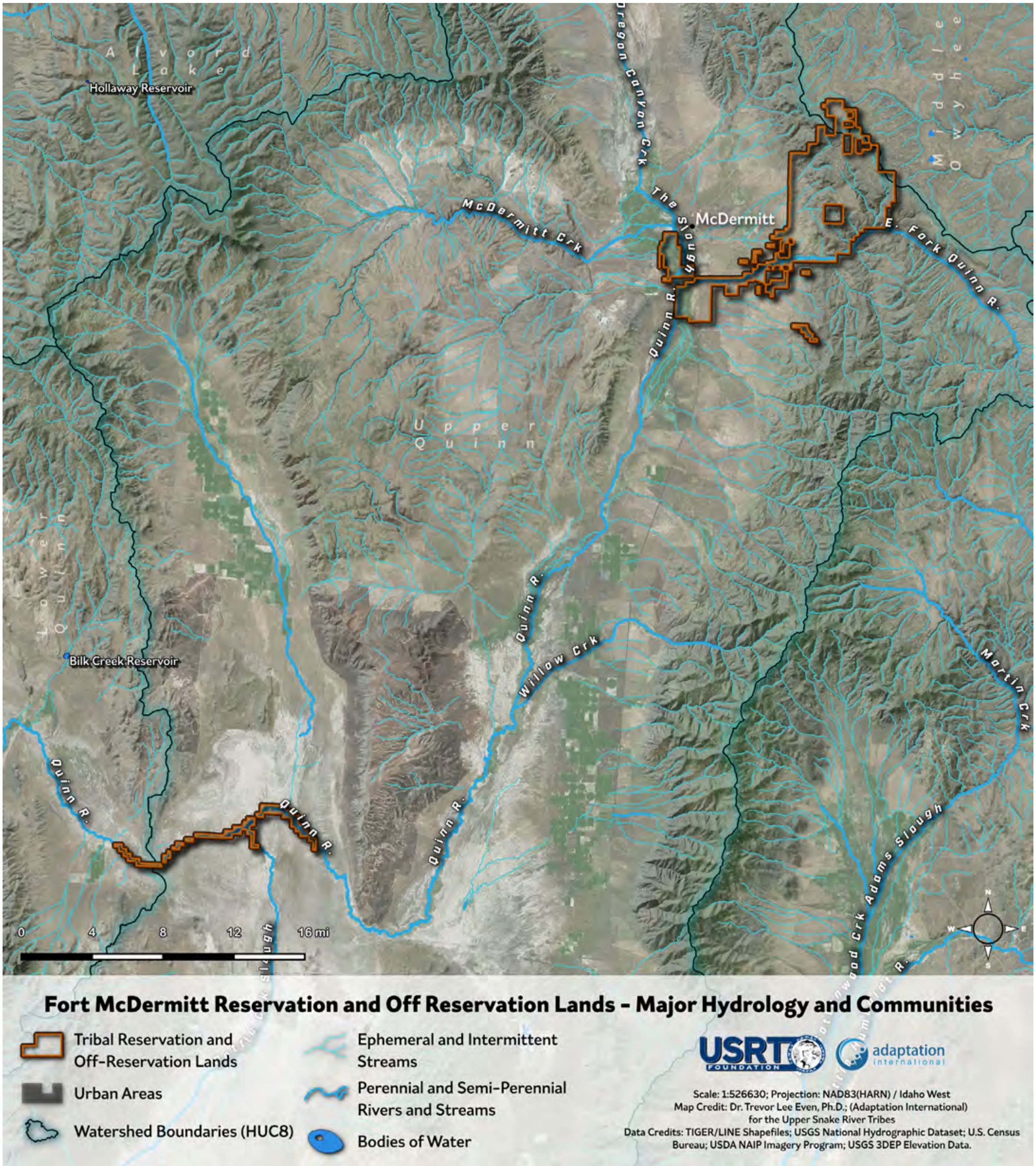
The Burns Paiute Reservation lies mainly outside the Snake River system, located within Oregon's Closed Basins, specifically within the Harney-Malheur Lakes and lower Silvies closed basins, where drainage terminates in Malheur Lake. However, the Burns Paiute Tribe owns several large properties that are within the Snake River basin, one, to the north, in the John Day Subbasin, and a second, to the east, along the Lower Malheur River.

East Fork (E.F.) Quinn River, above the confluence of the E.F. and West Fork (W.F.) Quinn outside the Fort McDermitt Reservation. Photo taken July 9, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

FORT MCDERMITT PAIUTE AND SHOSHONE TRIBE

The Fort McDermitt Paiute and Shoshone Tribe's Reservation spans around 16,534 acres in Nevada and 19,000 acres in Oregon, crossing the Nevada–Oregon border near the Quinn River in Humboldt and Malheur Counties. The headwaters of the Little Owyhee River originate on the reservation. Historically, the Quinn River Valley served as a winter campsite for the nomadic Northern Paiutes and some Western Shoshone. The Northern Paiutes share cultural and linguistic ties with the Shoshone, Bannock, and other regional Tribes. They traditionally relied on roots, seeds, fish, small mammals, birds, waterfowl, and larger animals like antelopes and deer.

The Fort McDermitt Reservation is located in the high desert region of northern Nevada and southern Oregon but is also home to wetland areas fed by seasonal flows and springs. The rivers and riparian zones of the region continue to support the Tribe's dietary, cultural, spiritual, and economic needs. However, the over allocation of groundwater presents a significant challenge, as large ranches and mines in the area extract much of the available water. Combined with environmental pressures such as prolonged drought and changing hydrological patterns, these withdrawals have led to diminished wetland functionality, requiring focused restoration efforts.

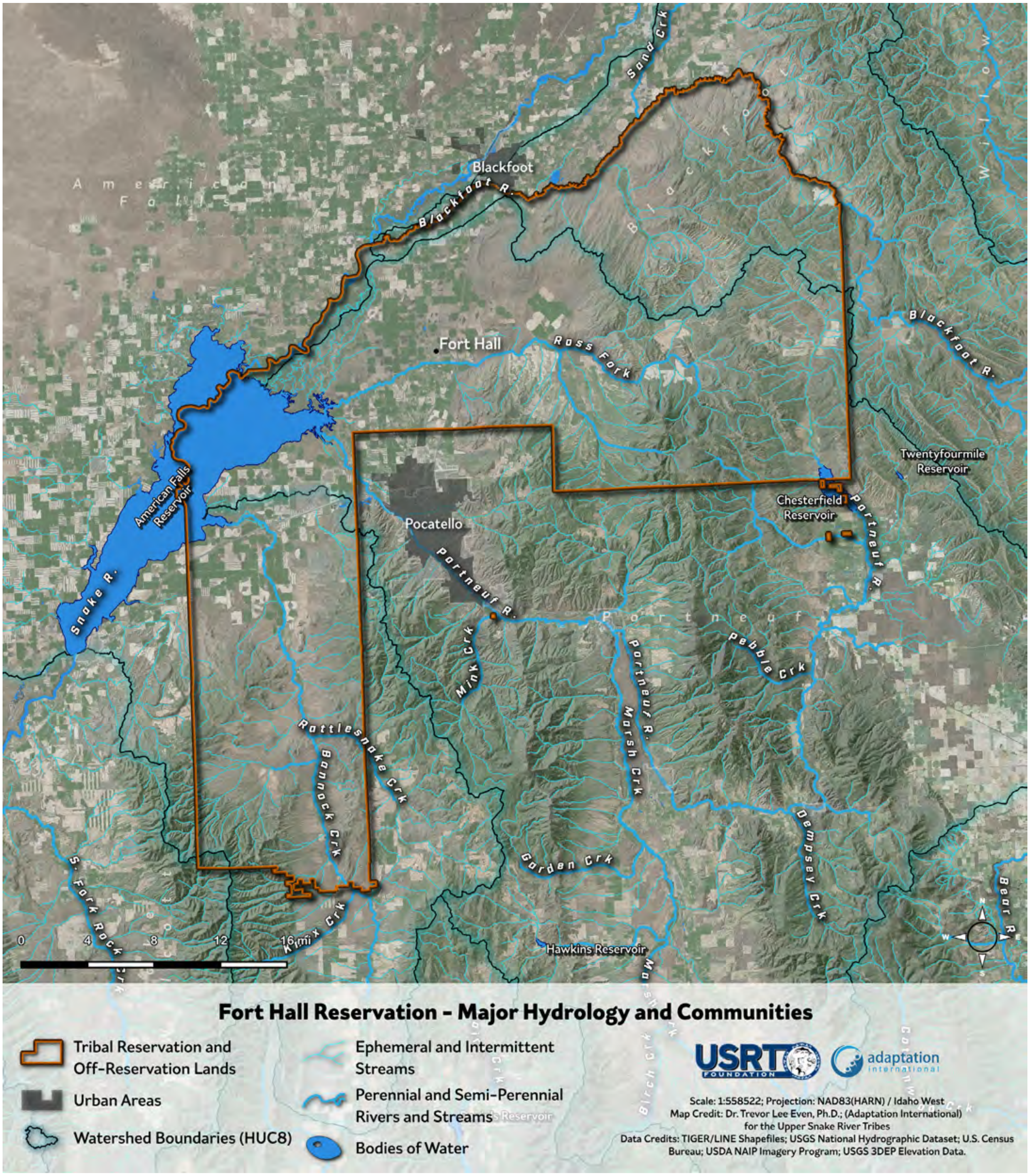


The Fort McDermitt Reservation includes a small area within the upper Middle Owyhee basin but is largely situated in the Black Rock Desert watershed, particularly the Upper Quinn subbasin.

Fort Hall Reservation. Photo taken October 15, 2024 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

SHOSHONE-BANNOCK TRIBES OF THE FORT HALL RESERVATION

The Fort Hall Reservation, located in southeastern Idaho, encompasses portions of the Snake River Plain, which includes diverse riparian and wetland habitats. Originally set aside as 1.8 million acres, the Reservation has been reduced to 546,500 acres due to survey errors, legislation, and the allotment processes. Historically, the Tribes subsisted as hunter-gatherers, relying on the rivers and riparian resources for food, culture, and economy. Key natural resources include salmon, native plants like camas bulbs, and wildlife such as moose, deer, and buffalo. The Snake and Blackfoot rivers and the American Falls Reservoir border the Reservation. These areas have long been central to the Shoshone-Bannock Tribes' cultural practices, particularly for harvesting plants used in ceremonies, traditional foods, and medicines. Agricultural runoff, habitat fragmentation, overgrazing, and the expansion of invasive species are key challenges negatively affecting wetlands on the reservation. These ecosystems and their associated riparian areas also face challenges like vegetation loss, streambank erosion, rising water temperatures, and siltation from grazing and flooding.

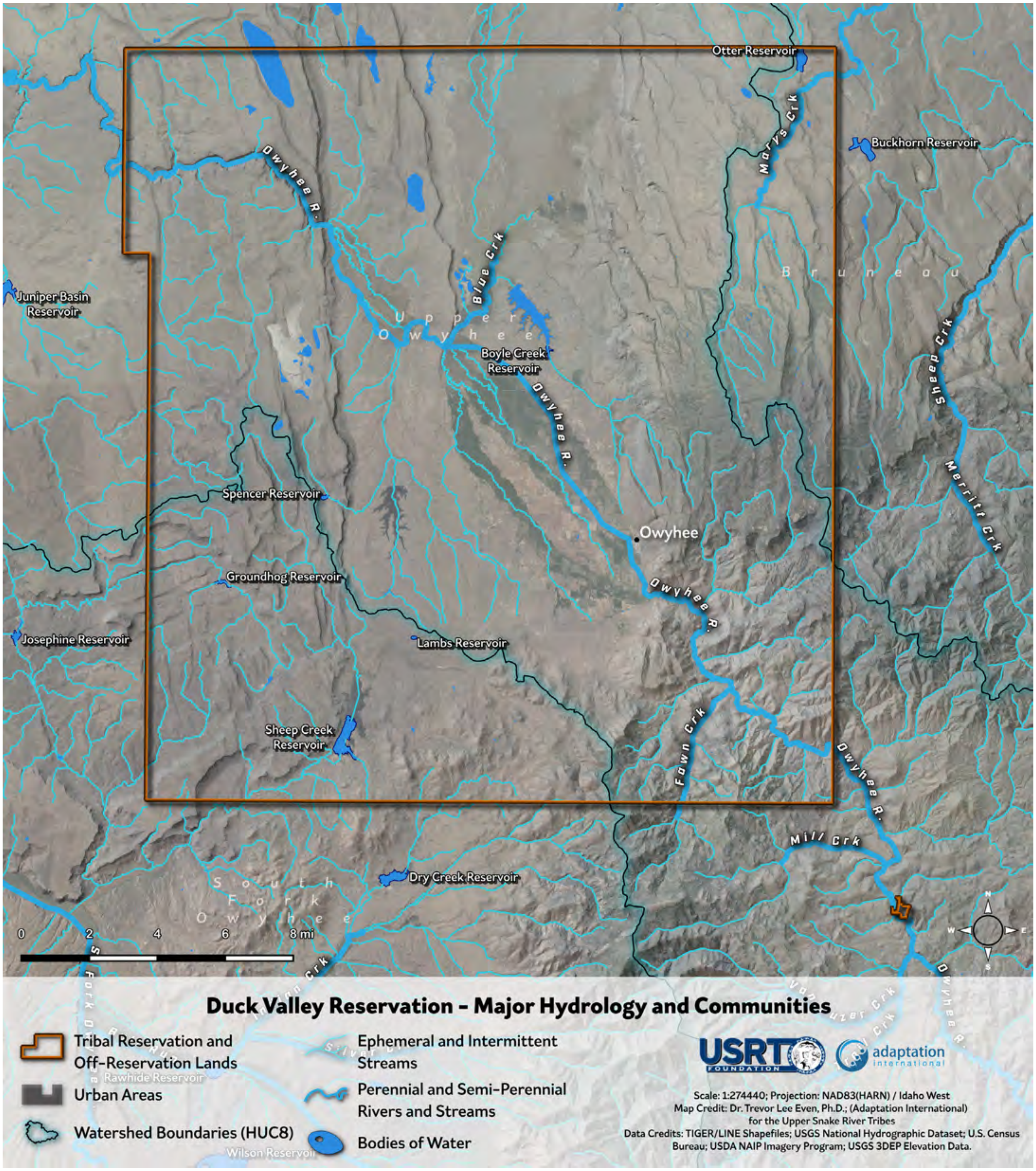


The Fort Hall Reservation depends on river flows from the Blackfoot, Portneuf, and American Falls (HUC8) watersheds.

Owyhee River Canyon, Duck Valley Reservation. Photo taken July 15, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

SHOSHONE-PAIUTE TRIBES OF THE DUCK VALLEY RESERVATION

The Duck Valley Reservation spans the Nevada–Idaho border and features wetland ecosystems supported by the Owyhee River and its tributaries. The Shoshone-Paiute Tribes of the Duck Valley Reservation, located along the East Fork of the Owyhee River on the Idaho–Nevada border, steward 289,819 acres, including 22,231 acres of wetlands. They have a deep connection to the land and its natural resources, which are integral to their cultural heritage and traditional practices as they historically traveled seasonally throughout the Western United States. These stream and riparian areas provide essential resources for the Tribes' subsistence and cultural needs, including plants used for basketry and medicinal purposes. The Tribes interacted and relied on salmon, steelhead, game, nuts, seeds, and roots as part of their traditional subsistence diet. Current threats to the wetland and riparian areas include water scarcity, livestock overgrazing and compaction of soil, and expansion of invasive species, all of which compromise the health of these ecosystems.



The Duck Valley Reservation primarily receives water from the Upper Owyhee basin, with portions bordering the Bruneau and South Fork Owyhee basins.

Mary's Creek on the Duck Valley Reservation. Riparian vegetation is in good condition, and the area would be a good source of building materials for BDAs. Photo taken August 19, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

CURRENT & FUTURE CLIMATE TRENDS

Overview

The Tribes face dynamic climate conditions across their reservation and off-reservation trust lands with: hot, dry summers; frigid, snowy winters; and wide ranges of precipitation both between locations and from year to year. Due to their continental position and dry atmospheric conditions, daily temperature swings can be dramatic. Overnight lows in the low 50s and daily highs in the 90s are a common occurrence in the mid-summer months. Facing winter-time lows that can fall near or below 0 °F, even at lower elevations, the Tribes must also deal with relatively short growing seasons, with even the warmest areas currently seeing just around 5 months per year with reliable frost-free conditions. Looking ahead, a warmer climate is expected to bring more unseasonably warm winter days and earlier spring warming, increasing the likelihood that storms which once produced snowfall instead generate dangerous rain-on-snow events, leading to rapidly rising rivers, greater erosion, and flooding in nearby communities.

For all of the communities, water supplies are mainly provided by heavy snowfall in the winter months. This snowfall primarily falls in upper elevation watersheds outside of reservation or off-reservation trust land boundaries. As a result, the communities rely on the stability of both local, "on the reservation" climate conditions, and those of areas where their water supplies originate. The rivers and riparian ecosystems that each Tribe manages provide a critical link between the snowpack in the source waters and the often-drier lowland areas that most of the Tribe's populations call home. As a result, riparian area resilience will continue to play a key role in the future of the Tribe's water supply and ecosystem story, keeping waters flowing and cool during dry years and slowing and storing flows during wet years.

Present-Day Climate

Despite these shared climate patterns, elevation differences shape local conditions. These differences affect how much snow each reservation and the associated watersheds receive, how long it lingers, and how quickly spring runoff occurs. Higher elevations tend to receive more snowfall and have shorter growing seasons due to cooler conditions. Similar differences are apparent in the precipitation patterns across the reservations. For example, local precipitation can peak in the high elevation portions of the Fort Hall and Duck Valley Reservations at 30 to 40 inches in an average year, with similar variance seen just outside of Burns Paiute and Fort McDermitt lands. Across the region, most of this moisture arrives between November and April, often as snow or cold-season rain. Summers are dry, with only occasional thunderstorms bringing short bursts of moisture. Water from snowpack is slowly released in spring, acting like a natural reservoir. However, much of the landscape's water is lost quickly due to evaporation, wind, and runoff over dry soils. Because of this, water supplies in shallow aquifers near rivers and the surface waters in the key perennial streams of each reservation are vital to each of the Tribes' ways of life.

Throughout the region, prevailing winds from the west and southwest combine with strong sun, low humidity, and high temperatures to drive high evapotranspiration rates (the rate at which plants release water from their leaves). In summer, more water is lost to the air than is gained from rain, intensifying drought stress on plants, rivers, and rangelands. This seasonal water imbalance is a major concern for agriculture, cultural plant gathering, and the health of riparian areas. During years with significant drought—whether caused by low winter snowfall or limited spring rainfall—already scarce water supplies can be further strained, while the risk of wildfire increases. Increasingly, intense rainfall episodes have also caused serious challenges, particularly in areas where prolonged drought has left watersheds too parched to readily absorb heavy rainfall. Because of this, flash flooding risks associated with degraded upland watershed and riparian area conditions are increasingly important to both long-term sustainability and day-to-day safety.

Reservation	Elevation (ft)	Temperature Average (in and % change)					
		Winter (Dec-Feb)	January Minimum	Summer (Jun-Aug)	July Maximum	Annual Precipitation (in)	Growing Season (days)
Fort Hall	4,300 to 8,600	24-28	15	60-68	89	10-41	110-160
Duck Valley	5,000 to 7,500	26-30	17	59-66	85	11-29	100-120
Fort McDermitt	4,100 to 6,600	29-32	16	63-67	90	8-22	130-160
Burns Paiute	4,150 to 5,100	27-30	15	62-65	78-87	10-22	100-120

Present-day climate baselines. Ranges represent averages from the lowest to highest areas (Elevation); coolest to warmest areas (Temperatures and Growing Season); and driest to wettest (Annual Precipitation). Ranges derived from Adaptwest Climate Project (2023) datasets, based on the 1991 to 2020 period. January Average Minimum Daily Temperatures and July Average Maximum Daily Temperatures accessed at wrcc.dri.edu/my/stations and the NWS COOP Network.

Climate Projections

Temperatures are projected to rise significantly in all seasons. By the 2050s (2040–2069) when today's youth are adults, average annual temperatures are expected to increase by 3.5°F to 8°F across the region. This means more extremely hot days in summer (with heat index values above 90°F) and fewer cold nights in winter. For agriculture, this may lead to longer growing seasons, but it also increases the risk of heat stress on crops, livestock, and native plants.

Hotter, drier summers will stress native plant communities, increase wildfire risk, and create more favorable conditions for invasive species like cheatgrass. Traditional food and medicine plants may become harder to find or shift their growing ranges. Rangelands could see reductions in forage quality and quantity, affecting both wildlife and livestock. Warmer conditions may also allow pests and plant diseases to spread more easily.

One of the biggest concerns is how warming temperatures are changing snowpack and the water cycle in and around the reservations. While the total amount of precipitation may not change much, when it falls and what form it takes will shift. Warmer winters will bring more rain and less snow, especially at lower elevations. Snowmelt will happen earlier in the year, shifting peak streamflow earlier in some reaches, and reducing streamflow in areas with less snow overall. This means less water will be available in riparian areas during the hot, dry summer months, when it's needed most. Though many areas may see overall increases in total precipitation, increased temperatures will intensify the water cycle, even in wet years, and will make the negative impacts of dry years more intense and far reaching.

Little Sheep Creek, Duck Valley Reservation. Photo taken July 16, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

Reservation-Specific Climate Patterns

BURNS PAIUTE RESERVATION AND OFF-SITE PROPERTIES

Average Temperature (°F)

Spring Precipitation (% change)

Frozen Precipitation (% change)

Future projections indicate a significantly warmer climate at the Burns Paiute Reservation, the wildlife mitigation properties at Logan Valley and Jonesboro Ranch, and the tribally owned Beech Creek Ranch. Across these sites, temperatures are expected to rise by at least 3 °F by the 2050s and 4 °F or more by the end of the century. These changes result in a longer growing season and up to one additional month of frost-free days by the end of the century. Vegetation, while benefiting from warmer temperatures in the spring and autumn, may see lower productivity in the hotter mid-summer months, and will generally experience accelerated drying during periods of low rainfall. While precipitation is projected to increase up to 16% by the end of the century, higher temperatures across the region will lead to overall reductions in the total amount of precipitation falling as snow. This will mean faster, more dramatic runoff in the spring, and intensified dry periods in the late summer. Future water and land management will likely benefit from efforts to restore watershed vegetation communities, ensure healthy riparian ecosystems, and improve water conservation.

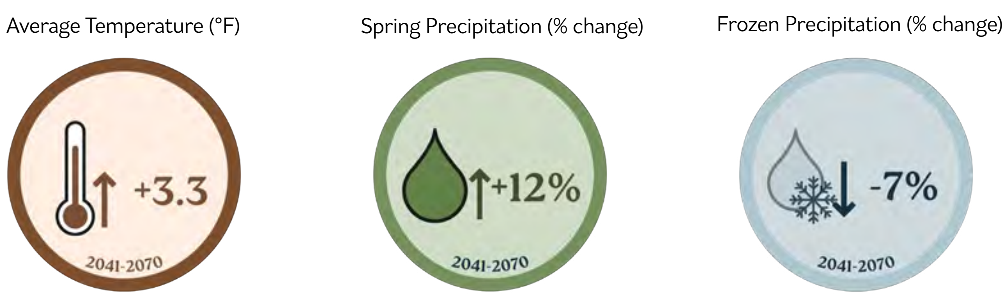
Burns Paiute Reservation	Average Temperature (°F)	Average Precipitation (in and % change)					
		Winter	Spring	Summer	Fall	Number of Days >= 90 °F Heat Index	Annual Frozen Precipitation (in and % change)
Historical climate (1991-2020)	48.4	3.6	3.2	1.8	2.4	29	3.3
Projected change from historical (2041 - 2070)	+3.1	+16%	-13%	-1%	+8%	+22	-13%
Projected change from historical (2071 - 2100)	+4.3	+19%	-21%	+17%	+12%	+30	-21%

Burns Paiute Reservation modeled historical conditions and future change under the “Middle of the Road” or SSP2-4.5 Scenario, based on an eight-model ensemble average. Derived from the University of Montana Native Resilience CMIP6 datasets.

Hunter Creek, Burns Paiute land. Heavily incised from past earthen dam reservoir that broke and incised stream channel. Riparian vegetation looks good. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

While the properties in the Upper Malheur will continue to see cooler and wetter conditions overall, due to its higher elevation and more northern position, the broader shifts in temperature and precipitation observed at sites to the south will also likely occur there. This may result in significantly higher precipitation in the upper reaches of the Malheur River headwaters, and more dramatic spring flows through the Lake, McCoy, and Big Creek systems – but also more intense drought years, as well as growing risk of wildfire events in the nearby mountain forests.

FORT McDERMITT RESERVATION AND TRIBAL LANDS



Future projections for the Fort McDermitt region depict a significantly warmer future at all elevations, with previously cooler areas beginning to see temperatures once only possible in the warmest parts of the Quinn River Valley by the 2041 to 2070 period. If current emissions trajectories continue, the region is projected to see increases of 3 °F or more by the 2050s period, and more than 4 °F by the 2080s. These hotter conditions will have significant consequences for wildlife, plant communities, and stream temperatures, especially in open areas where streams lack shade from intact riparian plant communities. Future precipitation projections suggest increased precipitation for the region, with a 10% to 12% increase throughout the century. However, higher temperatures will reduce already scarce snowfall at low and middle elevations and reduce snowpack longevity at high elevation sites in the Quinn River headwaters. With the associated likely increase in stream temperatures, there will be higher water use by vegetation, cattle, and wildlife. Future water management—including the restoration of riparian ecosystems—will likely become increasingly important as already challenging water supply conditions become even more complex.

Fort McDermitt Reservation	Average Temperature (°F)	Average Precipitation (in and % change)					
		Winter	Spring	Summer	Fall	Number of Days >= 90 °F Heat Index	Annual Frozen Precipitation (in and % change)
Historical climate (1991-2020)	48.3	3.4	3.0	1.5	2.3	30	3.6
Projected change from historical (2041 – 2070)	+3.3	+18%	+12%	+3%	+1%	+26	-7%
Projected change from historical (2071 – 2100)	+4.5	+19%	+10%	+16%	+2%	+36	-16%

Fort McDermitt Reservation modeled historical conditions and future change under the "Middle of the Road" or SSP2-4.5 Scenario, based on an eight-model ensemble average. Derived from the University of Montana Native Resilience CMIP6 datasets.

E.F. Quinn River, above the confluence of the E.F. and W.F. Quinn outside the Fort McDermitt Reservation, Photo taken July 9, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

FORT HALL RESERVATION AND OFF-RESERVATION TRUST LANDS

Average Temperature (°F) | Spring Precipitation (% change) | Frozen Precipitation (% change)

Future projections show a general increase in temperatures likely at all elevations, with many high elevation areas likely to experience temperatures normally seen only in the warmest parts of the reservation. As a result, more days above 90 °F heat index, drier overall summer conditions, and lower minimum streamflows in late summer are likely. Higher temperatures will mean that more precipitation falls as rain, rather than snow. There is also a higher likelihood of rain-on-snow events resulting in higher springtime flows and flooding. These conditions will intensify the need for both more careful water resource management and the maintenance of robust riparian ecosystems that can help cool, conserve, and slow the movement of water across the landscape. (Native Climate 2024; Thrasher et al. 2021, 2022).

Fort Hall Reservation	Average Temperature (°F)	Average Precipitation (in and % change)					
		Winter	Spring	Summer	Fall	Number of Days >= 90 °F Heat Index	Annual Frozen Precipitation (in and % change)
Historical climate (1991-2020)	46.1	3.5	3.9	2.5	3.0	11.0	3.2
Projected change from historical (2041 - 2070)	+3.6	+13%	+10%	-6%	+3%	+29	-18%
Projected change from historical (2071 - 2100)	+5.0	+13%	+10%	+6%	+1%	+42	-25%

Fort Hall Reservation modeled historical conditions and future change under the "Middle of the Road" or SSP2-4.5 Scenario, based on an eight-model ensemble average. Derived from the University of Montana Native Resilience CMIP6 datasets.

Upper Portneuf, Ft. Hall Reservation. Photo taken July 15, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

DUCK VALLEY RESERVATION

Average Temperature (°F)

Spring Precipitation (% change)

Frozen Precipitation (% change)

Under a scenario aligned with current emissions levels, the Duck Valley region can expect to see up to 3 °F warmer temperatures by the 2050s period, and up to 5 °F of warming by the end of the century (2080s). These shifts will make temperatures previously seen only in the warmest parts of the reservation possible at formerly cool, high elevation sites. They will also increase the growing season (with up to 20% more growing days per year by the end of the century). Future precipitation projections for the region generally portray increases in total precipitation levels, including increases in winter-time precipitation. However, higher temperatures will mean that a larger proportion of this precipitation falls as rain, rather than snow. As a result, springtime flooding from higher peak river flows may occur more frequently. More rapid water use by plants, and more consistent evaporation rates through the spring, summer, and fall, will further hasten the drying of landscapes throughout the water year, increasing the speed and intensity of drought condition formation.

Duck Valley Reservation	Average Temperature (°F)	Average Precipitation (in and % change)					
		Winter	Spring	Summer	Fall	Number of Days ≥= 90 °F Heat Index	Annual Frozen Precipitation (in and % change)
Historical climate (1991–2020)	47.1	4.6	3.7	1.8	3.0	16	5.2
Projected change from historical (2041 - 2070)	+3.4	+14%	+12%	+0%	+2%	+27	-9%
Projected change from historical (2071 - 2100)	+4.7	+15%	+12%	+0%	-1%	+37	-18%

Duck Valley Reservation modeled historical conditions and future change under the "Middle of the Road" or SSP2-4.5 Scenario, based on an eight-model ensemble average. Derived from the University of Montana Native Resilience CMIP6 datasets.

Mary’s Creek, Duck Valley Reservation. Relic beaver dam. Photo taken July 15, 2025 (credit: Lauren Noeker, USRT).

RIPARIAN HABITAT STRESSORS

Drought

Rising temperatures and declining soil moisture are increasing the frequency and severity of droughts in the Upper Snake River region. These conditions favor drought-tolerant and often invasive plant species, while stressing native riparian vegetation like willows and cottonwoods. Over time, this can shift the structure and composition of riparian zones, especially in higher elevations, where forests are more vulnerable to heat and water stress (Halofsky & Peterson, 2017).

Wildfire

Climate change is expanding wildfire seasons and intensifying fire behavior. In the Northwestern U.S., including the Snake River Basin, wildfire area is projected to increase by 200–300% by mid-century (Halofsky & Peterson, 2016). Combined with beetle outbreaks and invasive grasses, this creates feedback loops that further degrade riparian habitat, increasing vulnerability to erosion and limiting regeneration of native vegetation.

Erosion

Loss of riparian vegetation from drought, fire, and land use pressures leave streambanks more vulnerable to erosion. This not only reduces habitat quality for fish and wildlife but also contributes to sediment loading in streams, which degrades water quality and affects the health of aquatic habitats. In addition, the lack of vegetation can lead to scouring during high flows, destroying spawning habitat. In areas where peak flows are intensifying, unstable banks and disconnected floodplains are increasingly common.

Changes in the Hydrological Cycle

Warmer winters and changing precipitation patterns are shifting the timing and volume of streamflow. Snowmelt is occurring earlier, and spring peak flows may no longer align with riparian seed dispersal and germination, affecting recruitment of key tree species (Petersen et al., 2017). Reduced summer streamflow also lowers water tables, making it harder for shallow-rooted riparian plants to survive. In some cases, small creeks and springs may dry entirely, leading to the loss of riparian habitat altogether.

Agriculture and Rangelands

Livestock grazing and agricultural expansion have significantly altered riparian ecosystems in the region. Grazing near streams leads to bank erosion, vegetation trampling, and nutrient runoff, increasing sedimentation and pollutants in waterways (Eubank, 2004; Petersen et al., 2017). Agricultural runoff, carrying fertilizers, pesticides, and excess nutrients, degrades water quality and disrupts aquatic ecosystems. Irrigation further stresses water resources, reducing streamflow critical for riparian health. Groundwater withdrawals for agriculture also diminish tributary flows, reducing groundwater recharge into riparian zones.

Dams and Reservoirs

Dams, such as Palisades Dam, have altered natural hydrology, reducing peak flows essential for riparian habitat maintenance. Pre-dam, floods exceeding 700 cubic meters per second occurred every three years; post-dam, such events now happen only once in 44 years. This stifles gravel-bed movement, limits cottonwood regeneration, and disrupts the shifting habitat mosaic critical for biodiversity (Hauer & Lorang, 2004). Reservoirs also trap sediments, starving downstream riparian zones of nutrients, while regulated flows favor invasive species over native fish. Additionally, reservoir operations often reduce winter flows (October–April), forcing riparian habitats to rely on scarce alternative water sources (Petersen et al., 2017). Warm, nutrient-rich reservoir water further degrades downstream quality, while upstream banks erode due to fluctuating water levels.

Beyond hydrologic impacts, dams block access for anadromous fish such as salmon and steelhead, as well as other native resident fish species, cutting off vital nutrient pathways that historically connected rivers to riparian forests. The loss of marine-derived nutrients delivered by these migrations has had a significant impact on riparian habitat, reducing food availability for wildlife and altering ecosystem processes. For Tribes, these changes not only threaten fish migrations, but also medicinal plants and ceremonial sites, compounding cultural and ecological losses.

Beaver Removal

Beavers are keystone species in the Upper Snake River Basin, creating wetlands that supported biodiversity, groundwater recharge, and water filtration. However, historic trapping for the fur trade and more modern eradication programs to protect farmland and infrastructure have led to drier, more erosive riparian zones. Beaver dams once slowed river and stream flows, reduced flooding, and fostered native vegetation like willows (Pollock et al., 2014). Their reduced range in the Snake River basin has made riparian areas less resilient to drought and climate extremes. Reintroducing beavers, or mimicking their dams, can revive wetland habitats, benefit culturally significant species and improve water retention.

Non-Native Plant Invasion

Warmer winters and changing precipitation patterns are shifting the timing and volume of streamflow. Snowmelt is occurring earlier, and spring peak flows may no longer align with riparian seed dispersal and germination, affecting recruitment of key tree species (Petersen et al., 2014). Reduced summer streamflow also lowers water tables, making it harder for shallow-rooted riparian plants to survive. In some cases, small creeks and springs may dry entirely, leading to the loss of riparian habitat altogether.

IMPORTANCE OF RIPARIAN RESTORATION

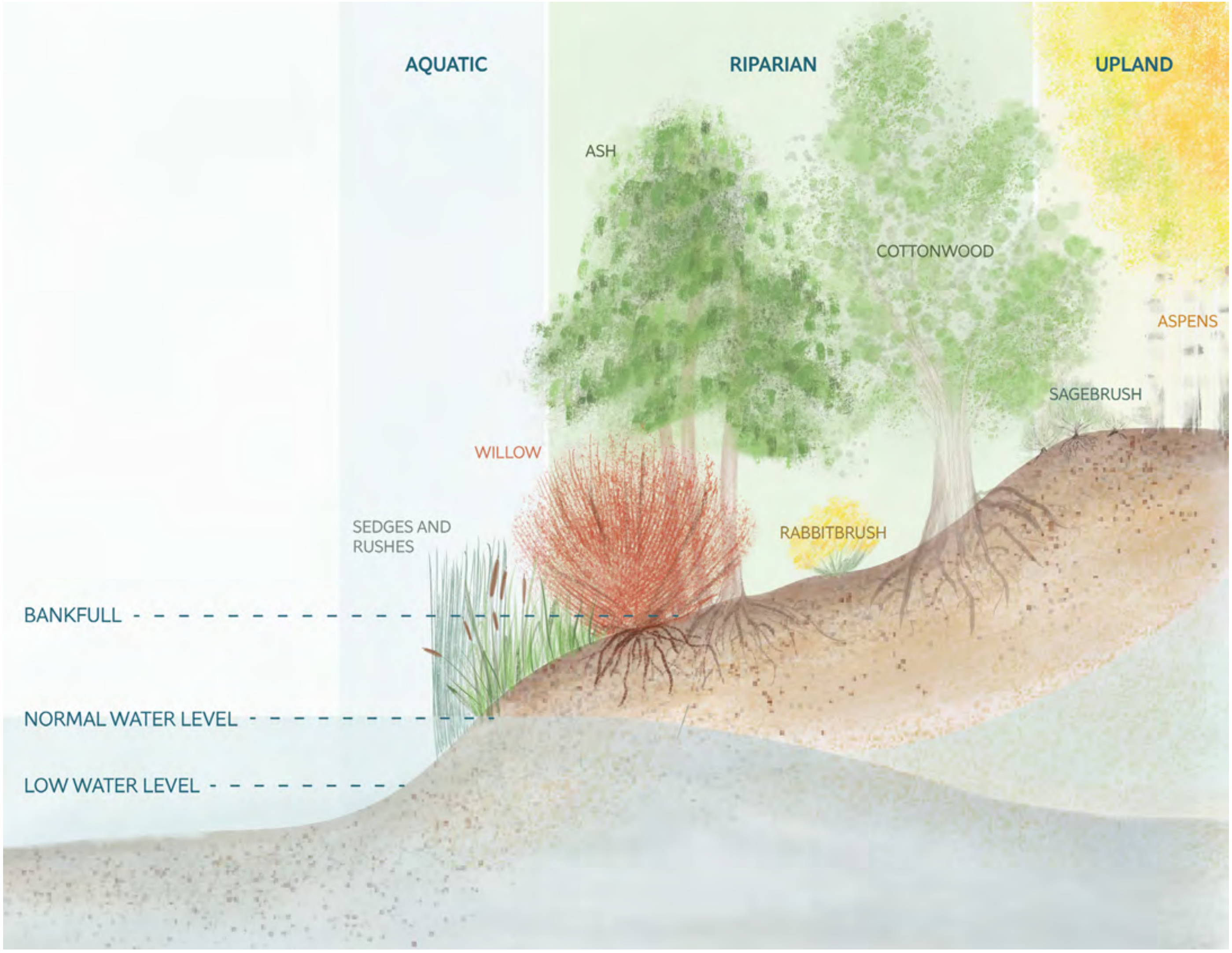
Riparian Areas

Riparian areas are the transitional zones between land and water, found along rivers, streams, lakes, and wetlands. These areas are characterized by their unique soils, vegetation, and hydrology, which create a distinct environment supporting both terrestrial and aquatic ecosystems. Riparian zones are directly influenced by the presence of water, leading to a higher concentration of moisture that sustains a diverse array of plants and wildlife. Although they occupy only a small fraction of the total land area in the Upper Snake River Basin, riparian areas play an outsized ecological role, providing critical habitat for fish, birds, and mammals and supporting the overall health of the river system.

Healthy riparian areas serve as natural buffers that protect water quality by filtering sediment, nutrients, and pollutants before they enter streams and rivers. Their dense vegetation stabilizes streambanks, reducing erosion and preventing excessive sedimentation in rivers and streams that can degrade aquatic habitats. These areas also play a crucial role in regulating water temperature by providing shade, which is particularly important for cold-water species like native salmonids. Riparian zones act as natural floodplains, absorbing and slowly releasing water to help mitigate the impacts of high flows and maintain groundwater recharge.

Highly functioning riparian areas hold substantial ecological value, providing benefits to water quality, soil health, and a variety of riparian species. One of the main values of riparian restoration is its ability to enhance ecological resilience, particularly in the face of disturbances that can compromise water quality such as agricultural runoff (Petersen et al., 2017; Halofsky & Peterson, 2017). Riparian areas intercept and filter pollutants, such as sediments, nutrients, and pesticides from surface runoff and groundwater, protecting downstream water sources and in-stream organisms from contaminants from human activity (Stutter et al., 2019). They also function as sites for stormwater retention and treatment, addressing both point and nonpoint sources of pollution (Kusler, 2016).

Riparian vegetation plays a role in water management by promoting infiltration and reducing the loss of water to evaporation, especially as precipitation patterns shift in the region (Seavy et al., 2009). Riparian vegetation can also regulate water temperatures, shading water bodies from direct sunlight and facilitating the mixing of cold groundwater with warmer surface waters. This helps create cold water refugia – cooler aquatic environments essential for species such as native salmonids



Aquatic, riparian, and upland habitat zones around a river or stream with associated vegetation.

(Seavy et al., 2009; Eubanks et al., 2004). Restoration can also aid soil health by limiting soil compaction, increasing permeability, reducing erosion, and regenerating soil function (USDA, N.D.).

Riparian restoration helps maintain or improve the essential functions and connections between terrestrial and aquatic ecosystems that have been compromised by climate change and other human activities. Defined as "the reestablishment of riparian functions and related physical, chemical, and biological linkages between terrestrial and aquatic ecosystems" (USDA, n.d.), riparian restoration aims to repair baseline ecosystem dynamics and diversity disrupted by human activity, enabling natural processes to do their job and the sustainable recovery of ecosystem structure and function (Eubanks et al., 2004).

Riparian areas have significant ecological and cultural importance, as they provide habitat for a wide variety of plant and animal species that are important for local Tribes' lifeways. Particularly in arid and semi-arid landscapes, such as the Upper Snake River Basin, riparian zones often constitute the most densely vegetated areas, enhancing their unique value and ecological function (Kusler, 2016).

FLOODPLAINS

Floodplains are important for enhancing ecological resilience, particularly in the face of increasing climate variability. A riparian floodplain is the low-lying land directly next to a river or stream that is prone to flooding, while an engaged floodplain is a section of a riparian zone that is actively involved in a flood.

Restoring the natural complexity of stream channels and floodplains is important for enabling riparian areas to buffer the effects of high peak flows (Raymond et al., 2014). Additionally, robust riparian zones can serve as a means to passively reduce the impacts of post-wildfire runoff, through their capacity to intercept debris and uptake nutrients. The re-establishment of natural hydrologic processes and floodplain dynamics through restoration is critical in climate change mitigation, as it allows ecosystems to adapt more effectively to significant environmental shifts and changing climate conditions.

Reducing the impacts of extreme flood events is important for terrestrial, aquatic, and human communities (Seavy et al., 2009). Floodplain restoration not only limits the adverse effects on human infrastructure but also mitigates impacts on riparian biodiversity and limits biological invasions (Perry et al., 2016). Additionally, riparian zones serve as dispersal corridors, connecting river valleys with smaller tributary streams from higher elevations, thus spanning a diverse range of microclimates (Szcodronski et al., 2024). Restoring floodplains enriches ecological networks and enhances the capacity of both natural and human systems to withstand and recover from disturbance events.

Co-Benefits

CARBON SEQUESTRATION

Riparian restoration offers benefits beyond ecosystem repair. One of the most important co-benefits is carbon sequestration, the process of capturing and storing atmospheric carbon dioxide (CO_2) in vegetation and soils. Healthy riparian corridors, especially those with intact wetland systems and native plant communities, play a vital role in the global carbon cycle by acting as carbon sinks. Carbon sinks are areas that absorb more carbon than they release.

Wetland soils, in particular, are known for their rich organic carbon content. Due to frequent saturation and slow decomposition rates, these soils can accumulate and retain large stores of carbon over time (Stutter et al., 2019). Similarly, riparian forests and floodplain woodlands, including regional species such as willow, cottonwood, alder, and dogwood, rapidly accumulate biomass, storing carbon both above and below ground for decades.

In the context of riparian restoration, carbon sequestration reinforces the importance of restoring natural vegetation structure and hydrological function. Rewetting floodplains, reconnecting stream channels, and planting native woody and herbaceous species not only enhance habitat quality and biodiversity but also remove carbon dioxide from the atmosphere.

PLANTS AND ANIMALS

Many riparian plants exhibit natural resilience, having adapted to endure hydrologic and geomorphic disturbances as well as seasonal and annual environmental variation. Restoring riparian habitats increases connectivity across riparian zones. In arid and semi-arid regions, riparian areas provide corridors for species movement (Szcodronski et al., 2024). This helps preserve ecological networks and support native species populations. This connectivity is crucial for promoting biodiversity, as it increases both habitat diversity and creates favorable conditions for native species. It also supports landscape-scale species richness, the number of species present in an area, and helps facilitate range shifts necessary for adaptation to changing environments (Perry et al., 2015). Riparian areas are also essential for providing thermal refugia for animals that face challenges in regulating their body temperature, such as salmon and trout, thereby supporting their survival in fluctuating environmental conditions (Seavy et al., 2009). Enhancing biodiversity can lead to improved ecosystem resilience. By having more species present and healthy, the likelihood that some of those species will successfully adapt to new conditions increases.

West Fork Bannock Creek, Fort Hall Reservation. Photo taken October 15, 2024 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

RESTORATION AS A PATH FORWARD

Process-Based Restoration

Process-based restoration is a goal-oriented approach to restoration that seeks to reestablish the natural processes in an ecosystem. Rather than focusing solely on reconstructing physical features or mitigating specific symptoms of degradation, this method emphasizes the dynamic interactions between water, sediment, vegetation, and organisms that, when healthy, create resilient river systems.

The focus is on restoring normative rates and magnitudes of physical, chemical, and biological processes, such as erosion and deposition, channel migration, and the succession of riparian vegetation (Beechie et al., 2010). For example, restoring channel-floodplain connectivity supports the creation and maintenance of robust river corridor functions (Wohl et al., 2024). Restoration programs that prioritize hydrological processes can use the inherent resilience of riparian systems to build more adaptive ecosystems. This requires clearly defining goals to ensure that restoration techniques are suited to the watershed or stream's unique context (Seavy et al., 2009; Roni et al., 2012; Wohl et al., 2024).

In contrast, engineering-based restoration often focuses on achieving channel form and stability, which, while important, may neglect the underlying processes that create and sustain healthy riverscapes. This approach can result in higher costs and a limited capacity to restore extensive stretches of river systems. Process-based restoration of river dynamics and the natural variability of habitat conditions foster sustainability and resilience within ecosystems and have the ability to outperform static engineered channels or habitats over time (Beechie et al., 2010; Wheaton et al., 2019). Unlike engineering approaches that constrain natural processes, process-based methods promote ecological integrity and adaptability (Palmer et al., 2005). The inclusion of riparian vegetation, for example, enhances habitat complexity, stabilizes streambanks, and regulates water temperature. These benefits are difficult to achieve through conventional engineering alone (McKergow et al., 2016). Ultimately, prioritizing natural dynamics over engineered control allows for more scalable and enduring restoration outcomes.

Incorporating Indigenous Knowledge into riparian restoration both strengthens human-ecosystem relationships and provides critical support for culturally grounded and multi-beneficial strategies for climate adaptation. This integration not only deepens the ecological foundation of restoration efforts but also fosters and supports collaborative stewardship of shared landscapes and futures (Wohl et al., 2024).

When incorporating Indigenous Knowledge it is important to center Indigenous leadership, sovereignty, and data governance throughout the restoration process. Restoration efforts that engage Indigenous Knowledge must do so ethically and equitably, honoring the intellectual property, values, and sovereignty of Indigenous communities (Robinson et al., 2021; Tran et al., 2025). For Tribes of the Upper Snake River region, integrating Indigenous Knowledge into riparian restoration is not only a matter of improving ecological outcomes; it is a path toward restoring cultural relationships with land and water. Restoration can support more just, resilient, and enduring riparian ecosystems.

THE LOW-TECH PROCESS-BASED RESTORATION PHILOSOPHY

Building on the principles of process-based restoration, the Low-Tech Process-Based Restoration (LTPBR) approach uses simple, low-cost, interventions to initiate or accelerate natural processes. LTPBR acknowledges that rivers are dynamic systems that naturally adjust and evolve through sediment transport, flooding, and vegetation succession (Beechie et al., 2010; Wheaton et al., 2019).

Instead of stabilizing channels with riprap or hard infrastructure, LTPBR encourages features like beaver dams, wood accumulations, and seasonal flood pulses to restore river dynamics. A key goal is to reestablish water flow patterns by reconnecting streams with their floodplains and allowing natural channel migration (Wheaton et al., 2019). These actions also support habitat diversity and native species.

In the Upper Snake River Basin, sediment transport processes—erosion, deposition, and delivery—are critical to maintaining stream structure and habitat. LTPBR supports the formation of riffles, oxbows, pools, and other geomorphic features essential for aquatic life. Projects often aim to mimic natural elements like beaver dams, debris jams, and wetland recharge areas. LTPBR also emphasizes riparian vegetation and seasonal disturbance regimes. Restoring flood cycles supports native plant communities, while improved soil structure and organic matter help stabilize systems over time.

Perhaps the most essential aspect of LTPBR is its landscape-scale vision. These projects aim to restore entire watersheds or river corridors, not just isolated sites. Connectivity is vital for aquatic species, riparian vegetation, the terrestrial species that depend on these areas, and the mosaic of interactions that sustain biodiversity. Implementing LTPBR at scale requires anticipating upstream/downstream effects and planning for future changes in land use or climate.

These projects must also be designed for long-term self-sufficiency. Because success ultimately relies on the return of natural processes, results may take time and won't always be immediately visible. LTPBR projects are involved and require deep knowledge of river systems, along with collaboration across stakeholders, including landowners, agencies, and Tribes. When successful, these projects yield co-benefits like water purification, flood attenuation, carbon storage, and the restoration of cultural and ecological connectivity across landscapes.

Beaver Dam Analogs

In areas where beavers are not present or have yet to be reintroduced, Beaver Dam Analogs (BDAs) are simple, human-built structures designed to mimic the form and function of natural beaver dams. Constructed with wood posts, branches, and other natural materials, BDAs are a LTPBR technique that helps reestablish the ecological role of beavers in riparian systems. By restoring the hydrological and geomorphic processes that dams naturally provide, BDAs can accelerate the recovery of degraded streams and riparian corridors.

West Fork Bannock Creek, Fort Hall Reservation. Photo taken October 15, 2024 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

WHY USE BDAs?

BDAs slow streamflow, raise local water tables, and promote the reconnection of channels with their floodplains. There are four main BDA functions: slow water, spread water, sink water, and store water. In semi-arid systems, like much of the Upper Snake River Basin, these outcomes are especially valuable for increasing water retention during drought and buffering against the impacts of climate variability, such as decreased snowpack or seasonal shifts from snow to rainfall. BDAs are an effective tool for maximizing variation within a watershed. The habitat complexity created by BDAs supports fish and aquatic species, traps sediment, reduces erosion, and promotes riparian vegetation growth. Over time, BDAs can also attract beavers to recolonize the system, creating a positive feedback loop for long-term resilience.

HOW DO BDAs WORK?

By partially or fully spanning the channel with woody material, BDAs slow water velocities, encourage overbank flooding, and increase infiltration into surrounding soils. This supports wetland formation, recharges groundwater, and promotes a mosaic of riparian plant communities. The structures also facilitate natural sediment transport and deposition processes, which help rebuild incised or degraded channels into more dynamic, functional streams.

WHEN AND WHERE TO USE BDAs

BDAs are most effective in incised or degraded stream channels with low gradients, especially where beavers historically played a role in shaping the landscape. In the Upper Snake River Basin, BDAs can align closely with Tribal goals of restoring watershed health, supporting culturally significant species, and improving climate resilience. Site selection should consider hydrology, land use, and long-term management priorities.

MATERIALS AND CONSTRUCTION

BDAs are intentionally simple and inexpensive to build. They typically use locally sourced native woody materials, with posts hand-driven or pounded into the streambed and interwoven with branches to create a semi-permeable barrier. Construction can often be accomplished with hand tools, minimizing the need for heavy equipment and reducing disturbance to the site.

MAINTENANCE AND MONITORING

Like natural beaver dams, BDAs are dynamic and evolve with seasonal flows. Maintenance may include rebuilding structures after periods of extreme flows or adapting their placement to accommodate new channel conditions. Where possible, beaver recolonization should be encouraged, as their activity can sustain and enhance the long-term benefits of the structures.

MONITORING

BDAs require periodic monitoring to ensure that structures remain functional and continue to support ecological processes. Monitoring should document changes from pre-restoration to post-restoration conditions, such as increases in water surface area, improvements in fish habitat, and shifts in channel and floodplain function.

Post-Assisted Log Structures

Post-Assisted Log Structures (PALS) are hand-built features designed to replicate the ecological role of debris in streams. Constructed with logs anchored by vertical posts, PALS mimic naturally fallen wood and engineered log jams, providing a low-cost, low-tech, alternative to large-scale engineered wood placement. By encouraging wood accumulation, sediment sorting, and habitat diversity, PALS help restore the geomorphic and ecological processes that sustain resilient riverscapes.

Panther Creek, example of Post-Assisted Log Structures (PALS). Photo taken July 15, 2022 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

WHY USE PALS?

PALS are particularly effective at improving instream habitat complexity. By increasing the retention of wood and sediment, PALS promote the formation of pools and create structural heterogeneity in stream channels. These features are vital for fish, especially native salmonids, providing refuge during high flows, creating rearing habitat, and establishing cover from predators. PALS also slow water velocity, reconnect streams with their floodplains, and promote natural channel evolution. In some cases, they can be used to direct flow toward specific areas of the streambank to encourage localized scour—sometimes referred to as “bank blasters.” In semi-arid regions, where wood recruitment is often limited, PALS offer a practical means of reintroducing this key ecological process.

HOW DO PALS WORK?

PALS function by disrupting the flow of water in ways similar to natural log jams. The anchored wood diverts stream energy, creates diverse flow paths, and promotes localized deposition of sediment and organic material. These processes deepen pools, form riffles, and enhance aquatic habitat. Over time, PALS encourage further recruitment and retention of natural wood, amplifying their long-term ecological benefits.

WHEN AND WHERE TO USE PALS

PALS are best suited for incised or simplified stream reaches with moderate gradients and limited natural wood inputs. They are particularly valuable in areas with fish passage goals, where habitat enhancement can support species recovery. In the Upper Snake River Basin, PALS can complement other low-tech features such as BDAs, creating a more diverse and connected suite of instream habitats.

MATERIALS AND CONSTRUCTION

PALS are constructed with native logs secured by posts driven into the streambed. Logs are interlocked with the posts to prevent movement during high flows. Hand tools are typically sufficient for construction, reducing cost and minimizing site disturbance. PALS are often built in clusters, mimicking the spacing and variability of natural wood jams.

MAINTENANCE

PALS can evolve over time with the dynamics of the stream. After high-flow events, structures should be inspected to ensure they continue to function as intended. Some natural rearrangement of wood is beneficial, as it reflects the variability of natural systems. Additional logs or posts can be added as needed to reinforce the structure or expand its influence.

MONITORING

Monitoring fish use and geomorphic response provides valuable insight into the effectiveness of PALS and helps guide future applications.

Large Woody Debris

Large Woody Debris (LWD) additions involve placing logs, root wads, and branches into stream channels to restore the role of natural wood in riparian systems. These structures may take the form of individual wood placements, constructed jams, or engineered log features designed to mimic the effects of fallen trees and natural accumulations. By reintroducing wood into simplified or degraded channels, LWD additions restore geomorphic processes, habitat complexity, and riparian connectivity.

While PALS and LWD are similar, LWD involves strategically placing whole trees or large logs in streams to restore habitat and hydraulic function in a manner more similar to the natural accumulation of fallen trees over time. PALS are built by anchoring smaller logs with driven posts to quickly create channel complexity and mimic natural wood jams.

Panther Creek, example of an LWD addition. Photo taken July 15, 2022 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

WHY USE LWD?

Historically, wood recruitment from fire, wind, floods, and natural tree fall played a vital role in shaping riverscapes. Where these processes have been interrupted by logging, fire suppression, or channelization, streams often lack the structural diversity needed to support healthy ecosystems. LWD additions slow water velocity, dissipate stream energy, and promote sediment sorting and channel evolution. They also provide critical instream habitat for native fish species and other aquatic organisms by creating pools, cover and refuge. Over time, these structures help reconnect streams with their floodplains and support riparian vegetation recruitment.

HOW DO LWD ADDITIONS WORK?

LWD structures interact with streamflow to redirect energy, promote pool scour, and generate diverse flow paths. By trapping and sorting sediment, they create dynamic habitat mosaics that support aquatic life. Logs and root wads provide overhead cover and instream complexity, improving habitat quality for fish and other organisms. At the same time, LWD helps stabilize streambanks, reduces erosion, and encourages vegetation establishment, reinforcing riparian resilience.

WHEN AND WHERE TO USE LWD

LWD additions are most effective in stream reaches that lack natural wood inputs, particularly incised or simplified channels with limited habitat structure. They are well-suited to watersheds where natural recruitment of wood is unlikely in the near future due to altered disturbance regimes or vegetation removal.

MATERIALS AND CONSTRUCTION

Locally sourced logs, root wads, and slash should be prioritized to minimize costs and maintain site compatibility. Wood can be secured with key logs, boulders, or anchoring to banks or other wood pieces, depending on stream size and flow conditions. The design should encourage natural interaction with streamflow while avoiding complete blockage of the channel. Where possible, structures should be placed in clusters to mimic the spatial distribution of natural jams.

MAINTENANCE

As with BDAs and PALS, LWD additions are intended to evolve with natural processes. Structures should be inspected following major flow events to ensure they remain functional and stable. Some shifting of wood is expected and can benefit habitat complexity.

MONITORING

Long-term monitoring should track geomorphic changes, fish use, and vegetation recruitment to evaluate ecological outcomes and guide adaptive management.

Information on BDAs, PALS, and LWD draws on research by Pollock et al. (2014), Bouwes et al. (2016), Westbrook et al. (2020). For more information on LTPBR processes, visit: Wheaton, J.M., Bennett, S.N., Bouwes, N., Camp, R., Maestas, J.D. and Shahverdian, S.M., 2019. Chapter 2 – Principles of Low-Tech Process-Based Restoration. In: J.M. Wheaton, S.N. Bennett, N. Bouwes, J.D. Maestas and S.M. Shahverdian (Editors), Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Utah State University Restoration Consortium, Logan, Utah. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/1.

Complementary Technique: Zeedyk Structures

Zeedyk structures, also referred to as rock erosion control structures, are low-profile, hand-built treatments constructed from rock, wood, and soil to restore hydrologic and ecological function in wet meadows, springs, and seeps. For the Tribes—particularly on the Fort McDermitt Reservation, where perennial stream networks are limited—Zeedyk structures offer a practical and low-tech approach to restoring degraded meadow systems. Rather than focusing on defined stream channels, these structures work across broad valley bottoms to slow, spread, and retain water on the landscape.

Zeedyk structures align with the principles of LTPBR by initiating natural recovery processes using simple materials and minimal disturbance. While they differ from instream techniques such as BDAs and PALS, they serve a complementary role by addressing degradation in areas where channels are ephemeral, incised, or absent altogether. The tools include one rock dams, media lunas, rock rundowns, and zuni bowls (Zeedyk & Clothier, 2009).

Zeedyk rock structures restoring an incised channel. Photo credit: Nathan Seward, Colorado Parks and Wildlife.

WHY USE ZEEDYK STRUCTURES?

In landscapes affected by headcutting and channel incision, wet meadows can dry, lose vegetation, and erode rapidly. Zeedyk structures interrupt this process by stabilizing headcuts, reducing erosive energy, and restoring shallow overland flow across meadow surfaces.
By increasing soil moisture and extending saturation, they support the recovery of sedges, rushes, and other culturally and ecologically important plants, improving drought resilience and sustaining late-season water availability.

HOW DO ZEEDYK STRUCTURES WORK?

Zeedyk structures function by slowing and spreading surface flow, reducing incision and encouraging water to reconnect with meadow soils. This increases infiltration and groundwater recharge, which supports vegetation recovery and reduces erosion over time. They are particularly useful in systems where restoring shallow hydrology is more important than confining flow within a defined channel.

WHEN AND WHERE TO USE ZEEDYK STRUCTURES

Zeedyk structures are most effective in wet or mesic meadows, springs, and seeps experiencing headcutting or concentrated flow, where shallow groundwater is still present but disconnected from the surface. Sites should allow water to spread across valley bottoms and support reconnection of meadow hydrology. They are especially useful in landscapes like the Fort McDermitt Reservation where perennial stream-based restoration approaches are limited.

MATERIALS AND CONSTRUCTION

Locally sourced rock, wood, and other natural materials are arranged to slow flow, spread water across the meadow surface, and stabilize actively eroding or incised areas while maintaining shallow overland flow connectivity.

MAINTENANCE

Zeedyk structures should be inspected periodically, especially after peak runoff events in the first year. Early maintenance may include repositioning rocks or wood and adjusting structures to maintain intended flow. As sediment accumulates and vegetation establishes, maintenance needs decrease, and by the third year most structures require minimal intervention. Because they function as a connected system, partial failure of individual structures is not necessarily problematic if overall meadow recovery is occurring. Over time, additional structures may be added to further raise groundwater levels and expand wet meadow conditions.

MONITORING

Monitoring should assess overall meadow recovery, including changes in groundwater levels, vegetation establishment, and hydrologic function across the connected system of structures.

This section is grounded in the principles described in Zeedyk et al. (1996), USDA NRCS (n.d), and Zeedyk and Clothier (2009) in Let the Water Do the Work: Induced meandering, an evolving method for restoring incised channels, which details the core concepts behind rock and wood erosion control structures for restoring incised channels and wet meadows. Supplemental guidance on structure types, field application, and implementation can be found at the Intermountain West Joint Venture's Zeedyk Structures resource hub, which compiles diagrams, examples, and practical tools for restoration planning and construction (IWJV, n.d.).

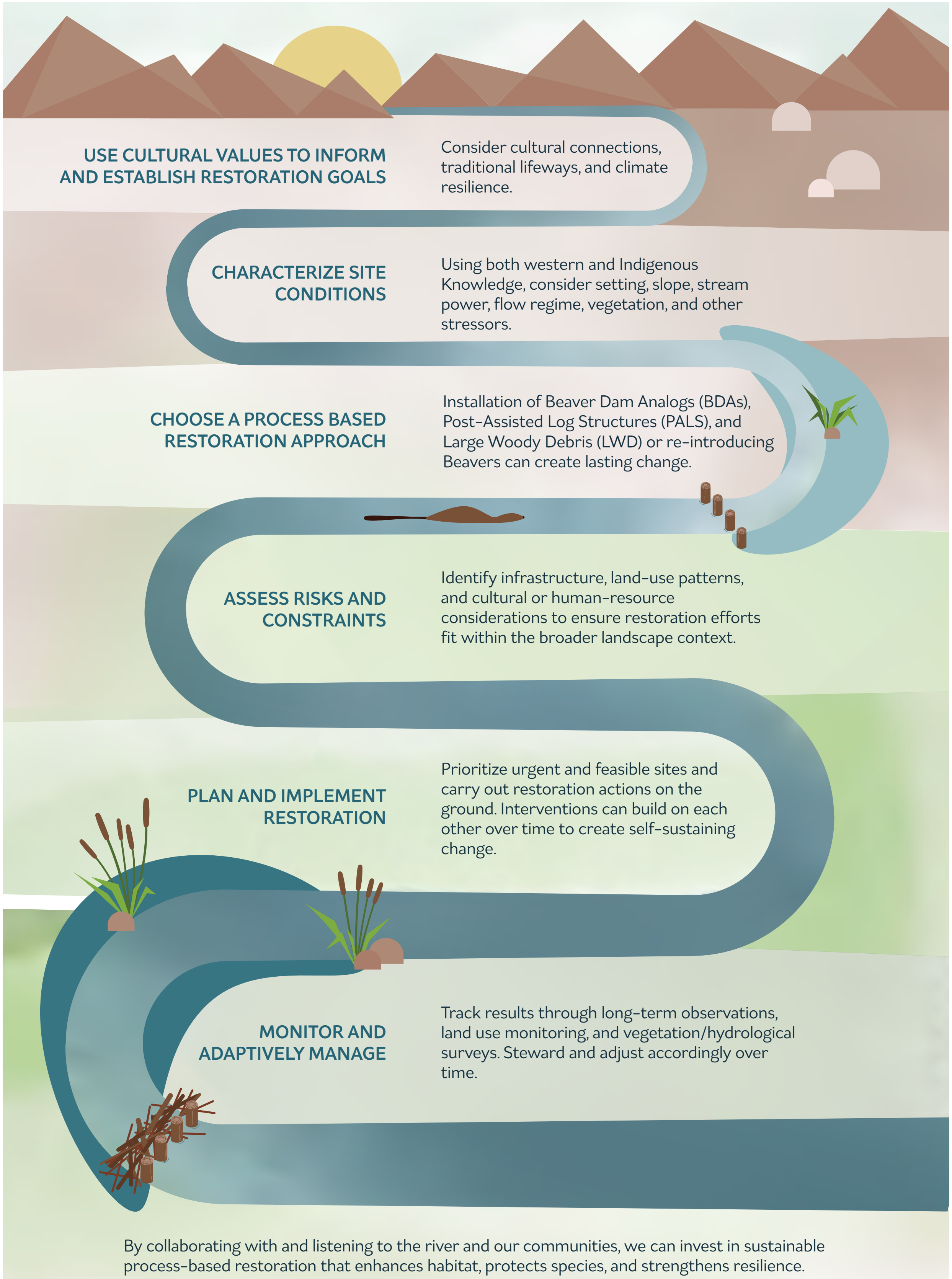
DEVELOPING A RESTORATION PLAN

Key Considerations

Restoration planning is not about prescribing a one-size-fits-all solution but rather about choosing strategies that allow natural processes to function better and enhance the resilience of the river systems.

Creating a restoration plan for riparian areas within the Upper Snake River Basin involves balancing ecological science, cultural priorities, and the realities of local land management. No two riverscapes are alike; each reflects a unique interplay of geology, hydrology, vegetation, land use, and cultural context. Restoration planning, therefore, is not about prescribing a one-size-fits-all solution but rather about equipping decision-makers with tools to assess local conditions and choose strategies that allow natural processes to function better and enhance the resilience of the river systems and the plants, animals, and people who depend on them.

This section highlights the general process for LTPBR based riparian restoration. Detailed beginnings of reservation-focused and site-specific restoration assessments for each reservation are included in the Appendices. Those guides describe stream sections, give an idea of their current condition, and suggest early restoration options. This section serves as a high-level roadmap to help Tribal Leaders, natural resource managers, and restoration practitioners evaluate where and how to invest in LTPBR.


USE CULTURAL VALUES TO INFORM AND ESTABLISH RESTORATION GOALS
Consider cultural connections, traditional lifeways, and climate resilience.
CHARACTERIZE SITE CONDITIONS
Using both western and Indigenous Knowledge, consider setting, slope, stream power, flow regime, vegetation, and other stressors.
CHOOSE A PROCESS BASED RESTORATION APPROACH
Installation of Beaver Dam Analogs (BDAs), Post-Assisted Log Structures (PALS), and Large Woody Debris (LWD) or re-introducing Beavers can create lasting change.
ASSESS RISKS AND CONSTRAINTS
Identify infrastructure, land-use patterns, and cultural or human-resource considerations to ensure restoration efforts fit within the broader landscape context.
PLAN AND IMPLEMENT RESTORATION
Prioritize urgent and feasible sites and carry out restoration actions on the ground. Interventions can build on each other over time to create self-sustaining change.
MONITOR AND ADAPTIVELY MANAGE
Track results through long-term observations, land use monitoring, and vegetation/hydrological surveys. Steward and adjust accordingly over time.
By collaborating with and listening to the river and our communities, we can invest in sustainable process-based restoration that enhances habitat, protects species, and strengthens resilience.

1. Establish Goals and Restoration Values

Key Considerations

Remember restoration is about more than rivers, it is about revitalizing culture, supporting traditional lifeways, and protecting resources.

The first step in developing a restoration plan is clarifying what you want restored and why. Ecological health is always a core objective, but goals often extend beyond ecological outcomes. These outcomes may include:

- Revitalizing cultural relationships with rivers and wetlands.
- Supporting traditional lifeways, such as fishing, hunting, and gathering.
- Increasing resilience to climate change and extreme weather.
- Improving water quality and protecting downstream resources.

2. Characterize Site Conditions

Key Considerations

Customizing approaches to local conditions is critical.

Every effective plan begins with a clear understanding of site conditions. At the landscape scale, factors like valley setting and slope provide insight into how a stream functions and how it might respond to restoration. At the reach scale – specific sections of the stream or river – identifying stressors and existing ecological functions helps guide the selection for the appropriate methods for restoration.

KEY CONSIDERATIONS INCLUDE

- Valley setting: confined vs. partly confined, which influences floodplain potential.
- Slope and stream power: steep headwater vs. low-gradient mainstem.
- Flow regime: snowmelt-driven vs. spring-fed, which affects sediment delivery, erosion, and beaver dam potential.
- Vegetation: woody vs. herbaceous riparian cover and adjacent upland communities.
- Stressors: grazing pressure, channel incision, diversions, infrastructure, or legacy impacts.

These factors are documented in the reservation-specific restoration guides (Appendix C) and can be revisited to refine local plans.

3. Considering Risks and Constraints

Restoration must balance ecological potential with social and management realities. These include factors like land ownership, ongoing land uses, community priorities, and the capacity for long-term maintenance. Understanding these social and management contexts early on helps ensure that restoration efforts are both effective and supported over time.

Key Considerations

Matching techniques to reach types increases the likelihood of success.

BEFORE CHOOSING METHODS, PLANNERS SHOULD ASK

- Is there nearby infrastructure (roads, diversions, fences, irrigation works) that could be affected by restoration actions?
- What land uses (e.g., grazing, agriculture, recreation) overlap with the restoration site, and how will they be supported or managed?
- Are there cultural resources or sacred sites nearby that must be protected?
- What level of community support and stewardship is available?

These questions help determine not only what restoration methods are suitable, but also what level of intervention is feasible in practice.

4. Choose a Restoration Approach

The next step is to identify which restoration strategies are most appropriate in that location. Process-based restoration emphasizes working with the natural potential of a site rather than imposing engineered designs. Matching techniques to reach types increases the likelihood of success and reduces the need for heavy intervention.

Key Considerations

Restoration planning is not about prescribing a one-size-fits-all solution but rather about choosing strategies that allow natural processes to function better and enhance the resilience of the river systems.

EXAMPLES INCLUDE

- Incised channels: PALS, BDAs, or beaver reintroduction.
- Degraded spring-fed streams: riparian planting or grazing management.
- Partly confined valleys with intact vegetation: beaver translocation or support of natural recovery with minimal intervention.
- High-gradient headwaters: LWD additions to promote channel complexity.

5. Sequence and Scale Restoration

Key Considerations

Interventions should be feasible, address urgent needs, and build on each other over time.

Process-based restoration works best when implemented at meaningful scales and sequenced over time. For example, introducing BDAs or PALS upstream can improve hydrology and habitat in downstream reaches. Conversely, beginning with grazing management in key headwaters can reduce pressure on sensitive riparian vegetation and increase the success of future instream interventions.

PLANNING SHOULD CONSIDER

- Where restoration is most urgent (sites with rapid degradation or high cultural/ecological importance).
- Where restoration is most feasible (sites with low risk of infrastructure conflicts and high potential for natural recovery).
- How interventions can build on each other over time to create self-sustaining change.
- Logistical considerations, such as the materials and labor required (e.g., number of posts or structures), the availability of local vegetation for construction, site access, and how materials and equipment will be transported to the stream.

Key Considerations

Monitoring allows for adaptive adjustments over time.

6. Using the Reservation-Specific Restoration Assessments

The appendices of this toolkit contain reservation-specific restoration assessments that include:

- Riverscape conditions, recovery potential, and constraints.
- Opportunities for restoration focused on springs, seeps, floodplains, and mesic meadows.
- Context for prioritization rather than prescriptive project design.

7. Apply Adaptive Management and Monitoring

Finally, a restoration plan should build in monitoring and flexibility. Not every action will produce the expected outcome, especially under changing climate conditions. Tracking how riparian systems respond, through vegetation surveys, hydrologic monitoring, or community observations, allows managers to adjust methods over time. It also provides an opportunity to build community involvement and support for these initiatives.

Duck Valley Reservation. Photo taken July 15, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

Volunteer/Grassroots Campaigns for Riparian Restoration

Mobilizing a grassroots volunteer effort in a Tribal community to restore riparian habitat involves careful planning, community engagement, and respect for cultural values and traditions. As a component of the LTPBR planning process, grassroots campaigns can be incorporated to help develop and install these structures in ways that are truly community driven, supported, and implemented.

COMMUNITY-LED PLANNING

- Work with the Tribal community to define the goals, objectives, and scope of the riparian habitat restoration project or projects.
- Ensure the project reflects the community's vision for their land and waterways.
- Set clear, achievable goals for the restoration effort, such as improving water quality, enhancing wildlife habitat, or reviving culturally significant plant species.
- Ensure that all restoration activities respect sacred sites, cultural heritage, and traditional practices.
- Empower the community to lead the restoration effort, with outside organizations or experts providing support rather than directing the project. This ensures that the project reflects the community's vision and priorities.

OUTREACH AND COMMUNITY INVOLVEMENT

- Use culturally appropriate methods to reach out to community members. This could include announcements at community events, Tribal newsletters, social media, or word of mouth.
- Highlight the cultural, environmental, and spiritual significance of riparian habitats to motivate participation.
- Partner with Tribal schools, youth programs, and community organizations to involve young people. Engaging youth fosters a sense of stewardship and connects them with their cultural heritage.

TRAINING AND EDUCATION

- Provide training sessions on riparian habitat restoration techniques, including planting native vegetation, removing invasive species, and stabilizing stream banks.
- Ensure that the training is hands-on and accessible to all volunteers.
- Include Tribal elders and knowledge holders in the training to share Indigenous Knowledge and practices related to the land and water.
- Develop educational materials that explain the importance of riparian habitats, the restoration process, and how the project will benefit the community and environment.

Arlo Crutcher, vista above Fort McDermitt Reservation, Photo taken July 9, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

VOLUNTEER EVENT COORDINATION

- Organize the logistics for volunteer events, including tools, materials, and transportation.
- Make sure the events are accessible to all, including elders and those with mobility challenges.

MONITORING AND LONG-TERM STEWARDSHIP

Involve volunteers in monitoring the success of the restoration project. This could include activities like tracking plant growth, observing wildlife, or assessing water quality.

- Involve volunteers or youth in the construction and monitoring of the restoration project, such as integrating activities into school-based projects where students help build structures and return each year to track plant growth, wildlife use, or water quality and assess project success.
- Engage the community in discussions about what's working, what needs improvement, and any changes needed.
- Encourage the community to take ownership of the restoration site, ensuring long-term care and protection.
- Host events to celebrate accomplishments in the restoration process.

Helpful Decision-Making Tools

The following tools can be particularly helpful in diving into and better understanding specific restoration techniques, accessing and using existing data, and collecting and sharing data to guide restoration projects. The digital version of the toolkit includes links to all the resources.

BEAVER RESTORATION ASSESSMENT TOOL

The Beaver Restoration Assessment Tool (BRAT) helps assess where and how extensively beavers can build dams across watersheds using a model that estimates dam-building capacity. It's designed to guide restoration and conservation efforts by focusing on beavers' role as ecosystem engineers.

RIVERSCAPES CONSORTIUM

The Riverscapes Consortium connects people with tools and data to study and restore river ecosystems. They simplify access to public data, support open-source modeling, and promote collaboration to address riverscape degradation globally.

WETLANDS GEOPROCESSOR

The Wetlands Geoprocessor uses research-based data to estimate how well constructed wetlands purify water, factoring in flow, storage, and nutrient loads. It offers detailed analysis, including efficiency and cost estimates, to support informed, goal-oriented planning.

VALLEY BOTTOM EXTRACTION TOOL

The Valley Bottom Extraction Tool (VBET) is used to map the valley bottom of a riverscape and separate it into basic landform types, like the channel and different levels of floodplain. It uses a digital elevation model (DEM) and a channel area polygon as inputs, along with topographic analyses to identify valley bottom areas. This information helps guide restoration by showing where streams can reconnect with their floodplains and support healthy riparian habitats.

Papoose Creek, Duck Valley Reservation. Photo taken July 15, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

IMPLEMENTATION & FOLLOW THROUGH

Funding

There are a variety of programs and groups that track funding and can potentially be used to secure funding for the development and implementation of different riparian restoration projects. A few examples are included below. In the digital toolkit, all resources are accessible through embedded links.

EPA WETLANDS PROTECTION AND RESTORATION

The U.S. Environmental Protection Agency offers Wetland Program Development Grants (WPDGs) to support states, Tribes, and local governments in building and strengthening wetland protection, management, and restoration programs.

U.S. FISH AND WILDLIFE FINANCIAL ASSISTANCE

The U.S. Fish and Wildlife Service provides grants and cooperative agreements that can support Tribal-led habitat restoration, species conservation, and riparian resilience projects. Funding opportunities and program information can be explored through the Service's Financial Assistance portal.

Beech Creek, Burns Paiute land. Dead Juniper in foreground Riparian vegetation is healthy. Active beaver in area. Photo taken August 13, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

USDA NATURAL RESOURCES CONSERVATION SERVICE - IDAHO STATE OFFICE

The Natural Resource Conservation Service (NRCS) offers financial and technical assistance to support Tribal-led, on-the-ground riparian and watershed restoration. Funding opportunities and local support can be accessed through NRCS service centers and state program pages.

TRIBAL FUNDING REGISTRY

The Tribal Funding Registry is a Native-led platform that compiles Tribal, federal, and foundation funding opportunities in one place, making it easier to find and apply for grants aligned with community priorities. The site also offers tutorials and direct support tailored to Tribal practitioners.

NATIONAL WILDLIFE FEDERATION WETLAND PROGRAM DEVELOPMENT GRANTS

The National Wildlife Federation Wetland Program Development Grants program supports Tribal-led efforts to build capacity and implement wetland and riparian restoration through planning, monitoring, and on-the-ground action.

NATIONAL ASSOCIATION OF WETLANDS MANAGERS

The National Association of State Wetland Managers website provides guidance for funding Tribal wetland programs, including detailed resources on Wetland Program Development Grants and strategies for combining multiple funding sources. The site offers practical tools, checklists, and training materials to help navigate funding, build competitive proposals, and sustain restoration efforts.

Key Elements of the Environmental Compliance Process

It is critical to note that process-based restoration projects are relatively simple to design and implement. However, the implementation of projects in riparian habitat types can trigger several environmental review, permitting, and funding requirements that a Tribal professional needs to be aware of during the development of the project plan. As environmental compliance requirements continue to evolve, Tribal staff should coordinate with relevant agencies before implementing stream restoration projects. The following section is intended as a brief primer of what types of environmental review processes will be necessary to permit LTPBR actions.

NATIONAL ENVIRONMENTAL POLICY ACT

Requires federal agencies to assess the environmental impact of their proposed actions on Tribal lands. Tribal land managers must ensure that any federal actions, such as construction projects or land use changes, are reviewed for environmental impact through an Environmental Assessment (EA) or an Environmental Impact Statement (EIS).

CLEAN WATER ACT

Ensures that activities comply with water quality standards. Tribal land managers must oversee the protection of water resources, such as rivers, lakes, and wetlands.

ENDANGERED SPECIES ACT

Protects threatened and endangered species. Tribal land managers must ensure that activities do not harm these species or their habitats.

ARCHEOLOGICAL RESOURCE PROTECTION ACT

Tribal land managers must also focus on protecting cultural and natural resources, such as sacred sites, traditional practices, and native species. This often involves integrating cultural considerations into environmental compliance processes.

TRIBAL ENVIRONMENTAL PROGRAMS

Many Tribes have established their own environmental programs or departments to manage and oversee compliance with federal laws. These programs may be supported by federal grants and can include monitoring, enforcement, and educational activities.

South Fork Trail Creek, Burns Paiute land. Intermittent stream with a ribbon of riparian vegetation. With the addition of BDAs, the riparian zone can be expanded laterally. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

A U.S. federal law enacted in 1990 to address the rights of Tribes and their descendants to reclaim human remains and cultural items. NAGPRA provides a legal process for Native American Tribes, Alaska Native villages, and Native Hawaiian organizations to reclaim human remains, funerary objects, sacred objects, and objects of cultural patrimony held by federal agencies and institutions that receive federal funding. The act also aims to protect Native American burial sites and ensure that discoveries of human remains or cultural items on federal or Tribal lands are handled respectfully.

Programmatic Planning for Riparian Restoration Actions

Environmental compliance protects not just ecosystems, but also Tribal sovereignty, cultural resources, and the long-term success of restoration efforts. It ensures that restoration actions meet legal standards while honoring the rights, traditions, and stewardship goals of the Tribes. Below are some key considerations and the value of going through these processes.

1. ENVIRONMENTAL REVIEW REQUIREMENTS

Activities in riparian zones may trigger environmental reviews under laws like the Clean Water Act, or the Endangered Species Act. These reviews help identify potential impacts and necessary protections.

2. PROGRAMMATIC PLANNING (NEPA)

The development of programmatic planning documents is one of the primary recommendations as a component of this handbook through the National Environmental Policy Act (NEPA) process. Programmatic planning allows federal agencies and the Tribes to evaluate the environmental impacts landscape level restoration actions rather than focusing on individual projects. For Tribes undertaking multiple LTPBR projects, creating a Programmatic Environmental Assessment (PEA) or Programmatic Environmental Impact Statement (PEIS) can save time and provide a clear framework. These documents assess broader, landscape-scale impacts and allow for "tiering", a process where future individual projects can move forward with simpler, quicker reviews.

3. CONSISTENCY AND CLARITY

A programmatic approach also helps Tribal staff apply consistent environmental safeguards across projects. This clarity supports better coordination, informed decision-making, and adaptive management, so that restoration work stays effective as conditions change.

4. CULTURAL AND LEGAL ALIGNMENT

Compliance processes should integrate Tribal values and cultural knowledge. Restoration efforts are not just technical undertakings, but are acts of healing that involve sacred places, traditional practices, and community connections to the land and water.

A programmatic planning approach will help establish consistent environmental standards and mitigation measures across multiple restoration projects or individual restoration actions within the reservation. This approach will help ensure that all related activities adhere to the same environmental goals and criteria. Tribal members, Tribal leadership and technical staff will all benefit from the predictability that comes with having a clear planning framework in place from the initiation of a restoration program.

Programmatic planning supports adaptive management by providing a framework for monitoring and adjusting programs as they are implemented. As new projects or actions are proposed under the program, they can be scaled and adjusted based on the findings of the initial programmatic analysis. This allows the Tribes to respond to new information or changing conditions over time, ensuring that environmental protections remain effective. Finally, identifying potential conflicts or environmental concerns at the programmatic level allows Tribal staff and leadership to address them early in the planning process, reducing the likelihood of delays or legal challenges during later project-specific reviews.

West Fork, Bannock Creek, Fort Hall Reservation. Photo taken October 15, 2024 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

South Fork Trail Creek, Burns Paiute land, Mock Orange shrubs with willow, heavily impacted by grazing, but a good place for BDA placement. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

CLOSING

This toolkit is intended to be a living resource that grows and evolves alongside Tribal restoration work. The discussion, strategies, and decision-support tools highlighted in this toolkit are starting points meant to be adapted to local conditions, informed by community priorities, and designed to address changing climate realities. Riparian restoration is a long-term commitment that requires patience, creativity, and collaboration. By blending Indigenous Knowledge with process-based restoration methods, the Tribes are charting a path toward ecological and cultural resilience. The work ahead will take many hands and voices, but it is rooted in the enduring strength of the rivers and the Peoples who have cared for them since time immemorial. It is our hope this guide serves as a practical resource for tribal staff and helps implement riparian restoration actions for generations to come.

Key Considerations

By blending Indigenous Knowledge with process-based restoration methods, the Tribes are charting a path toward ecological and cultural resilience.

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Quinn River, the river goes subterranean and the riverbed is dry just below this location Fort McDermitt Reservation, Photo taken July 9, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

Appendix A - Literature Library

This appendix provides a selection of key studies from the Riparian Restoration Literature Library, focused on Carbon sequestration, Climate Risks & Vulnerabilities, Culturally Relevant Species, Low-Tech Process-Based Restoration, and Riparian Restoration. This is a partial list of available resources. To request access to PDFs or the full literature library, please contact Dennis (Dennis.daw@usrtf.org).

KEY:

- Carbon sequestration
- Climate Risks & Vulnerabilities
- Culturally Relevant Species
- Low-Tech Process-Based Restoration
- Riparian Restoration

Title	Brief Summary	Suggested Citation
Accounting for aboveground carbon storage in shrubland and woodland ecosystems in the Great Basin	Shrublands and woodlands store far more carbon than previously estimated, illustrating the importance of non-forest systems in regional carbon budgets. Reinforces the need to protect and restore shrub-dominated landscapes.	Cleary, M. B., Pendall, E., & Ewers, B. E. (2010). Aboveground and belowground carbon pools after fire in mountain big sagebrush steppe. Rangeland Ecology & Management, 63(2), 187-196.
The effects of cheatgrass invasion on US Great Basin carbon storage depend on interactions between plant community composition, precipitation seasonality, and soil climate regime	Carbon impacts of cheatgrass vary by climate and soil conditions; not all sites respond the same. Supports locally tailored restoration strategies rather than blanket assumptions.	Maxwell, T. M., & Germino, M. J. (2022). The effects of cheatgrass invasion on US Great Basin carbon storage depend on interactions between plant community composition, precipitation seasonality, and soil climate regime. Journal of Applied Ecology, 59(11), 2863-2873.
A synthesis of the effects of cheatgrass invasion on US Great Basin carbon storage	Cheatgrass invasion significantly reduces above- and belowground biomass carbon and increases fire-driven losses. Re-establishing native sagebrush is critical for carbon recovery.	Nagy, R.C., Fusco, E.J., Balch, J.K, Finn, J.T., Mahood A., Allen, J.M., & Bradley B.A. . A synthesis of the effects of cheatgrass invasion on US Great Basin carbon storage. J Appl Ecol. 2020;00:1–11. https://doi.org/10.1111/1365-2664.13770
The Carbon Security Index: A novel approach to assessing how secure carbon is in sagebrush ecosystems within the Great Basin	Introduces a tool (CSI) to evaluate rangeland carbon vulnerability. Shows that protecting intact sagebrush cores is key to long-term carbon security and informing restoration priorities.	O'Connor, R. C., Boyd, C. S., Naugle, D. E., & Smith, J. T. (2024). The Carbon Security Index: a novel approach to assessing how secure carbon is in sagebrush ecosystems within the great basin. Rangeland Ecology & Management, 97, 169-177.
Spatial and temporal changes in ecosystem carbon pools following juniper encroachment and removal	Western juniper encroachment alters carbon storage, especially in surface soils and litter layers under tree canopies. After juniper removal, surface carbon pools remain altered for years, suggesting that brush management influences near-surface carbon cycling even in the medium term	Throop, H. L., & Lajtha, K. (2018). Spatial and temporal changes in ecosystem carbon pools following juniper encroachment and removal. Biogeochemistry, 140(3), 373-388.

Title	Brief Summary	Suggested Citation
Cheatgrass Percent Cover Change: Comparing Recent Estimates to Climate Change–Driven Predictions in the Northern Great Basin	Fire and cheatgrass invasion fragment sagebrush ecosystems, reducing forage and habitat for species such as the greater sage grouse. Future climate models indicate that cheatgrass cover may increase slightly, raising fire risk in critical habitats.	Boyte, S. P., Wylie, B. K., & Major, D. J. (2016). Cheatgrass percent cover change: comparing recent estimates to climate change– driven predictions in the northern Great Basin. Rangeland Ecology & Management, 69(4), 265-279.
Biological soil crusts are more prevalent in warmer and drier environments within the Great Basin ecoregion: implications for managing annual grass invasion	Biocrusts, such as lichens and mosses, thrive in arid conditions and help prevent dominance by invasive annual grasses. Their role is especially important in sagebrush ecosystems to maintain resistance to vegetation change.	Condon, L. A., Bradford, J. B., & Coates, P. S. (2024). Biological soil crusts are more prevalent in warmer and drier environments within the Great Basin ecoregion: implications for managing annual grass invasion. Restoration Ecology, 32(6), e14150.
Climate Change Vulnerabilities and Adaptation Options for Forest Vegetation Management in the Northwestern USA	Dry forests face increasing threats from drought, wildfire, and insect outbreaks under climate change. Adaptation strategies focus on building resilience and reducing stressors to sustain forest ecosystems.	Halofsky, J. E., & Peterson, D. L. (2016). Climate change vulnerabilities and adaptation options for forest vegetation management in the northwestern USA. Atmosphere, 7(3), 46.
Effects of Changing Climate on the Hydrological Cycle in Cold Desert Ecosystems of the Great Basin and Columbia Plateau	The Great Basin and Columbia Plateau are warming, with increased drought frequency, expanded invasive grasses, and longer wildfire seasons. Adaptation strategies include managing water, controlling invasive species, and planning for ecosystem transitions.	Snyder, K. A., Evers, L., Chambers, J. C., Dunham, J., Bradford, J. B., & Loik, M. E. (2019). Effects of changing climate on the hydrological cycle in cold desert ecosystems of the Great Basin and Columbia Plateau. Rangeland Ecology & Management, 72(1), 1-12.
Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives	Adaptive strategies for federal forests include altering stand and landscape structures, moving species, and regional planning to increase ecological resilience. Legal flexibility exists, but social and economic barriers may limit implementation.	Spies, T. A., Giesen, T. W., Swanson, F. J., Franklin, J. F., Lach, D., & Johnson, K. N. (2010). Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landscape ecology, 25, 1185-1199.
A Stream Evolution Model Integrating Habitat and Ecosystem Benefits	Beaver dams play a key role in restoring stream hydrology by altering water flow patterns, which can mitigate floods, support base flows, and improve degraded stream conditions. Flow states at beaver dams are highly dynamic and responsive to short-term hydrological events like rainfall, suggesting restoration planning should account for this variability.	Cluer, B., & Thorne, C. (2014). A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications, 30(2), 135-154.
State of Washington Oregon Spotted Frog Recovery Plan	This plan outlines comprehensive strategies for Oregon Spotted Frog recovery, including habitat protection, restoration, and potential reintroduction into suitable areas.	Hallock, Lisa. 2013. Draft State of Washington Oregon Spotted Frog Recovery Plan. Washington Department of Fish and Wildlife, Olympia.
Persistence at distributional edges: Columbia spotted frog habitat in the arid Great Basin, USA	Active beaver presence significantly enhances habitat for Columbia spotted frogs by creating deeper water, emergent vegetation, and stable hydroperiods. Persistence at range edges is facilitated by permanent water, connectivity, predator-free refugia, and beaver-engineered habitats.	Arkle, R. S., & Pilliod, D. S. (2015). Persistence at distributional edges: Columbia spotted frog habitat in the arid Great Basin, USA. Ecology and Evolution, 5(17), 3704-3724.

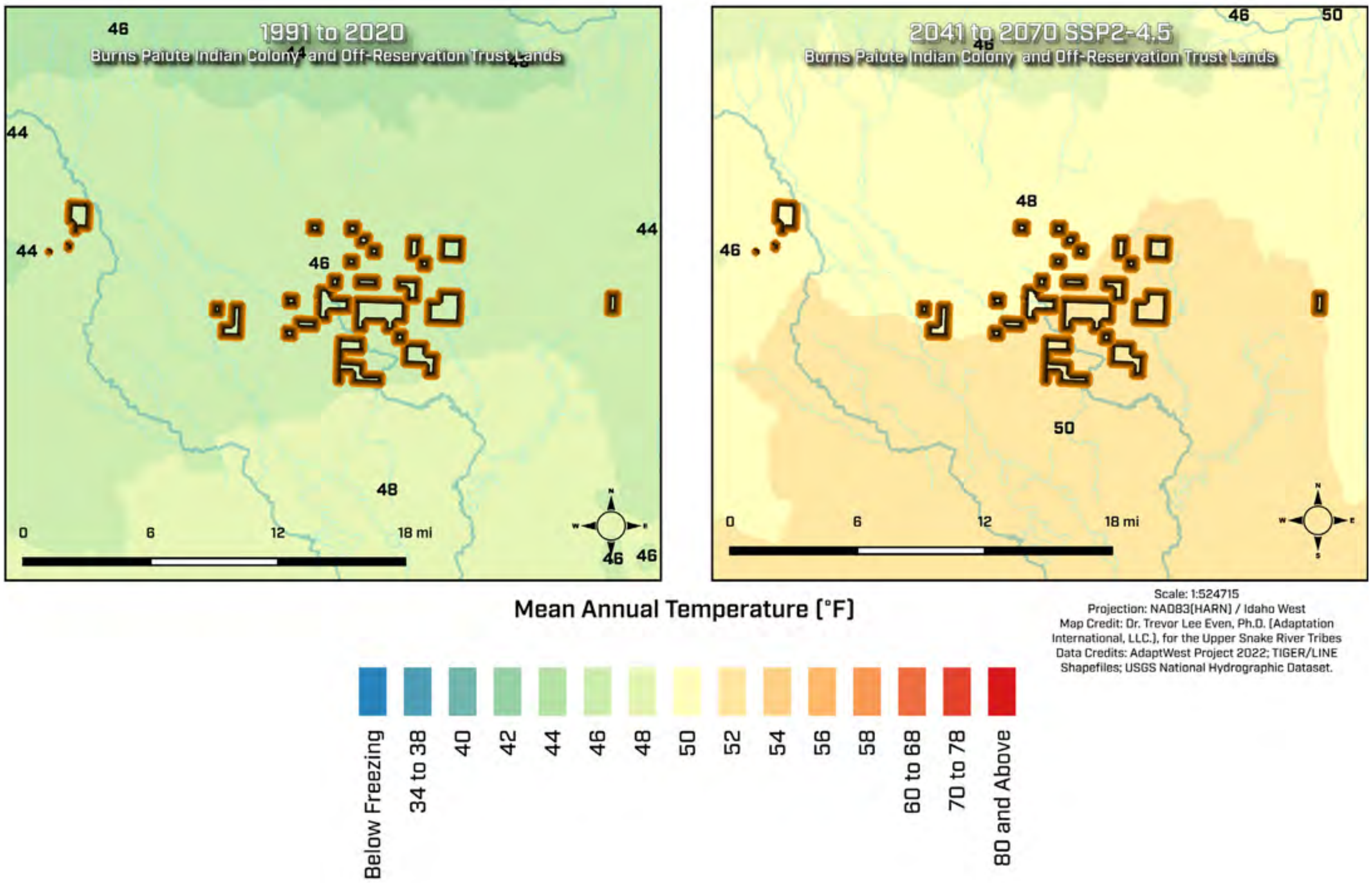
Title	Brief Summary	Suggested Citation
Short Term Dynamics of Beaver Dam Flow States	Beaver dams play a key role in restoring stream hydrology by altering water flow patterns, which can mitigate floods, support base flows, and improve degraded stream conditions. Flow states at beaver dams are highly dynamic and responsive to short-term hydrological events like rainfall, suggesting restoration planning should account for this variability.	Aguirre, I., Hood, G. A., & Westbrook, C. J. (2024). Short-term dynamics of beaver dam flow states. Science of the Total Environment, 919, 170825.
Relocated beaver can increase water storage and decrease stream temperature in headwater streams	Beaver relocation can create significant surface and groundwater storage while cooling downstream streams by ~2.3°C within a year. The effectiveness of relocation depends on site-specific floodplain and stream morphology.	Dittbrenner, B. J., Schilling, J. W., Torgersen, C. E., & Lawler, J. J. (2022). Relocated beaver can increase water storage and decrease stream temperature in headwater streams. Ecosphere, 13(7), e4168.
Beaver: The North American freshwater climate action plan	Beaver-based restoration—through relocation, mimicry, and coexistence—can enhance climate resilience by improving water quality, biodiversity, and floodplain connectivity. Strategic implementation offers untapped potential for restoring degraded streams	Jordan, C. E., & Fairfax, E. (2022). Beaver: The North American freshwater climate action plan. Wiley Interdisciplinary Reviews: Water, 9(4), e1592.
Water Is Life: Importance and Management of Riparian Areas for Rangeland Wildlife	Riparian areas are critical habitats in arid rangelands, supporting 70–80% of terrestrial wildlife during drought and providing ecosystem services. Restoration and management improve resilience to drought, wildfire, and flooding.	Maestas, J. D., Wheaton, J. M., Bouwes, N., Swanson, S. R., & Dickard, M. (2023). Water is life: Importance and management of riparian areas for Rangeland Wildlife. In Rangeland Wildlife Ecology and Conservation (pp. 177-208). Cham: Springer International Publishing.
Rediscovering, reevaluating, and restoring Entiatqua: Identifying pre-Anthropocene valleys in North Cascadia, USA	Post-Anthropocene changes have simplified historically complex river-wetland corridors, contributing to salmon habitat decline. Reconstructing pre-disturbance conditions informs restoration priorities.	Powers, P., Staab, B., Cluer, B., & Thorne, C. (2022). Rediscovering, reevaluating, and restoring Entiatqua: Identifying pre-Anthropocene valleys in North Cascadia, USA. River Research and Applications, 38(9), 1527-1543.
Habitat Guidelines for Mule Deer	Provides ecoregion-specific guidelines to maintain and restore mule deer habitats in the Colorado Plateau, considering major impacts and contributing ecological factors.	Watkins, B. E., C. J. Bishop, E. J. Bergman, A. Bronson, B. Hale, B. F. Wakeling, L. H. Carpenter, and D. W. Lutz. 2007. Habitat Guidelines for Mule Deer: Colorado Plateau Shrubland and Forest Ecoregion. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies.
Low-Tech Process-Based Restoration of Riverscapes Design Manual	Practical manual for implementing BDAs and PALS to restore connectivity, slow water, and promote self-sustaining recovery in degraded channels. Reinforces the philosophy of "letting the system do the work" — a key foundation of Tribal low-tech strategies.	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. Available at: http://lowtechpbr.restoration.usu.edu/manual
Process-based Principles for Restoring River Ecosystemsv	Defines core principles of process-based restoration, emphasizing restoration of natural hydrologic, sediment, and biological processes rather than constructing static habitat features. Highlights the need to align actions with a site's natural potential and scale restoration to watershed-level drivers.	Beechie, Timothy J., David A. Sear, Julian D. Olden, George R. Pess, John M. Buffington, Hamish Moir, Philip Roni, and Michael M. Pollock. "Process-based principles for restoring river ecosystems." BioScience 60, no. 3 (2010): 209-222.

Title	Brief Summary	Suggested Citation
Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (Oncorhynchus mykiss)	Watershed-scale evidence that BDAs increase juvenile steelhead density, survival, and habitat complexity in degraded streams. Demonstrates how beaver colonization and nature-based structures promote ecosystem recovery.	Bouwes, N., Weber, N., Jordan, C.E., Saunders, W.C., Tattam, I.A., Volk, C., Wheaton, J.M. and Pollock, M.M., 2016. Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (Oncorhynchus mykiss). Scientific reports, 6(1), p.28581.
Using BDAs for Fish and Wildlife Recovery on Public and Private Rangelands in Eastern Oregon	Case study on BDAs adoption across private and public rangelands, emphasizing ecological benefits and social/policy challenges. Highlights the importance of landowner collaboration and permitting guidance, relevant for Tribal stakeholder partnerships and expanding beaver-based restoration on working lands.	Davee, Rachael; Gosnell, Hannah; Charnley, Susan. 2019. Using beaver dam analogs for fish and wildlife recovery on public and private rangelands in eastern Oregon. Res. Pap. PNW-RP-612. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 29 p.
Riverscapes as natural infrastructure: Meeting challenges of climate adaptation and ecosystem restoration	Advocates treating riverscapes as natural climate-adaptation infrastructure, emphasizing space for rivers to flood, move sediment, and support wetlands. Reinforces Tribal approaches that center nature-based climate resilience over grey infrastructure.	Skidmore, P., & Wheaton, J. (2022). Riverscapes as natural infrastructure: Meeting challenges of climate adaptation and ecosystem restoration. Anthropocene, 38, 100334.
Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands	Satellite-based evidence that low-tech methods including BDAs structures boost vegetation productivity and ecological resilience across semiarid rangelands. Supports Tribal land-scale restoration by demonstrating long-term, scalable ecosystem benefits.	Silverman, N.L., Allred, B.W., Donnelly, J.P., Chapman, T.B., Maestas, J.D., Wheaton, J.M., White, J. and Naugle, D.E., 2019. Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands. Restoration Ecology, 27(2), pp.269-278.
Riparian Restoration	This USDA guide introduces foundational principles for protecting and restoring riparian ecosystems, emphasizing education, adaptive management, and monitoring. It highlights common impacts—particularly those linked to recreation—and provides practical planning and design strategies that align well with low-tech and process-based approaches for culturally grounded, land-stewardship-led restoration in Tribal watersheds.	Ellen (Charlotte Ellen) Eubanks ; Technology & Development Program (U.S.); Technology & Development Center (San Dimas, Calif.); United States. Bureau of Land Management San Dimas, Calif. : U.S. Dept. of Agriculture, Forest Service, Technology & Development Program; 2004
River regulation, decline of ecological resources, and potential for restoration in a semi-arid lands river in the western USA	Explores hydropower and irrigation impacts on the Upper Snake River, showing how altered flows and sediment supply degrade ecosystem integrity. Provides ecological justification for process-based and hydrologic reconnection strategies central to Tribal watershed restoration.	Hauer, F. R., & Lorang, M. S. (2004). River regulation, decline of ecological resources, and potential for restoration in a semi-arid lands river in the western USA. Aquatic Sciences, 66, 388-401.
Protecting and Restoring Riparian Areas	Reviews ecological functions of riparian zones and policy mechanisms for their protection and restoration. Highlights the importance of coordinated Tribal, federal, and local action to safeguard culturally and ecologically significant waterways.	Kusler, J. (2016). Protecting and restoring riparian areas. Association of State Wetland Managers. Windham, ME.

Title	Brief Summary	Suggested Citation
Standards for ecologically successful river restoration	Establishes five criteria for restoration success, emphasizing measurable ecological improvement, resilience, and transparent monitoring. Supports Tribal adaptive management and accountability frameworks.	Palmer, M.A., Bernhardt, E.S., Allan, J.D., Lake, P.S., Alexander, G., Brooks, S., Carr, J., Clayton, S., Dahm, C.N., Follstad Shah, J. and Galat, D.L., 2005. Standards for ecologically successful river restoration. Journal of applied ecology, 42(2), pp.208-217.
Incorporating climate change projections into riparian restoration planning and design	Provides strategies to integrate climate and hydrologic forecasts into restoration planning, including species selection, flood regime design, and adaptive management. Highly applicable to Tribal climate resilience and future-condition planning.	Perry, L. G., Reynolds, L. V., Beechie, T. J., Collins, M. J., & Shafroth, P. B. (2015). Incorporating climate change projections into riparian restoration planning and design. Ecohydrology, 8(5), 863-879.
Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats	Foundational guide outlining structured, process-based approaches to river and watershed restoration, supported by global case studies. Provides planning frameworks and implementation strategies that help Tribal restoration teams develop context-specific, watershed-scale programs grounded in hydrologic and geomorphic processes.	Roni, P., & Beechie, T. (Eds.). (2012). Stream and watershed restoration: a guide to restoring riverine processes and habitats. John Wiley & Sons.
Riverscapes as natural infrastructure: "Meeting challenges of climate adaptation and ecosystem restoration"	Argues for managing river corridors as natural infrastructure to buffer climate-driven flooding, drought, and wildfire. Highlights the need to restore floodplain connectivity and natural flow processes — a core principle in Tribal process-based restoration and watershed climate resilience strategies.	Skidmore, P., & Wheaton, J. (2022). Riverscapes as natural infrastructure: Meeting challenges of climate adaptation and ecosystem restoration. Anthropocene, 38, 100334.
The science and practice of river restoration	Reviews advances in river restoration, emphasizing process-based methods, social-ecological systems thinking, and the importance of climate adaptation and measurable outcomes. Aligns with Tribal efforts to pair ecological processes with cultural values and local stewardship.	Wohl, E., Lane, S. N., & Wilcox, A. C. (2015). The science and practice of river restoration. Water Resources Research, 51(8), 5974-5997.

Appendix B - Historic and Future Climate

BURNS PAIUTE RESERVATION



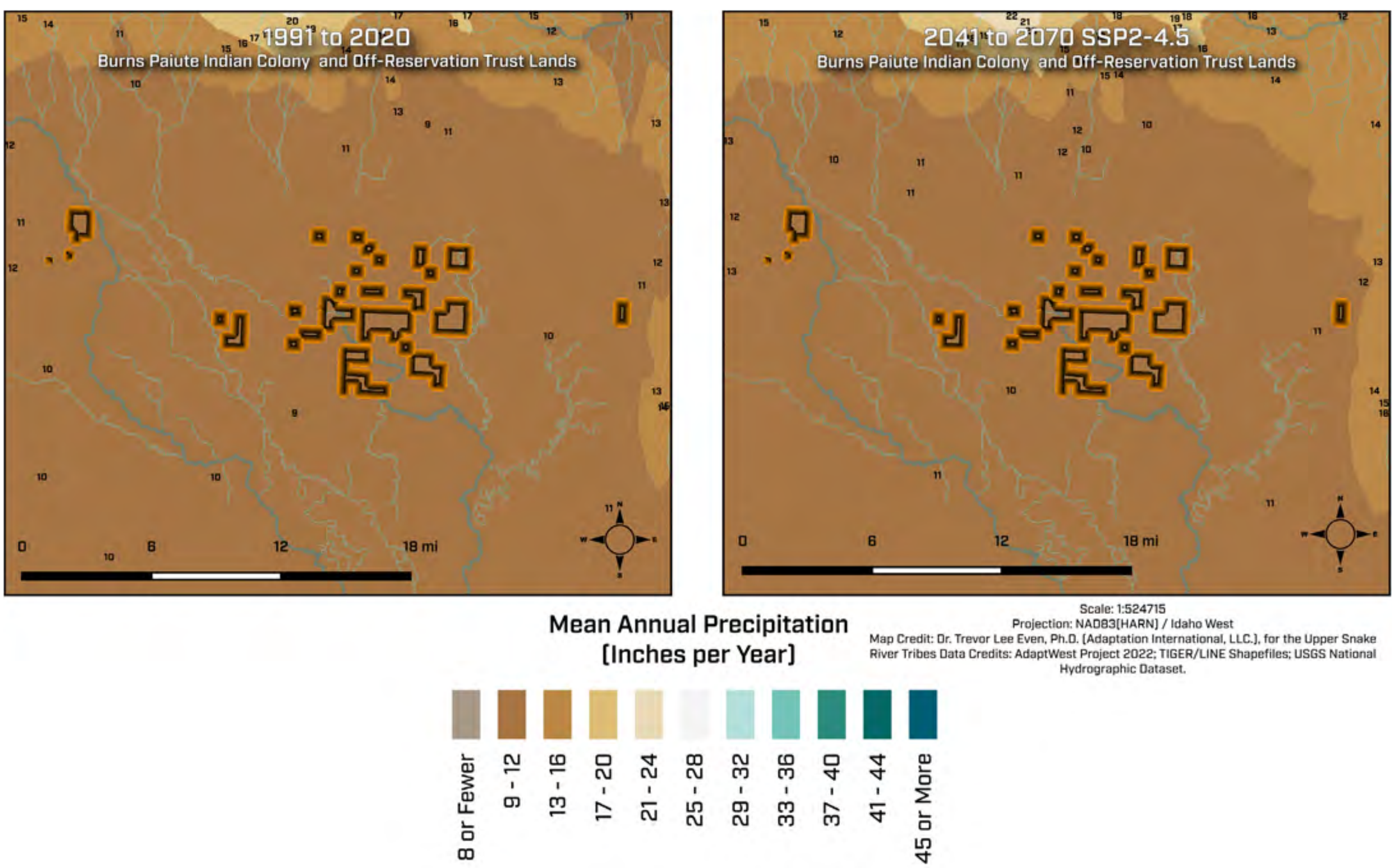
Burns Paiute Indian Reservation and Off-Reservation Trust Lands Mean Annual Temperatures, 1991-2020 and 2041-2070 projections.

Because most of the Burns Paiute Tribal Reservation (BPT) and Off-Reservation lands are located in the greater Malheur Lake basin lowlands, there is relatively little temperature variation across the tribal territory, with average annual temperatures ranging between 44 °F and 46 °F between the reservation holdings near BPT and the off-reservation parcels south of Harney. Like other USRT tribal communities, the BPT sees dramatic seasonal variations in temperature, with weather station records at the Burns Municipal Airport showing December average daily lows of 14 °F, and July average highs of 87 °F for the 1973 to 2025 period. December is generally the coldest month, with record lows of -30 °F recorded as recently as December 12, 2021. July and August regularly vie for the hottest month, with all time high of 107 °F recorded on July 12, 2002, and the second highest day, August 2, 2024, showing 104 °F. Spring onset generally begins in April, with the average last frost sometime in late May. As a result, the frost-free season is just over 160 days long, making spring and early summer water management a critical facet of the tribe's agricultural operations.

Burns Paiute Tribe: Scenario	Time Period	Average Temperature [°F]	Growing Degree Days [°F]	Number of Frost-Free Days [days]	Number of Days >= 100 ºF [days]	Normal Length of Growing Season [days]
Modeled Historical	1991 to 2020	48.4	2139.6	216.4	0.9	163.1
Middle of the Road / Current Trajectory (SSP2-4.5)	2041 to 2070	+3.1	+572.3	+24.7	+3.9	+21.4
Middle of the Road / Current Trajectory (SSP2-4.5)	2071 to 2100	+4.3	+813.5	+33.7	+6.8	+29.0

Burns Paiute Indian Reservation and Off-Reservation Trust Lands Mean Annual Temperatures, 1991-2020 and 2041-2070 projection Reservation and Off-Reservation Trust Lands Mean Annual Precipitation, 1991-2020 and 2041-2070 projection.

Future projections for the region depict a significantly warmer reality, with ensemble mean projections under the current emissions trajectory yielding a 3 °F increase by the 2041 to 2070 period, and a 4 °F increase by the end of the century. These changes result in a significantly longer growing season – nearly 40% longer, in terms of total growing degree days – and up to a month more frost-free days by the end of the century. These shifts also result in an increase in extreme heat index conditions, as well as an increase in the number of days above 100 °F. As a result, outdoor workers, livestock, wildlife, and river systems will all face increasing stress in this already dry region. Vegetation, while benefiting from warmer temperatures in the spring and autumn, may see reduced productivity in the hotter mid-summer months, and will generally experience more rapid drying during periods of low rainfall. Stream temperatures may also see notable increases, especially in areas with limited riparian vegetation cover.



Burns Paiute Indian Reservation and Off-Reservation Trust Lands Mean Annual Precipitation, 1991-2020 and 2041-2070 projection.

Precipitation variation across the BPT is also minimal, due to the generally consistent elevation gradient across the tribe's land holdings in the Malheur Lake Basin, with the area as a whole seeing around 11 inches of rainfall per year, and around 38 inches of total snowfall. Nearby mountains to the north and northwest provide critical snowpack and river flows to the region, and can see much higher precipitation and snowfall totals, however. As a result, the winter and spring months are the most critical when determining the region's water year conditions, with December generally being the wettest month at the Burns Municipal Airport Station with 1.6 inches on average. July and August are generally very dry, with averages of just 0.3 inches per month for the 1973 to 2025 period.

Future projections for the area suggest that increased precipitation may occur, with 11% increases projected by the 2041 to 2070 period under current emissions trajectories, and a 16% increase possible by the end of the century. Fall and Winter precipitation are the most consistent contributors to these increases in this scenario. However, higher temperatures across the region will lead to overall reductions in the total amount of precipitation falling as snow. This will lead to both lower total snowpacks in many years, as well as the faster melting of snowpack in both local mountain ranges and in upper portions of the Silvies River Basin. This will mean faster, more dramatic runoff in the spring, and more intense dry periods in the late summer. Additionally, water systems will be stressed by increased demands from vegetation, and an atmosphere more conducive to evaporation. These challenges will be combined with the possibility of increased storm intensity in the region, as well as the increased risk of flash floods that come as a result. Future water and land management will likely benefit from efforts to restore watershed vegetation communities, ensure healthy riparian ecosystems, and improve water conservation.

Burns Paiute Shoshone Tribe Reservation: Scenario	Time Period	Precipitation [in]													
		Annual		Annual Frozen		Spring		Summer		Fall		Winter		Max 3-day	Maximum
Modeled Historical	1991 to 2020	11		3.3		3.2		1.8		2.4		3.6		0.9	
Middle of the Road / Current Trajectory (SSP2-4.5)	2041 to 2070	+1.2	+11%	-0.4	-13%	+0.5	-1%	0.0	-1%	+0.2	+8%	+0.6	+16%	+0.1	+10%
Middle of the Road / Current Trajectory (SSP2-4.5)	2071 to 2100	+1.8	16%	-0.7	-21%	+0.5	+17%	+0.3	+17%	+0.3	+12%	+0.7	+19%	+0.1	+16%

Burns Paiute Indian Reservation and Off-Reservation Trust Lands Mean Annual and Seasonal Precipitation, 1991-2020 and 2041-2070 projection.

Appendix C - Upper Snake River Tribes Low Tech Process-Based Restoration

Prepared by: Boyd Bouwes, Watershed Solutions, Inc. Scott Shahverdian, Anabranch Solutions

1. PROJECT SUMMARY

This assessment serves as an appendix to the Upper Snake River Tribes Riparian Restoration Toolkit. The Toolkit provides a shared, tribally grounded framework for process-based riparian restoration, this assessment applies those concepts across four reservation landscapes to identify riverscape condition, recovery potential, and priority areas for action. The Riparian Restoration Toolkit was developed through a collaboration between the Upper Snake River Tribes Foundation (USRT) and its member tribes (the Burns Paiute Tribe, the Fort McDermitt Paiute and Shoshone Tribe, the Shoshone-Bannock Tribes, the Shoshone-Paiute Tribes), Adaptation International, and Watershed Solutions, Inc. (WSI) to advance LTPBR practices across tribal lands in the Upper Snake River Basin. The project integrates geomorphic assessment, Indigenous Knowledge, and applied low-tech restoration techniques to support ecosystem recovery and climate resilience.

2. PURPOSE

The purpose of this assessment is to identify opportunities for improving riverscape conditions on lands stewarded by the Upper Snake River Tribes. The USRT Assessment builds upon methodologies and conceptual frameworks developed in the Panther Creek Riverscapes Assessment (2019) and Conceptual Restoration Plan (2019). These frameworks provided a model for linking geomorphic condition, recovery potential, and restoration prioritization to tribal objectives for watershed stewardship. The same process-based restoration approach—emphasizing the protection of intact processes, reconnection of floodplains, and restoration of structural elements such as large wood additions and beaver activity—is applied across the Upper Snake River Tribes' watersheds to guide restoration strategy and prioritization. This assessment provides an adaptation of those frameworks, aligning geomorphic and biological data with Indigenous priorities for ecological restoration, climate adaptation, and cultural resilience.

HOW TO USE THIS ASSESSMENT

Readers are encouraged to use this assessment alongside the Toolkit as follows:

1) Review the Toolkit to understand restoration processes and tools.
2) Consult the USRT Assessment to understand landscape-level opportunities and constraints.
3) Identify priority areas within each reservation based on process potential.
4) Select restoration approaches consistent with Toolkit guidance.
5) Apply monitoring and training frameworks described in this appendix.
6) Adapt and refine approaches through shared learning and observation.

Used together, the Toolkit and this assessment support Tribally led, locally informed, and scientifically defensible restoration across the Upper Snake River Tribes.

HOW THE TOOLKIT AND ASSESSMENT WORK TOGETHER

The Toolkit is designed to be used first, providing readers with:

- A shared understanding of riparian and meadow processes.
- An overview of low-tech, process-based restoration approaches.
- Guidance on monitoring, adaptive management, and workforce development.

The USRT Riverscape Assessment then:

- Applies those concepts across four Tribal reservation landscapes.
- Describes riverscape condition, recovery potential, and constraints.
- Highlights opportunities for restoration focused on springs, seeps, floodplains, and mesic meadows.
- Provides context for prioritization rather than prescriptive project design.
- This assessment is not a project list. Instead, it serves as a decision-support tool to help Tribes:
- Focus limited resources where restoration processes are most likely to succeed.
- Align restoration actions with hydrologic realities.

3. GEOMORPHIC AND ECOLOGICAL SETTING

Watersheds in the aboriginal territory of the USRT member Tribes span a gradient from confined mountain canyons to unconfined alluvial valleys, with corresponding shifts in geomorphic processes and restoration opportunities. Classifying valley settings by confinement (confined, partly confined, unconfined) provides a consistent framework for understanding recovery potential across USRT member Tribes territories. Valley setting and reach type strongly determine the range of feasible restoration actions. For example, confined reaches are suited to conservation and wood recruitment strategies, while partly confined and unconfined reaches provide opportunities for LTPBR such as BDAs, PALS, and LWD.

3.1 Geomorphic Condition and Recovery Potential

The watersheds can be classified into geomorphic condition classes (good, moderate, poor) and corresponding recovery potential tiers (intact, high, moderate, low). This classification provides a predictive understanding of where restoration will yield the most rapid ecological benefits. Reaches in moderate condition with high recovery potential often provide the best return on investment for process-based actions, whereas poor condition reaches may require longer-term, staged recovery efforts.

4. LIMITING FACTORS AND RESTORATION POTENTIAL

Limiting factors across the watersheds include grazing, reduced habitat complexity, floodplain disconnection, loss of beaver and large wood, altered sediment and temperature regimes, and channel simplification. Restoration opportunities should therefore prioritize "letting the system do the work" by reinstating structure and hydrologic connection rather than relying on engineered channel forms.

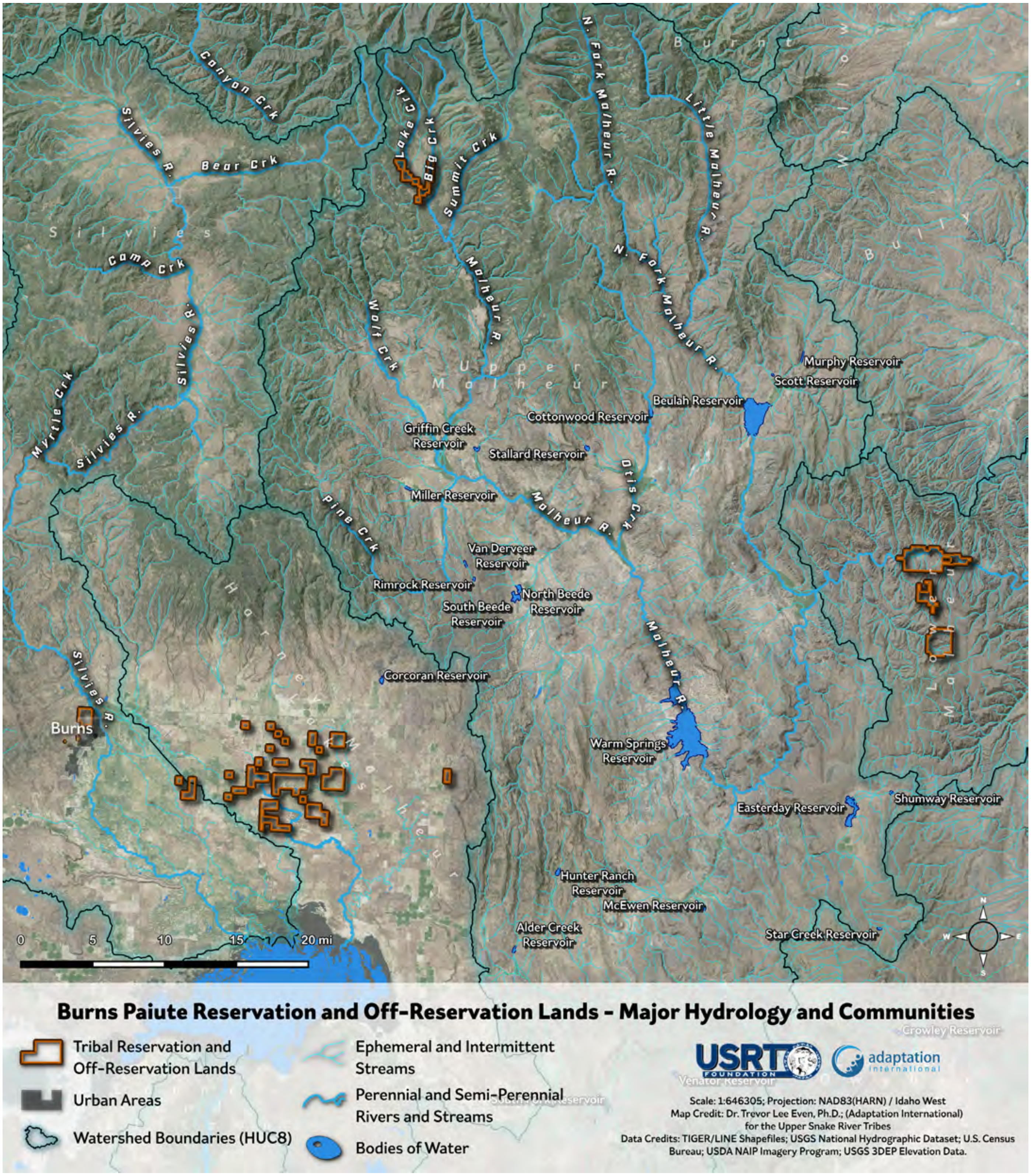
Restoration should focus on the following:

- Protect high-quality habitats and maintain natural processes (align with USRT conservation goals).
- Remove barriers and reconnect disconnected habitats (align with Clean Water Act and fish passage objectives)
- Restore long-term processes (riparian function, sediment and wood recruitment, floodplain connection)
- Restore short-term processes (habitat complexity, wood and beaver reintroduction, temperature refugia)

5. REPORT STRUCTURE

This toolkit presents the assessment for the Burns Paiute – Burns Paiute Tribe. Separate toolkit versions were developed for each of the Upper Snake River Tribes and are available at: http://uppersnakerivertribes.org/projects/Restoring-Rivers

6. BURNS PAIUTE RESERVATION



Burns Paiute Reservation hydrology and community (source: USRT).

The Burns Paiute Tribal Reservation (BPT) restoration focuses on a set of key perennial stream systems that support ecological function, cultural use, and long-term water resilience across the off-reservation lands. These streams—including Hunter Trail and South Trail Creek (Jonesborough property), Beech Creek and Little Beech Creek, and Lake Creek and Big Creek (Logan property).

Hydrologically, these streams are characterized by perennial flow sustained by groundwater inputs, springs, and valley-bottom storage, making them particularly important in an otherwise water-limited landscape. Their headwaters, floodplains, and adjacent wet meadows play a critical role in maintaining baseflow, moderating water temperature, and supporting late-season water availability. While springs, seeps, and wet meadows occur throughout the landscape, their primary importance in this setting lies in their function as supporting systems that sustain and stabilize perennial streamflow, rather than as isolated restoration targets.

Historic land use practices—including channel straightening, floodplain disconnection, grazing pressure, and wet meadow drainage—have altered many of these stream corridors. In several locations, channels have become incised or confined, reducing floodplain interaction and diminishing the ability of these systems to store and slowly release water. These impacts have increased sensitivity to drought and climate variability and reduced the resilience of riparian vegetation and aquatic habitat along streams such as Beech creek, Little Beech Creek, and tributary reaches of Hunter Trail and South Trail Creek.

Restoration planning for the Burns Paiute off-reservation lands, therefore, emphasizes process-based recovery of perennial stream corridors, with targeted actions focused on reconnecting channels to their floodplains, restoring valley-bottom function, and reinforcing groundwater–surface water interactions. LTPBR approaches—implemented strategically along Hunter Trail, South Trail Creek, Beech Creek, Little Beech Creek, Lake Creek, and Big Creek—are well suited to this landscape because they can be adapted to individual reaches while contributing to broader watershed-scale recovery. When paired with monitoring that emphasizes baseflow persistence, floodplain inundation, riparian vegetation response, and channel stability, this approach provides a realistic, defensible, and Tribally grounded pathway for restoring and sustaining the Burns Paiute Tribe's priority perennial stream systems.

Burns Paiute Assessment

The Burns Paiute Reservation is highly discontinuous, consisting of numerous parcels that are not always connected. This assessment focused on parcels and creeks identified by project partners, including:

- Hunter Trail (Jonesborough property).
- South Trail Creek (Jonesborough property).
- Beech Creek.
- Little Beech Creek.
- Lake Creek (Logan property).
- Big Creek (Logan property).

HUNTER CREEK

- Perennial tributary to the Malheur River, confluence located ~8 km east of Juntura, Oregon.
- Maximum basin elevation is 1,710 m (5,610 ft).
- Valley width 25 – 50 m.
- Incision trench width 5 – 15 m.
- Slope 2 – 5%.
- Riparian species can be found within the incision trench, on an inset floodplain. Riparian abundance varies throughout the area.

Upper Hunter Creek on Burns Paiute land, example of limited riparian species. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

RESTORATION POTENTIAL, LTPBR, AND POTENTIAL LIMITING FACTORS

- LTPBR is unlikely to reverse the significant incision that has taken place on Hunter Creek, but it does have the ability to improve riparian conditions within the incision trench, especially where riparian abundance is low.
- At present, Hunter Creek has a limited capacity to support beaver. The sustainability of beaver within the potential project area depends significantly on conditions found on lower Hunter Creek, which was not visited during the field reconnaissance.
- BDAs or PALS structures could increase channel-floodplain connectivity and increase water availability for riparian vegetation, as well as increase instream habitat for redband trout.
- The width of the incision trench limits the possible expansion of riparian areas, since LTPBR is unlikely to reverse the large-scale incision that has already taken place.
- Location high in the drainage (limited drainage area) suggests that peak flows are limited and geomorphic changes are likely to be limited.

Upper Hunter Creek on Burns Paiute land, example of limited riparian species. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

SOUTH TRAIL CREEK

- Intermittent tributary to the Malheur River.
- Coarse substrate.
- Slope 3 – 6%.
- Confined.
- Limited riparian vegetation.

RESTORATION POTENTIAL, LTPBR, AND POTENTIAL LIMITING FACTORS

- Intermittent conditions are an important natural constraint on riparian extent in South Fork Trail Creek.
- LTPBR may be able to increase temporary water storage and riparian expansion in the valley bottom, but whether or not it leads to a shift in vegetation from upland to riparian composition is influenced by natural streamflow conditions.
- South Trail Creek does not have the capacity to support long-term persistent beaver dam activity.

South Trail Creek on Burns Paiute land, example of a low-flow section of stream. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

South Trail Creek on Burns Paiute land, example of a dry section of stream. Photo taken August 12, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

BEECH CREEK

Beech Creek on Burns Paiute land, showing significant riparian vegetation within an inset floodplain. Photo taken August 13, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

- Tributary to the John Day River at Mt Vernon, Oregon.
- Currently has capacity to support moderate beaver dam; historically likely supported abundant beaver dams.
- Valley bottom width ranges 100 – 200 m.
- Slope ~1%.
- Channel flows within an incision trench.
- There is a significant riparian area, but as a percentage of the valley bottom, riparian vegetation is limited.

LITTLE BEECH CREEK

- Tributary to Beech Creek.
- Valley bottom width 20 – 50 m.
- Slope 1 – 4 %.
- Moderate riparian abundance.
- No evidence of beaver activity in recent historic aerial imagery.
- Currently has capacity to support moderate beaver activity.

Little Beech Creek on Burns Paiute land, supporting significant cottonwoods and riparian vegetation within an inset floodplain. Photo taken August 13, 2025 (credit: Boyd Bouwes, Watershed Solutions, Inc.)

RESTORATION POTENTIAL, LTPBR, AND POTENTIAL LIMITING FACTORS

- Both Beech Creek and Little Beech Creek have the ability to support beaver dam activity.
- Large wood (i.e., wood jams) may be an important habitat feature in Beech Creek where estimated Q2 > 300 cfs.
- LTPBR can facilitate beaver activity by creating deep water habitat.
- Instream structures such as BDAs and PALS can increase instream habitat complexity and cover for fish.
- Limited riparian extent, especially large wood, mean large wood inputs are likely to be limited in the absence of restoration.

LAKE CREEK AND BIG CREEK

Due to their similar location and characteristics, Lake Creek and Big Creek are discussed together:

- Located in the headwaters of the Malheur.
- Elevation 1,530 m (5,020 ft).
- Maximum basin elevation 2,450 m (8040 ft).
- Valley bottom width 200 + m.
- Slope < 1%.Multiple historic channels are visible in aerial imagery.
- Big Creek currently has a riparian area that supports a mix of woody and herbaceous riparian species; Lake Creek is currently dominated by herbaceous riparian vegetation.
- Reference conditions on both creeks would include a high water table, abundant riparian vegetation, and would likely support multiple channels.

RESTORATION POTENTIAL, LTPBR, AND POTENTIAL LIMITING FACTORS

- LTPBR could improve channel-floodplain connectivity across a range of flow conditions, leading to expanded riparian areas and increased water storage (i.e., wetland conditions) along Lake Creek and Big Creek.
- BDAs and PALS can increase channel complexity to benefit instream species.
- BDAs and PALS could activate side channels.

Burns Paiute Conclusion

Restoration priorities for the BPT are associated with the off-reservation lands. Streams such as Hunter Trail and South Trail Creek (Jonesborough property), Beech creek and Little Beech Creek (tributaries to the John Day River), and Lake Creek and Big Creek (Logan property**)** provide year-round surface water, sustain riparian vegetation, support fish and wildlife habitat, and hold cultural significance for the Burns Paiute Tribe. Protecting and restoring the function of these streams is central to long term watershed resilience and Tribal stewardship.

Hydrologic analysis and field observations indicate that while these streams maintain perennial flow, their long-term condition is closely tied to floodplain connectivity, valley-bottom storage, and groundwater interaction. Historic channel modification, floodplain disconnection, and land use pressures have reduced the ability of many reaches to access adjacent floodplains, store sediment, and slowly release water through dry periods. As a result, restoration success in these systems should be evaluated not by increases in peak flow, but by improvements in baseflow persistence, floodplain inundation frequency, riparian vegetation recovery, and channel stability.

Process-based restoration approaches are well suited to the Burns Paiute landscape because they can be applied incrementally across diverse ownerships, while reinforcing natural hydrologic and geomorphic processes. Strategic use of LTPBR actions along priority reaches of Hunter Trail, South Trail Creek, Beech Creek, Little Beech Creek, Lake Creek, and Big Creek can reconnect channels to floodplains, enhance valley-bottom storage, and strengthen groundwater-surface water linkages that sustain perennial flow. These actions, when paired with monitoring, provide a realistic and defensible pathway for restoring ecological function while supporting cultural values and long-term water security.

Taken together, the Burns Paiute restoration strategy emphasizes protecting existing perennial streams, restoring the processes that sustain them, and building resilience to future climate variability. By focusing on priority stream corridors and integrating restoration across off-reservation lands, the Tribe is positioned to achieve meaningful, landscape-scale outcomes that honor cultural connections, support ecological recovery, and reinforce Tribal sovereignty and stewardship for future generations.

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Upper Snake River Tribes Foundation & Watershed Solutions, Inc. (2025). Riparian Restoration Toolkit: Draft Report.

Appendix D – Wetland and Riparian Plant Guide

From the Wetland Restoration Guide for Culturally Significant Plants of the Burns Paiute Tribe, Fort McDermitt Paiute and Shoshone Tribe, the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation, and the Shoshone-Paiute Tribes of the Duck Valley Reservation. To access the full resource, contact Dennis (Dennis.daw@usrtf.org).

BURNS PAIUTE PLANTS OF ETHNOSIGNIFICANCE

Traditional Name	Scientific Name	Common Name	Ethnosignificance
Wanasi, keka	*Allium spp.*	Wild Onion	Wild onions are gathered and used as sustenance and mixed with meats.
Unknown	*Astragalus leptaleus*	Park Milk-vetch	Known for potential medicinal applications.
Wanapi	*Apocynum cannabinum*	Indian Hemp or Hemp Dogbane	Fibers historically used for making ropes, nets, and clothing. Medicinally it was used for treating various ailments and issues associated with the heart and lungs.
Passigo'	*Camassia leichtlinii*	Camas	Larger bulbs of camas are used as a staple food and as a sweetener.
Koogi Paazigo (blue camas)	*Camassia quamash*	Camas	Camas roots (bulbs) are a staple food. They are harvested, cooked, and eaten as a nutritious food source.
Unknown	*Carex*	Sedges	Could be used medicinally for general sickness.
Syybi	*Cornus sericea*	Redosier Dogwood (Red Willow)	Bark used ceremonial as part of smoking practices. Stems were used for weaving and basket making and in cradle boards.
Saiby	*Schoenoplectus acutus*	Tule or Hardstem Bulrush	Used for making mats, baskets, ceremonial plant, and other traditional uses. The seeds are also edible and can be ground into flour.
	Potamogeton spp.	Sago Pondweed	Sago pondweed is an important food source, with its starchy rhizomes being harvested and eaten.
Seebi	*Salix sp.*	Willow	Has a variety of uses including making of baskets, bowls, trays and cradle boards.
	Salix amygdaloides	Peachleaf Willow	Potentially used for in traditional crafts and unknown medicines.
Togo or Togoyabi	*Salix boothii*	Booth's Willow	Potentially used for in traditional crafts and unknown medicines.
Togo or Togoyabi	*Salix exigua*	Coyote Willow or Narrowleaf Willow	Commonly used for basketry and crafting tools.
Togo or Togoyabi	*Salix geyeriana*	Geyers's Willow	Used medicinally for pain relief.
Togo or Togoyabi	*Salix lutea*	Yellow Willow	Potentially used for in traditional crafts and unknown medicines.
	Scirpus americanus	Common Three-square	Unknown use.
Unknown	*Typha spp.*	Cattail	Cattails are used for weaving baskets, mats, and other traditional crafts. The roots and shoots are also edible and have been used as a food source.

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The Upper Snake River Tribes Foundation (USRT) would like to acknowledge and thank all of the Tribal staff and Tribal members who contributed to the development of the toolkit through site visits and sharing knowledge about their reservations. USRT would also like to thank Adaptation International, Watershed Solutions, and Mizuna Creative for their contributions to the project and the Bureau of Indian Affairs for its generous funding of this project. Access the full digital version of the toolkit at https://uppersnakerivertribes.org/projects/Restoring-Rivers.

Front and Back Cover: Big Creek, Logan Valley in the Burns Paiute Reservation. August 13, 2025.
Photo: Boyd Bouwes, Watershed Solutions, Inc.