



## **Increasing rangeland resilience through collaborative, climate-adaptive, community-engaged rangeland restoration with the Ute Mountain Ute Tribe in Southwestern Colorado, USA**

Lockard, EL<sup>1</sup>; Bradbury, ES<sup>2</sup>; Bruegger, RA<sup>3</sup>; Stoner, D<sup>4</sup>; Swartz, EH<sup>2</sup>; Havrilla, CA<sup>2</sup>

<sup>1</sup>Colorado State University Extension Montezuma County, Cortez, CO 81321, USA, emily.lockard@colostate.edu; <sup>2</sup>Dept. Forest and Rangeland Stewardship, Colorado State University, Fort Collins, CO; <sup>3</sup>Colorado State University Extension Western Region, Grand Junction, CO;

<sup>4</sup>Natural Resources Department, Ute Mountain Ute Tribe, Towaoc, CO

**Key words:** community-based restoration; Indigenous peoples; ecological restoration; climate adaptation; seed-based restoration

### **Abstract**

Seed-based restoration of degraded landscapes in dryland systems often fails to result in desired revegetation. Locally specific strategies are needed to overcome barriers to native plant establishment. To meet these challenges, we convened a collaborative team that emphasises relationship building, including scientists from the United States Geological Service (USGS), Colorado State University (CSU) and CSU Extension (CSUE) at the request of Ute Mountain Ute Chairman Heart to bring restoration research to Tribal lands in southwestern Colorado, USA. Our team has continued to focus on restoring ecosystem structure and function, improving productivity for grazing and ensuring access to cultural resources.

In 2020, collaboration with the Ute Mountain Ute Tribe (UMUT) began, and two experimental sites were established: a USGS RestoreNet (Field Trial Network for Dryland Restoration) plot and a culturally important location for hyperlocal seed-based restoration questions and treatments rooted in Indigenous knowledge systems. In the first phase, we explored local challenges and tested innovative approaches, informed by community input, Western scientific literature and traditional ecological knowledge. Using an intentionally scaled approach and rigorous scientific methods, the sites test climate-adaptive restoration treatments in 4-m<sup>2</sup> plots including ground modifications, seeding vs. outplanting seedlings, herbicide treatments to suppress invasive species, and others.

Preliminary results show effective restoration strategies include imprinting the landscape with pits, outplanted restoration islands and the importance of integrated invasive species management. Equally importantly, we have built relationships and met Tribal needs through education and outreach.

Since 2020, we have gained insight into the challenges and successes of working collaboratively across a land-grant university, tribal government, governmental institutions and other community groups. By honouring different perspectives and expertise, we are creating actionable science and building relationships essential to the restoration, future grazing and long-term health of arid systems on Tribal lands.

## **Introduction**

Arid and semiarid (dryland) ecosystems cover roughly 40% of the earth's land surface, provide critical ecosystem services and are increasingly prone to degradation associated with climate change (Hoover et al. 2020). Following degradation, recruitment of native plants through natural recovery is often unsuccessful. Similarly, seed-based restoration in dryland systems often fails to result in desired revegetation (Shackelford et al. 2021). Barriers to native plant establishment from seed include water limitation, extreme temperatures, depleted soil and competition with invasive species (Shackelford et al. 2021). Acknowledging these challenges, we sought to explore reasonable treatments that could be applied at scale when attempting to restore lands in dryland ecosystems.

On Tribal lands, the challenges to restoration are exacerbated by the reduction of Indigenous peoples' sovereignty, land dispossession, ongoing displacement, oppression and heightened climate change vulnerabilities (Archuleta et al. 2015, Farrell et al. 2021). Recognising the multifaceted barriers to restoration, the team decided to investigate active restoration techniques on a small scale that could be practical and applied at the large scale needed for the region on rangelands. Locally specific, culturally informed and scientifically grounded strategies are needed to develop appropriate and effective restoration approaches (Wickham et al. 2022).

To meet these challenges, at the request of UMUT Chairman Heart to bring restoration research to Tribal lands in southwestern Colorado, we convened a collaborative team that emphasises relationship building, starting in 2021. This team includes staff from UMUT Environmental Programs, the Dryland Ecology and Management Lab at CSU, CSUE, and the United States Geological Survey (USGS) RestoreNet team. Building on the networked trials from the USGS RestoreNet team, we were able to install a RestoreNet research site incorporating treatments of interest to UMUT Environmental Programs staff to meet the needs of their restoration goals, that are appropriate for the environment and community cultural values (Laushman et al. 2022, Long et al. 2020). As we collaboratively developed potential treatments, we kept the goal of increasing forage for livestock grazing and the practical application of treatments in mind so successful treatments could be scaled in the future. Project collaborators were also able to openly communicate about the needs for staff funding and labour to make this project possible.

As the 10-year RestoreNet project continues, our team and projects have expanded beyond our initial rangeland restoration project. Building on RestoreNet, a second experiment site was established in 2022, at a culturally important location to test additional hyperlocal seed-based restoration questions and treatments rooted in Indigenous knowledge systems.

## **Methods**

### ***Frameworks and principles for collaborative restoration projects with Indigenous peoples***

The collaborators in this project came with various levels of experience and expertise in working with traditional ecological knowledge, rangeland restoration, Land Grant Universities and/or Tribal Nations. We have looked to team members' experience as well as others who have demonstrated successful collaborations addressing ecological restoration and specifically collaborative projects with Tribal Nations (Wickham et al. 2022, Long et al. 2020). This project is one of many that are partnering U.S. academic institutions and government agencies, as well as their policies, protocols and scientific bodies of knowledge, to support the sovereignty and implementation of Indigenous knowledges. Throughout the project, the aim of researchers embedded in U.S. institutions is to provide resources and expertise while following the lead of the UMUT's community members and staff. By honouring and weaving these different ways of knowing, we work towards repairing relationships between human and ecological functions (Robinson et al. 2021).

### ***Relationship building and goal setting***

Building relationships and establishing new collaborative research projects has, in our experience, taken time and required consistency in the people and entities involved. CSU/CSUE staff's initial collaboration with the UMUT on rangeland restoration projects was due to chance meetings, planned organisational meetings,

community listening sessions and persistence from both sides. These relationship-building efforts are what brought Chairman Heart to an online stakeholder meeting hosted by local, regional and on-campus CSU faculty introducing the idea and gauging community interest in a land restoration project. This meeting was followed by an in-person site tour and then a request to bring dryland restoration research to UMUT land (Laushman et al. 2022).

### ***From ideas to implementation***

Translating ideas to implementation would not have been possible without dedicated Tribal collaborators who continue to engage with this project and navigate Tribal approval processes. From the beginning, clear communication and expectations ensured we were able to meet each other's needs. Additionally, a data-sharing agreement to protect and describe when data could be shared or used between partners was a critical aspect of project development and ensuring findings from Tribal lands were shared in a manner that respects Tribal sovereignty.

### ***Leveraging a regional restoration field trial network (RestoreNet) to meet local needs***

First, in 2021, local, regional and on-campus faculty from CSU/CSUE and the Tribal staff collaborated with the USGS to establish a RestoreNet site (Havrilla et al. 2020, Laushman et al. 2022), a distributed dryland restoration field trial, on UMUT Tribal land to test restoration treatments of interest. Using an intentionally scaled approach and rigorous scientific methods, the sites test climate-adaptive restoration treatments in 4-m<sup>2</sup> plots including ground modifications, seeding vs. outplanting seedlings, and other locally identified treatments of interest including *Tamarisk sp.* (saltcedar, a common invasive tree in the area) mulch and polymer beads. As a large-scale networked restoration trial network RestoreNet, led by USGS in partnership with universities and a variety of research partners, tests consistent treatments across environmental gradients but also allows for additional local questions. A desire to ask additional hyperlocal questions outside the RestoreNet framework at a slightly more mesic site led to the establishment of a second experiment.

### ***Place-based restoration trials at a culturally important site***

Second, we established a separate field site for restoration research at a culturally important location to test additional hyperlocal seed-based restoration questions and treatments rooted in Indigenous knowledge systems. Treatments at this site included the use of locally available materials left over from cultural harvest practices, and low-tech rock structures rooted in Indigenous knowledge to slow and spread water (Martin et al. 2010). The strength of this project has been a focus on local place-based treatments and culturally relevant practices valued by members of the team and the communities in which they live.

## **Results**

### ***RestoreNet***

Preliminary results from the RestoreNet site demonstrate that imprinting pits (modelled after waffle gardens used by Indigenous peoples across the Southwest) and covering the soil with mulch have increased seed germination. These two techniques increase water retention and soil nutrient availability. Further, seedlings that were grown in a greenhouse, then outplanted to the site show promise, as a higher percentage of these seedlings have survived and flourished over the three years since the site was established than seeded species. This result indicates that restoration islands, a technique in which small groups of seedlings are planted, then self-seed to increase the native plant community, may be beneficial for restoration in the area (Davies et al. 2020).

### ***Place-based restoration***

While seeded species recruitment has been limited, this site has emphasised the need to consider integrated invasive species management as an essential aspect of restoration work at this location of cultural importance. Of the treatments tested, low-tech rock structures that slow and spread sheet water flows and coarse woody debris that creates favourable microclimates at the soil surface seem to be the most effective.

### **Meeting local needs**

Through these projects, we have also gained insights on collaboration, building trust and respecting the many ways of knowing. We have learned that thoughtful consideration can make implementing new ideas more successful. Ensuring all partners are invited to participate throughout a process including in the planning process, implementation on site and to provide feedback as a plan is developed, ensures an investment and sense of ownership in the project's long-term success.

As a result of trust building, sharing and discussing results, we have also created interest in larger-scale studies and projects that can take what we have learnt and apply it at scale, leveraging what we have learnt about treatments and species success to be more successful with future restoration projects. Also, building relationships and discussing local needs led to the development of different types of collaboration to address further needs related to rangeland health and management. Through collaboratively organising educational workshops for ranchers or sourcing funding for rangeland monitoring, collaborations stemming from one rangeland research project have grown to include multiple projects to meet many different community-based goals.

### **Discussion**

Since 2020, we have gained insight into the challenges and successes of working collaboratively across a land-grant university, Tribal government, governmental institutions and other community groups. By honouring different perspectives and expertise, we are creating actionable science and building relationships essential to the restoration, future grazing and long-term health of arid systems on tribal lands.

The continued efforts of many individuals led to effective working relationships. From this foundation, we can continue to further expand projects to meet the rangeland restoration needs of the Tribe. We can also reflect on our successes and struggles to continue to improve working relationships, community outreach and understanding the strengths that come from respecting many ways of knowing and the many ways we can understand, relate to and value rangelands.

### **Acknowledgements**

We thank the UMUT, including Chairman Manuel Heart for leadership; Hannah Ertl for contributions to establish the research sites; and Farley Ketchum Sr., Ben Robinson and Scott Clow for continued collaboration and support. We thank the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) and USDA Northern Plains Climate Hub, Cooperative Ecosystem Studies Unit (CESU) (Award Number: NR223A750023C019) for providing the funds necessary to support research at the culturally important location.

### **References**

- Archuleta J, Beeton T, Benally G, Clow S, Connolly M, Cuthair V, Ertl H, Hammond A, Hammond G, Howe B, Johnstone T, King-Washington T, Knight T, Larrick C, McNeeley S, Mills RA, Morris F, Munoz H, Pelt I, Rangwala I, Taylor N, Wall H, Wells G, Whiteskunk S (2015) Ute Mountain Ute Tribe Climate Action Plan, Towaoc, CO, USA.
- Davies KW, Bates JD, Clenet D (2020) Improving restoration success through microsite selection: an example with planting sagebrush seedlings after wildfire. *Restoration Ecology* 28: 859–868.
- Farrell J, Burow PB, McConnell K, Bayham J, Whyte K, Koss G (2021) Effects of land dispossession and forced migration on Indigenous peoples in North America. *Science* 374(6567).
- Havrilla CA, Munson SM, McCormick ML, Laushman KM, Balazs KR, Butterfield BJ (2020) RestoreNet: an emerging restoration network reveals controls on seeding success across dryland ecosystems. *Journal of Applied Ecology* 57(11), 2191–2202.
- Hoover DL, Bestelmeyer B, Grimm NB, Huxman TE, Reed SC, Osvaldo S, Seastedt TR, Wilmer H, Ferrenberg S (2020) Traversing the wasteland: a framework for assessing ecological threats to drylands. *BioScience* 70(1), 35–47.
- Laushman KM, McCormick ML, Munson SM, Balazs KR, Butterfield BJ (2022) Protocol for installing and monitoring a RestoreNet restoration field trial network site. U.S. Geological Survey, Techniques and Methods 2–A18, Reston, Virginia, USA.

- Long JW, Goode RW, Lake FK (2020) Recentring ecological restoration with tribal perspectives. *Fremontia* 48(1), 14–19.
- Long JW, Lake FK, Goode RW, Burnette BM (2020) How traditional tribal perspectives influence ecosystem restoration. *Ecopsychology* 12(2), 71–82.
- Martin JF, Roy ED, Diemont SA, Ferguson BG (2010) Traditional Ecological Knowledge (TEK): ideas, inspiration, and designs for ecological engineering. *Ecological Engineering* 36(7), 839–849.
- Robinson JM, Gellie N, MacCarthy D, Mills JG, O'Donnell K, Redvers N (2021) Traditional ecological knowledge in restoration ecology: a call to listen deeply, to engage with, and respect Indigenous voices. *Restoration Ecology* 29(4).
- Shackelford N, Paterno GB, Winkler DE, Erickson TE, Leger EA, Svejcar LN, Suding KL (2021) Drivers of seedling establishment success in dryland restoration efforts. *Nature Ecology & Evolution* 5(9), 1283–1290.
- Wickham SB, Augustine S, Forney A, Mathews DL, Shackelford N, Walkus J, Trant AJ (2022) Incorporating place-based values into ecological restoration. *Ecology and Society* 27(3).