Colorado Plateau Native Plant Program 2017 Annual Meeting. February 28 – March 2, Monticello, UT

Four Corners School Canyon Country Discovery Center

Submitted presentation descriptions & abstracts in order.

Not all presentations will have descriptions or abstracts and/or some are not yet finalized.

This is a first posting to inform those interested in registering for the meeting. A final document may be posted later or handed out at the Meeting.

Beginning morning February 28:

Stella M. Copeland[1], John B. Bradford[2], Bradley J. Butterfield[1], Seth M. Munson[2], David S. Pilliod[3], Justin L. Welty[3]. 1 Northern Arizona University, Flagstaff, AZ; 2 U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ 3 U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise ID

Long-term trends in restoration and associated land treatments in the Southwest United States

Restoration treatments, such as re-vegetation with seeding or invasive species removal, have been applied on United States public lands for decades. Temporal trends in these management actions have not been extensively summarized previously, particularly in the southwestern US where invasive plant species, drought, and fire have altered desert ecosystems. We assessed long-term (1940–2010) trends in restoration using approximately 4000 vegetation treatments conducted on Bureau of Land Management (BLM) lands across the southwestern U.S. We found that since 1940, the proportion of seeding and vegetation/soil manipulation (e.g. vegetation removal or plowing) treatments have declined while prescribed burn and invasive species treatments have increased. Treatments in pinyon-juniper and big sagebrush communities have declined, while treatments in desert scrub, creosote bush, and riparian woodland communities have increased. There has been an increasing frequency of restoration-focused objectives along with an increase in the number of species and the proportion of native species in seed mixes. Inflation-adjusted cost per area has risen in the decades from 1981–2010 for vegetation/soil manipulation, seedings, and prescribed burn treatments. Seeding treatments were implemented in wetter and warmer years relative to several years before and after the treatment and warmer and drier years when compared to the climate conditions of the entire study period (1935-2015). These results document shifts in treatment practices on public lands in the southwestern US over 70 years, and suggest that treatments are increasingly large, expensive, and related to wildfire and invasive species control.

Travis Nauman, U.S. Geological Survey, Southwest Biological Science Center, Moab, UT

Disturbance Automated Reference Toolset (DART): Prioritizing ecological rehabilitation from energy development on the Colorado Plateau.

A new disturbance automated reference toolset (DART) was developed to monitor human land surface impacts using soil-type and ecological context. DART identifies reference areas with similar soils, topography, and geology; and, based on a satellite vegetation index, compares the disturbance condition to the reference area condition using a quantile-based approach. DART identifies sites that

have excessive bare ground exposure and depressed vegetation cover when comparing sites using the Soil Adjusted Total Vegetation Index (SATVI). Assessment of ecological recovery at oil and gas pads on the Colorado Plateau revealed that more than half of well-pads were below the 25th percentile of reference areas, particularly in grasslands, blackbrush (Coleogyne ramosissima) shrublands, arid canyon complexes, and warmer areas with more summer-dominated precipitation. State administered areas also had significantly lower recovery rates than other land holdings. Results showcase the usefulness of DART for assessing discrete

Rob Massatti and Troy Wood, Southwest Biological Science Center - USGS Flagstaff, AZ

The applicability of next-generation sequencing (NGS) to native plant materials development including a case study: population structure and local adaptationin Syntrichia (Tortula) ruralis, an important component of biological soil crusts

A fundamental question when developing conservation and restoration plans is how best to match plant materials to target site conditions. Selecting propagules that are locally adapted to the biotic and abiotic conditions they will encounter ensures that resources are used effectively, thereby broadening the reach of restoration and conservation activities. However, for most restoration species, information to guide propagule-site matching is limited. Next-generation sequencing (NGS) may prove to be a fundamental tool to assist plant material selection and development. NGS data have become cost-effective to generate, and the tools to process, analyze, and interpret them are becoming more accessible. I will present examples to illustrate how these data have been used to elucidate historical and contemporary factors influencing the geographic patterns of species' genetic variation, and I will explore how such inferences can impact conservation strategies, such as the development of seed transfer guidelines. Finally, I will describe ongoing NGS work at the Colorado Plateau Native Plant Program, where the goal is to provide the BLM actionable information on restoration species important to the Colorado Plateau.

Biological soil crusts are foundational to natural ecosystem function in semi-arid regions of the world, including the Western U.S. They are composed of phyletically diverse organisms, including microbes, green algae, lichens, and mosses. While diminutive, these assemblages have a large ecological impact - for example, they stabilize soil, fix nitrogen, and store water, nutrients, and organic matter. Importantly, these functions facilitate the establishment of vascular plants. Biocrusts are extremely susceptible to mechanical disturbance and thus have been depleted throughout the semi-arid West. As a result, restoration of functional ecosystems in this region may often depend on the re-establishment of biocrust communities. However, successful restoration must anticipate often extreme environmental gradients, for example the decreasing intensity of monsoonal precipitation on the Colorado Plateau from the Mogollon Rim to the Uinta Basin. Such gradients are expected to select for locally adapted genotypes; consequently, materials for restoration should be sourced carefully to optimize restoration outcomes. Sourcing may be especially important for biocrust mosses, including the widely distributed *Syntrichia ruralis,* which are predominantly asexual and thus may be less able to respond to selection imposed at a restoration site or during materials development. To expand our basic knowledge of biocrusts and gain insight into how best to restore them, we used next-generation sequencing to genotype *Syntrichia ruralis* populations collected across the monsoonal gradient of the Colorado Plateau. We found that populations exhibit significant genetic differentiation, and present evidence that some of this differentiation may reflect local adaptation. The genetic techniques employed here provide a promising and cost-effective mechanism to characterize genetic differentiation and diversity of restoration species, and they may prove to be useful tools to guide future restoration efforts.

Kevin Gunnell and Danny Summers, Utah Department of Wildlife Resources and Great Basin Restoration Center Seed Warehouse, Ephraim, UT

From the Wild to Farm and Back Again: A Strategy for Native Plant Material Development and Utilization

Due to the research and seed procurement provided by the Utah Division of Wildlife Resources (UDWR) Great Basin Research Center, and through the proactive restoration work of Utah's Watershed Restoration Initiative (WRI) the state of Utah is in a unique position to play a role in all aspects of plant material development and utilization in wildland seeding efforts. We review the multiple strategies and efforts of plant material development that the UDWR uses to increase the availability of materials for use in landscape scale restoration and rehabilitation projects throughout the state. We discuss the prioritization and selection of species and ecotypes to meet restoration objectives, the development and testing required for establishment and growth of plant materials in both agronomic and rangeland settings, and the strategy and role of the UDWR in the establishment and maintenance of a commercial market for the procurement and utilization of plant materials in landscape scale restoration efforts. All of the

Kelly Memmott, Dixie and Fishlake National Forests

Common Garden Germination Trial of native and Introduced grasses with multiple treatments/ amendments.

On the conclusion of Phase I, the study of the adaptability of six native grasses; Achnatherum hymenoides, Elymus elymoides, Hesperostipa comata, Koelaria macrantha, Poa fendleriana, and Poa secunda, planted at five sites within the Colorado Plateau, it became necessary to study the success of seeding these species into different rangeland treatment settings. Three accessions of the native species were then seeded into plots that were treated as burned, non-burned, the addition of fire retardant, straw as mulch, and a mixture of both. Two methods of seeding were used, drill (scarified) and broadcast. These native grass species were planted with three of the most seeded introduced species; Agropyron cristatum, Psathyrostachys juncea, and Thinopyum intermedium. Four of the sites from Phase I were used in this study, they were in the Colorado Plateau footprint and within the following National Forest systems; Ashley, Dixie, Fishlake, and Manti Lasal. All four plots were prepared and burned in 2013 and seeded in the fall. The germination resulted in a failure in 2014 so the seeding was repeated again in the fall. Germination was recorded three times during the spring and summer of 2015 and 2016. A photo record was also taken. Results show that Agropyrum cristatum had the best emergence across all aspects of the study. Thinopyrum intermedium was second followed by Achnatherum hymenoides, and Elymus elymoides. Scarified plots (drilled) resulted in nearly five times more emergence than the broadcast plots.

Katrina Tso[1], Brad Butterfield[1], Troy Wood[2]. 1 Northern Arizona University, Flagstaff, AZ; 2 U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ

Genetic and cytotypic variability in a dominant southwestern grass (Bouteloua gracilis): Implications for restoration and seed sourcing

With the increasing frequency of large-scale restoration efforts, the need to understand the adaptive genetic structure of natural populations and their relation to heavily-utilized cultivated surrogates is critical. Bouteloua gracilis, or blue grama grass, is a wind-dispersed, perennial grass with a wide-spread distribution in western North America. The species is often ocally dominant and is used regularly in restoration treatments. Environmental variation, which has been shown to influence functional trait characteristics in blue grama, also is often correlated with patterns of genetic variation in plants in ways that can be inferred to be adaptive. We report initial results from AFLP (Amplified Fragment Length Polymorphism) analysis of blue grama samples representative of the species' habitat diversity on the Colorado Plateau and adjacent regions. These results, along with data on ploidy variation, are being used to guide the selection of new blue grama sources that best complement those currently available on the commercial market.

Carla Roybal, Department of Biological Sciences, Northern Arizona University Brad Butterfield: Merriam-Powell Center for Environmental Research and Department of Biological Sciences, Northern Arizona University Troy Wood: USGS Southwest Biological Science Center

Intra-specific trait variation of Western grasses

Because of the extensive range of many western grasses, heritable, functional variation may arise within a species in response to local factors, such as climate. Better understanding within-species variation may allow land managers to select populations of grass suited to a particular restoration need, such as soil stability or forage quality. Therefore, we conducted a common garden experiment to: 1) investigate the degree of intraspecific variation within 9 different western species, 2) characterize below-ground functional traits, 3) describe below ground functional trait characteristics in relation to aboveground trait axes. In addition to characterizing intraspecific variation, we believe these goals will also help identify relationships between climate and functional trait expression, which will help streamline population selection for restoration seed mixes in the future.

Bruce M. Pavlik and Sarah E. Barlow, Red Butte Garden, U of Utah

Using Rana to Screen Plant Species for Effective Pollinator Support During Ecosystem Restoration

Rana is a motion-activated video system for monitoring insect visitation to flowers. We use it here to evaluate SOS plant species for pollinator support.

Molly McCormick, Northern Arizona University, Flagstaff, AZ

Understanding and Supporting Pollination Systems in Changing Environments

Extensive environmental change is impacting ecosystem services, including pollination. Effects of invasion, phenological shifts, and habitat fragmentation have both positive and negative impacts to the quantity and quality of the pollination interaction. Understanding that mutualistic relationships, like pollination, have complex and nuanced responses to change is essential for improving mitigation efforts. Pollination ecology can be used to inform when and how to intervene in novel or changed ecosystems. In this talk, I will discuss results from various research projects trying to better understand how to support pollinators in arid ecosystems. This includes choosing plant species and planting design, considering site characteristics, and understanding human resources and limitations. Researchers, land

managers, and restoration practitioners can use these tools to increase efficiency in projects aimed at enhancing resiliency in a time of change.

Stanford Young, UCIA, USU

SEED: Species Variability In A Small Package

Seeds are unique iterations of a plant species genetic code. In order to predict how a given seed lot may perform at a specific site, the genetic identity, genetic purity, and mechanical quality factors must be known. All these details are described in the bulletin "How to be a seed connoisseur" developed by the Utah Crop Improvement Association and Utah Seed Laboratory

David L. Hoover1, Michael C. Duniway2 and Troy Wood3 1USDA-ARS, Rangeland Resources Research Unit, Fort Collins, CO; and 2US Geological Survey, Southwest Biological Center, Moab, UT; and 3US Geological Survey, Southwest Biological Center, Flagstaff, AZ

Ecological responses of *Pleuraphis jamesii* to altered intra-annual precipitation patterns

Pleuraphis jamesii is an important C4 grass species that spans a sharp monsoon gradient in the southwest US. This field trial assesses the plasticity of *P. jamesii* to intra-annual variability in precipitation patterns. In particular, we are examining if populations of *P. jamesii*, spanning this monsoon gradient, are adapted to their local precipitation seasonality or if they have plastic responses (in phenology, ecophysiology, and growth) to a different intra-annual precipitation patterns. In the fall of 2014, we collected individuals of *P. jamesii* from four source population sites across a gradient in monsoon intensity (monsoon/annual precipitation) ranging from 0.5 in SE New Mexico to 0.2 in NE Utah, and transplanted them into a common garden field trial at the Canyonlands Research Center near Moab, UT. Between April and September of 2015, plants in the common garden were provided supplemental irrigation to aid with establishment. From March through September 2016 ambient rainfall was excluded from all plots

Molly McCormick, Kate Watters, Anna Schrenk, Friends of Verde River Greenway and Northern Arizona University

Building a Restoration Economy in the Verde Valley with Native Plants

Regional efforts to restore the Verde River watershed are currently underway. However, successful watershed restoration is made possible by a reliable and affordable supply of native plant materials. Currently there is very little native seed production or native plant from local genotypes in Northern Arizona. This has been hindered more by economic and institutional inefficiencies than by biological constraints as multiple entities work independently to meet small-scale restoration needs.
The Verde Native Plant Materials Partnership is a small collective of buyers and growers of native plant materials in the Arizona New Mexico mountains ecoregion consisting of local non-profit organizations, federal and state agencies, the University of Northern Arizona, environmental consulting companies, and the Yavapai-Apache tribe. These stakeholders are working together to identify and produce appropriate native plant materials in the region for public lands and riparian restoration, common garden research, and pollinator conservation. Coordinated production is expected to increase the availability and diversity of plant materials, stimulate the native seed industry, stabilize the seed market, reduce restoration costs, and ultimately improve restoration success.

We are working to meet the demand for local seed while diversifying income for agricultural producers in our region, beginning in 2017 with a one acre pilot grow out for Tonto National Forest, in partnership with the Southwest Seed Partnership. The goal of our partnership to use science and seed transfer zones to reliably produce, clean, store, and ship enough weed-free seeds to meet the demand of small, regional restoration projects

Kathleen Balazs, Brad Butterfield, Northern Arizona University, Flagstaff, AZ

Using species functional traits and local climate variables to predict restoration outcome across the Colorado Plateau

Seed establishment in a restoration setting is likely dependent upon matching species functional traits to local environmental conditions. We tested this prediction by merging a restoration outcomes dataset from the Colorado Plateau with a suite of functional traits derived from databases and local environmental conditions. Results pending final analysis.

March 2:

Ann Marie Aubry and Shannon Hatch, BLM Moab, UT and Tamarisk Coalition

Lessons Learned from Riparian Revegetation

Results from several riparian revegetation projects following Tamarisk removal efforts will be presented. A comparison of several different projects funded by local partnerships (WRI, DRRP and Grand Valley Riparian Restoration Partnership) along the Colorado and Dolores Rivers show mixed results. Appropriate Planning efforts, successful plant species and planting techniques will be highlighted

Rebecca Mann, Liz Ballenger, Mike Duniway, Mark Miller.

Using connectivity Modifiers to restore degraded grasslands in Canyonlands and Arches National Parks

The National Park Service and US Geological Survey are working in collaboration to restore highly degraded grasslands in Arches and Canyonlands National Parks. We are employing novel tactics, designed to overcome the ecological processes that reinforce degraded, weed-dominated plant communities. The key has been to use small barriers that minimize soil erosion and create safe sites for native plant establishment. The success of this approach was revealed in a four-year pilot study, where we observed a 90% establishment rate of native perennial grasses seeded inside the barriers.

Kristina Young, Northern Arizona University Matthew Bowker, Northern Arizona University Sasha Reed, Southwest Biological Science Center Michael Duniway, Southwest Biological Science Center Jayne Belnap, Southwest Biological Science Center

Attempts to restore biological soil crust and stabilizing eroding soils in Bandelier National Monument, NM

Soil erosion is a persistent problem in many dryland systems globally. Continuous soil erosion can lead to loss of top soil, decreased plant-available water, extreme soil surface temperatures, and freeze-thaw activity, all of which hinder vegetation establishment and reduce site productivity. Here, we inoculated plots on the actively eroding Pinyon-Juniper mesa tops of Bandelier National Monument with greenhouse cultured native biocrusts, and administered the erosion intervention treatments of flashing, slash placement, and seeding. While we did not detect an effect of inoculum addition or erosion intervention treatments on soil stability, we did see significant changes to biotic and soil characteristics across the spatial extent of our experiment and over time. Taken together, this research provides an understanding of the intra-annual variation within these dryland systems and bring us closer to developing effective techniques to arrest soil loss in these important social ecological regions.

Owen W. Baughman - University of Nevada, Reno

Collaborations between researchers and practitioners yields practical and informed guidance for seed selection and restoration planning

Addressing the many challenges of restoring native vegetation in highly invaded, semi-arid ecosystems is too large a task for any one organization. Managers at the Winnemucca, Nevada BLM District Office and researchers at the University of Nevada Reno have maintained a productive collaboration that has produced science-based yet practicable guidelines aimed at improving restoration success. In particular, this collaboration has resulted in a simple and rapid method of evaluating and selecting appropriate sources of native seed based on relatively short-term survival and growth under the same kinds of conditions as those encountered during restoration. Additionally, collaborations have identified and demonstrated new opportunities for restoration in exceptionally challenging areas where few options remain. These examples illustrate the value of research-friendly management and management-friendly research in responding to some of the challenges of wildland restorati on.

M.N. Grant-Hoffman, S. Parr, M. Paschke, J. Jonas-Brattens, A. Lincoln, K. Holsinger
BLM Grand Junction Field Office, CO; Upper Colorado Environmental Plant Center, Meeker, CO; Colorado State Universi,ty Fort Collins, CO; BLM Montrose Field Office, CO

Salt desert restoration studies

Restoration of salt desert communities with the use of native plant species can be difficult at best; especially in areas that are dominated by invasive annual species. Establishment of native perennial plants may take several growing seasons when precipitation is minimal, less than 25cm (10in) annually. Invasive annuals, however, may grow and reproduce in years with lower precipitation, therefore increasing their presence in the seed bank and increasing competition for germinating native plants in years with higher precipitation. While the BLM has historically seeded with perennial grasses after disturbance, this technique has had limited success in salt desert communities and may not be appropriate for salt desert habitats. The BLM's Western Colorado National Conservation Areas in partnership with the Upper Colorado Environmental Plant Center (UCEPC) and Colorado State University (CSU) are working towards determining Best Management Practices for salt desert restoration. There are several steps to our proposed project including: a comprehensive literature review which was funded and completed by CSU; collection and grow outs of native shrub species, which was funded and is in progress by UCEPC; seed bank studies in partnership with CSU, for which funding is pending; and on the ground testing of shrub, forb, and some grass materials, along with tests of restoration techniques, which is partially funded. We hope to continue this research with seed bank studies beginning in the

summer of 2017, and on the ground test plots to be installed in Fall 2018. Specific species and techniques to be tested are still being considered but will be based on input from co-authors, other practitioners, the literature review, and previous studies.

Rachel Hosna, CPNPP Great Basin Institute Resource Associate, BLM Moab Field Office, UT

Regional Seed Collection Guidance

One of the most important tasks for an ecoregional program like the Colorado Plateau Native Plant Program (CPNPP) is providing good guidance to seed collectors. Seed is the critical component for all activities related to native plant materials development, but collecting it can be expensive. In an effort to maximize efficiency, the CPNPP will be providing targeted guidance to each of the collecting field offices in 2017. The goal is that the guidance can be easily integrated into any plans that a team may already have in place. This guidance focuses on the Bower et al. 2014 provisional seed zones, looking at which zones may have the greatest utility in terms of total area covered and importance for current and future disturbances. This information is then looked at in the context of what seed is already available according to the CPNPP database. Integrating these two should result in guidance that outlines target areas for collection and a request for collections that is specific to a particular field office. This is still a work in progress; more data about current and future needs would help refine target areas for collection.

Avery Uslaner, Red Butte Botanic Garden at Univ. of Utah, CPNPP Great Basin Institute Resource Associate, BLM State Office, Salt Lake City, UT

Data driven seed collection using Python and weather forecasts

Timing is critical for a successful Seeds of Success collection when the seeds of your target populations are vulnerable to storms or heat waves and are separated by hours of driving. Using the programming language Python coupled with 7-day forecasts and historical weather data, seed collections can be intelligently tracked and scheduled to prioritize collections under threat of anomalous weather events.

Jessi Brunson, BLM Moab Field Office

Vernal Field Office SOS/ Plant Materials Development past, present & future.

The BLM Vernal Field office has been collecting native seeds for the Seeds of Success program for almost 10 years now. We've collected hundreds of amazing species, but we are now thinking bigger. In the past, our seed collection priorities were based on sage-grouse habitat, plants with high pollinator value, CPNPP priorities, and endemic plant communities. We are expanding on that in 2017 by better coordination with other programs in our own office and with state of Utah habitat improvement programs.

Akasha Faist, University of Colorado Boulder, CO and Sasha Reed, USGS Southwest Biological Science Center, Moab, UT

The science of seed banks: providing information about existing soil seed banks to inform management

Active seeding of native plants is a common practice to aid in the recovery of disturbed lands, yet while often used, seeding has been shown to have variable degrees of success. Within these efforts the soil seed bank composition is rarely taken into consideration, but emerging data from a number of ecosystem types suggest that the existing soil seed bank can play an important role in facilitating or hindering active seeding efforts. To identify how seed banks could be used as a tool to augment active restoration, we propose a study to determine soil seed bank species under both disturbed lands and undisturbed reference sites. In particular, our questions are: (1) What is the native and exotic plant potential in the seed banks of the Colorado Plateau? and (2) How do these seed banks vary by land use, soil type, and aboveground plant community composition? The results of the proposed work will inform strategies for using active seeding and existing seed banks to restore native plant communities following common

Jacqualine Grant and Matthew Ogburn, Department of Biology, Southern Utah University, Cedar City, UT

Native plants on green roofs for water conservation, support of native pollinators, and as a seed source for community native landscaping

Green infrastructure is the integration of plants into built environments to manage stormwater, control temperature, or reduce energy costs. One type of green infrastructure, the green roof, has direct application to ecosystem restoration on the Colorado Plateau because green roofs cover rooftops with plants. However, most green roofs do not use native plants. The focus of our research program at Southern Utah University is to increase the use of native plant materials in urban restoration projects and on green roofs throughout the Colorado Plateau. In this presentation we will describe how our research contributes to (1) the increased availability of regionally adapted native plant materials through green roof propagation practices, and (2) community understanding of the values and importance of using native plant materials for ecosystems restoration.

Nora Talkington and Leanna Begay, Navajo Natural Heritage Program, Navajo Fish and Wildlife.

Introduction to the Navajo Natural Heritage Program and the "budding" Navajo Native Plants Program.

The NNHP currently monitors 39 threatened, endangered, and sensitive plant and animal species on Navajo. This information is used to inform the scientific community about the status of species on Navajo and to develop conservation measures for protecting sensitive species from threats such as development, livestock grazing, and oil and gas production. Navajo Fish and Wildlife is currently in the initial stages of developing a Native Plants Program through a partnership with the Navajo Forestry Department. This program will provide riparian and upland plant materials for restoration projects on Navajo, employment for community members, and outreach about native plants and ethnobotanical uses.