Poster Session Monday 2 Abstracts

Poster Session Monday 2: Poster Pod 14, Poster 79

CAPTURING LONG-TERM CHANGE THROUGH REPEAT PHOTOGRAPHY: HISTORIC PHOTOS FROM SOUTHEASTERN UTAH.

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ABSTRACT

Drylands of the Colorado Plateau have displayed varying levels of resilience to historic drivers of environmental change, including climate and land-use. Implications of forecasted increases in aridity and more variable climatic conditions for this region will likely vary   among plant communities, soil types, and topographic settings. An improved understanding of long-term dynamics of Colorado Plateau ecosystems can be used to better understand potential impacts of future climates on these ecosystems, including loss of productivity, exotic species invasion, or shifts in dominant plant species or functional types. In this study, we use historic repeat photography to gain insight into how ecosystems of the Colorado Plateau have responded to past climatic changes and land use. By examining historic on-the-ground oblique photos and comparing with modern images of the same locations, we can observe how plant communities have changed or persisted over multiple decades in a region where there is limited long-term data. Our set of ~1300 photos spans several regions of the Colorado Plateau, including the four National Parks and Monuments within southeastern Utah. We have developed a website to share a representative subset of photos spanning ecosystem types, original photo dates, and amount of change observed. The website includes captions interpreting the scene and observed change using language accessible to the general public. Often, the slow nature of change in dryland plant communities can erroneously lead both expert and casual observers to consider these ecosystems as static, particularly within National Parks. We anticipate this research and coupled outreach material will provide a greater understanding of the dynamic nature of Colorado Plateau ecosystems for both the research and land management community as well as the general public.

LONG-TERM TRAJECTORIES SUGGEST DIVERGENT RESPONSES OF NATIVE AND NON-NATIVE PERENNIALS AND ANNUALS TO MANAGEMENT TREATMENTS

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ABSTRACT

Land managers frequently apply vegetation removal and seeding treatments to restore ecosystem function following woody plant encroachment, invasive species spread, and wildfire. However, the long-term outcome of these treatments is unclear due to a lack of widespread monitoring. We quantified how vegetation removal (via wildfire or management) with or without seeding and environmental conditions related to plant community composition change over time in 491 sites across the intermountain western United States. Most community metrics took over 10 years to reach baseline conditions posttreatment, with the slowest recovery observed for native perennial cover. Total cover was initially higher in sites with seeding after vegetation removal than sites with vegetation removal alone but increased faster in sites with vegetation removal only. Seeding after vegetation removal was associated with rapidly increasing non-native perennial cover and decreasing non-native annual cover. Native perennial cover increased in vegetation removal sites irrespective of seeding and was suppressed by increasing non-native perennial cover. Seeding was associated with higher non-native richness across the monitoring period as well as initially higher, then declining, total and native species richness. Several cover and richness recovery metrics were positively associated with mean annual precipitation and negatively associated with mean annual temperature, whereas relationships with weather extremes depended on the lag time and season. Our results suggest that key plant groups, such as native perennials and non-native annuals, respond to restoration treatments at divergent timescales and with different sensitivities to climate and weather variation.

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SOIL SEED BANKS AND FIRE: BROAD RECOVERY PATTERNS ACROSS FOUR NORTH AMERICAN DESERT SYSTEMS

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ABSTRACT: MS STUDENT

Dryland plant community recovery after wildfire can be variable and legacies of these fires can extend not only to the above ground plant community composition, but also to the soil seed banks. These viable seeds within the soil are the potential plants of the future and seed banks can provide insight into *in situ* site potential. Even with this fundamental role in structuring future plant communities, the degree to which dryland soil seed banks are impacted by fire and their subsequent post-fire succession is poorly understood. To address this knowledge gap, we use a time-since-fire approach to investigate the changes in soil seed bank communities 10 and 30 years after fire (relative to paired unburned sites) and to address the influence of aboveground vegetation and microsites (e.g., shrub and interspace) on seed bank composition. We addressed changes in soil seed bank composition across four North American deserts (Colorado Plateau, Great Basin, Chihuahuan, and Sonoran). Soil samples were collected in the field and a greenhouse emergence technique was used to release and quantify seeds in the soil seed bank. Preliminary results showed that seed bank species richness was highest in the Sonoran desert and lowest in the Colorado Plateau and Great Basin deserts. Soil seed densities were similar across deserts, except for the Sonoran desert, where densities were significantly higher. Seed densities under shrub and interspace microsites tended to vary across deserts and time-since-fire. Interestingly, however, seed bank abundance was generally higher in burned sites relative to unburned sites for the Great Basin, while the opposite trend was found in the Sonoran. By investigating both the above- and belowground plant communities we hope to better understand ecosystem resiliency after fire in dryland systems across the Southwest and provide important information to resource managers considering and prioritizing management actions following fire.

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IMPACT OF LARGE HERBIVORE USE IN MEADOWS ON LENTIC FUNCTION, WETLAND EXTENT, AND VEGETATION HYDRIC STATUS

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ABSTRACT: MS STUDENT

Livestock and wild horses disproportionately favor riparian areas over uplands when seasonal temperatures are high or upland vegetation becomes dry, especially in flatter, more accessible terrain. Long-term trampling by excess or prolonged stocking can cause damage to riparian roots, reducing the riparian extent. This study sought to assess how large herbivore use in meadows may impact riparian plants needed for or leading to lentic functions and related wetland extent (in relation to potential meadow size) and vegetation hydric status (wetness). We examined wild horse and livestock grazing variables of timing, duration, and intensity of livestock grazing, based on the focus provided by the Grazing Response Index to consider opportunities for plant growth. Trail cameras were used to determine the relative amount of livestock and wild horse use at randomly chosen meadows likely to be high quality sage-grouse late-brood rearing habitat in each of seven allotments. Data collected using a modified draft lentic assessment, inventory, and monitoring protocol informed the interpretation of riparian proper functioning condition (PFC) assessments about management for PFC. Lentic PFC assessments indicate that none of the study lentic areas have maintained their size, now less than 60% of potential (PFC Item 3), all have altered flow patterns (Item 6), and all were functional at risk. Meadows were grazed by horses over periods long enough for individual preferred plants to be grazed by horses at least three times. At locations grazed by horses and cattle, the duration over which horse grazing occurred was always longer and the number of days and animal minutes of grazing were greater for horses than cattle. While grazing management tools and strategies apply to livestock. Few are used for wild horses. There appears to be a need to expand tools and strategies for wild horse management for riparian areas, their functions, and values.

AC SALTLANDER GREEN WHEATGRASS AND SMOOTH BROMEGRASS PERFORMANCE UNDER WATERLOGGING, SALINITY AND COMBINED CONDITIONS

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ABSTRACT

Waterlogging, salinity and a combination of the two can greatly inhibit forage growth and productivity in North America. AC Saltlander green wheatgrass (*Elymus hoffmannii* Jensen & Asay, ACS) is an excellent saline tolerant cool season grass with good forage productivity and nutritional qualities, but it's waterlogging tolerance has not been determined. Study objective was to evaluate effects of waterlogging duration, salinity alone and a combination of both on ACS and smooth bromegrass (*Bromus inermis* Leyss., SB) forage yields, nutritive qualities and regrowth. The waterlogging alone experiment occurred in 2016, and the combined waterlogging with salinity (ECe = 8.1 dS·m-1) experiment was conducted in 2017 in a climate-controlled greenhouse. An incomplete Latin square design was used with six treatments [two species (ACS and SB) × three waterlogging duration (no waterlogging, three- and five-weeks continuous waterlogging)] and five replications. The ACS forage yield, plant height, acid detergent fiber (ADF) and neutral detergent fiber (NDF) were higher ($P<0.05$) than SB in either three- or five-weeks waterlogging, salinity alone and a combination of both. Both species resumed regrowth after excess water receded, and their regrowth forage yield and nutritive value were similar in either waterlogging or salinity alone, while ACS regrowth yield was higher ($P<0.05$) than SB in either three- or five-weeks combination of waterlogging and salinity. For both species, forage yield, plant height and total nitrogen were lower ($P<0.05$) while ADF and NDF were higher ($P<0.05$) in the combined waterlogging and salinity treatment compared to waterlogging or salinity alone. AC Saltlander was better than SB to tolerate up to five weeks of waterlogging, salinity or a combination of both. The combination of waterlogging and salinity was more detrimental to ACS and SB forage production than either waterlogging or salinity alone.

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DEVELOPING CONSERVATION MEASURES TO RESTORE AND REHABILITATE RANGELANDS ON DEGRADED SAGE-GROUSE HABITAT IN SOUTHEASTERN OREGON

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ABSTRACT: UNDERGRADUATE STUDENT

The sagebrush steppe is one of the most diverse ecosystems in the United States, yet it is also the most imperiled. Invasive annual grasses (IAGs) are a primary threat, which has led to the precipitous decline of sagebrush obligate species—like the greater sage-grouse. In 2015, the US Fish & Wildlife Service (USFWS), and Soil & Water Conservation Districts across eight eastern Oregon counties developed a Greater Sage-Grouse Programmatic Candidate Conservation Agreement with Assurances (CCAA), which provides landowners enrolled in the program assurances if the sage-grouse is ever listed as an endangered species. Incidentally, the CCAA calls for the development of conservation measures on degraded sage-grouse habitat. Our objective was to determine if fire, herbicide, and mechanical action—combined with seeding native and introduced plants—improved degraded sagebrush rangelands where IAGs were the primary plant functional group in the understory of decadent Wyoming big sagebrush. Four study sites were located within 160 km of Burns, OR between 825-1400 m above sea level. Five treatments and a control were applied within six 30 m x 11 m subplots at the sites. Treatments included a modified rangeland drill (MRD), disking (D), Imazapic+Glyphosate (IG), prescribed burn (PB), and PB+IG. Treatment plots were divided lengthwise according to native (N; bluebunch wheatgrass (*Pseudoroegneria spicata*), bottlebrush squirreltail (*Elymus elymoides*), and Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) or introduced species (I; desert wheatgrass (*Agropyron desertorum*), Siberian wheatgrass (*Agropyron fragile*), and forage kochia (*Bassia protrata*). Annual and perennial grass cover originally consisted of 31± 21%*m-2 and 2±2%*m-2, respectively. Moreover, annual and perennial grass density consisted of 304± 221 individuals*m-2 and 0.2±0.4 individuals*m-2, respectively. Shrub cover and density were 5±5%*m-2 and 0.2±0.2 individuals*m-2, respectively. Overall, our data demonstrate that PB+IG and IG plus seeding were the most effective restoration treatments for perennial bunchgrasses.

COMPETITIVE RELEASE OF A DOMINANT WARM SEASON GRASS IN RESPONSE TO SELECTIVE MORTALITY

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ABSTRACT

The Colorado Plateau has experienced increases in warming and decreases in water availability over the past few decades, with models projecting more frequent and intense droughts over the next century. Because ecosystems of this region are already extremely water-limited, changes in water availability could have large ecological impacts that may differential impact plant functional types. Consequently, these projected changes present substantial challenges to land managers responsible for sustaining or restoring ecosystem services such as livestock forage, wildlife habitat and soil conservation. Here we report the results of a four-year extreme seasonal drought experiment (66% precipitation reduction) imposed on a native semiarid grassland of southeastern Utah and companion plant removal experiment. In the drought experiment, decreased soil moisture in both warm- and cool-season drought plots led to decreased cover of grasses and forbs overall. However, the dominant warm-season grass, *Pleuraphis jamesii* (James' galleta), exhibited an unexpected increase in aboveground biomass in the cool-season drought treatment relative to the control. We hypothesized that this increase was driven by a competitive release mechanism and further investigated these results by conducting a plant removal experiment. Results from this companion experiment suggest that removal of neighboring plant competitors increases water availability to *P. jamesii,* although the magnitude of competitive release is dependent on the neighboring plant functional types. Collectively, these results suggest that seasonal changes in water availability can alter the structure of Colorado Plateau ecosystems by differentially impacting plant species and enabling competitive release of certain dominant grasses.

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WHAT IS ECOLOGICAL DROUGHT IN RANGELANDS? A QUANTITATIVE DEFINITION FROM A BURNED SAGEBRUSH STEPPE

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ABSTRACT

Ecological droughts are water-availability deficits that induce threshold-like ecosystem responses, making them an important aspect of rangeland ecology and management. Ecological droughts may decrease forage availability, shift plant community composition, and reduce restoration success. Although drought impacts are recognizable at the individual plant level, there are few examples where ecological drought has been quantitatively defined at management-relevant scales (i.e., pastures, ecoregions). Traditionally, drought has been determined by coarse drought indices, which such as the duration and magnitude of soil-water deficit that causes plant mortality or establishment failure. Here, we provide a quantitative definition of ecological drought for post-fire establishment of big sagebrush. We identified 627 sites in the Great Basin that burned and were seeded with sagebrush (1979-2009), and asked whether the SPEI drought index or more concise simulations of surface soil-water availability (MPa) would better reveal water availability and duration differences between sites where sagebrush established compared to those where it did not ("successful", or "unsuccessful"). Preliminary results indicate that SPEI values did not differ between successful and unsuccessful sites. In contrast, soil-surface (0-5 cm) water potentials, simulated using weather data and the SoilWat2 model, were greater where sagebrush successfully established. Successful sites remained wetter than -2.5 MPa for 7 more above-freezing days in March than did unsuccessful sites. March is considered a critical time period for germination and initial survival. This small difference in duration of water availability for seedlings during their typical emergence period was highly impactful on restoration outcome. Thus, a seven-day March soil-water availability deficit may represent ecological drought conditions for post-fire sagebrush recovery in this ecoregion. These preliminary findings suggest that translating weather information into soil-water availability can increase our understanding of how water limitation can trigger state changes in rangelands and other ecosystems.

WESTERN JUNIPER WATER UPTAKE AND SOIL MOISTURE RELATIONSHIPS: PAIRED-WATERSHED STUDY IN CENTRAL OREGON, USA

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ABSTRACT: Ph. D STUDENT

This study sought to quantify changes in transpiration with implementation of western juniper (*Juniperus occidentalis*) control in two adjacent juniper-dominated experimental watersheds, wherein one watershed received treatment (treated) and the other served as untreated watershed. Juniper trees were instrumented with sap flow sensors to monitor whole plant water use in mature and juvenile trees in the untreated watershed as well as in sapling trees in the treated watershed where juniper was controlled in 2005 but regrowth has occurred. Additionally, we evaluated soil moisture dynamics at the tree type scale and characterized soil moisture content and transpiration relations among the tree types in both watersheds. Leaf water potentials were monitored for juniper trees to support the data of transpiration. The field data indicates that transpiration varies significantly among juniper types, with values greatest in mature, intermediate in juvenile, and least in sapling juniper trees. Results also showed that mature juniper trees use approximately between 70 to 90 times more water than sapling trees. This supports our hypothesis that there would be great potential for increasing water yield by eliminating the water uptake by juniper trees. In relation to soil moisture, transpiration varies seasonally and annually for all juniper types, with values tending to be higher in the summer season (2.76 and 115.2 liter per day for sapling and mature respectively) for the wet year 2017 compared to higher values in the spring season (1.0, 1.61, and 72.7 liter per day for sapling, juvenile and mature trees respectively) for the dry year 2018. The decreasing range between predawn and midday water potentials for all juniper types with summer progression for the year 2018 indicates lower water consumption as soil drying continues. Our study suggests that a significant amount of water can be saved due to western juniper management.

PERENNIAL GRASS SUPPRESSION OF CHEATGRASS: COMPARISON AMONG TWO NATIVES ONE EXOTIC

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ABSTRACT

Long-term control of the invasive annual grass, cheatgrass, is predicated on its biological suppression. Perennial grasses, which have been shown to effectively suppress cheatgrass, vary in their suppressive ability. We compared the ability of a non-native grass ('Hycrest' crested wheatgrass) and two native grasses (Snake River wheatgrass and bluebunch wheatgrass) to suppress cheatgrass. In a greenhouse setting with separate tubs, 5 replicates of each perennial grass were established for 96 days upon which two seeds of cheatgrass were then sown at distances of 10, 30, and 80 cm from the established plants. Water was not limiting to growth of cheatgrass. Relative to cheatgrass grown at 80 cm, all perennial grasses significantly reduced aboveground biomass at 30 cm (68% average reduction) and at 10 cm (98% average reduction). Sown at 10 cm from established perennial grasses, cheatgrass aboveground biomass was inversely related with perennial grass root mass per unit volume of soil. All cheatgrass sown at 10 cm from 'Hycrest' crested wheatgrass died within 38 days. Before sowing of cheatgrass, soil 10 cm from established perennial grasses had significantly less mineral N than soil taken at 30 and 80 cm. Relative to cheatgrass tissue N for plants grown at 80 cm, cheatgrass nearest to the established perennial grasses contained significantly less tissue N. All perennial grasses inhibited the NO_2^- to NO_3^- nitrification step; for 'Hycrest' crested wheatgrass, soil taken at 10 cm from the plant had a molar proportion of NO_2^- in the NO_2^- + NO_3^- pool of greater than 90%. In summary, a combination of reduced nitrogen availability, occupation of soil space by perennial roots, and attenuation of the nitrogen cycle contribute to suppression of cheatgrass.

TIMING TO GERMINATION BY FUNCTIONAL PLANT GROUPS ACROSS FOUR DIFFERENT DESERTS

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ABSTRACT: UNDERGRADUATE STUDENT

Increasing our understanding of germination timing of rangeland plants has many management applications. The purpose of this study is to compare the timing to germination of core functional plant groups and life cycles from the soil seed bank in four North American deserts. Our research asks, does this timing differ across core functional groups such as grasses, forbs, and shrubs, as well as annuals versus perennial life cycles, and is this relationship maintained across deserts? Understanding timing to germination in these desert ecosystems is critical to helping us achieve our management goals. By better-understanding germination rates from the seed bank, we can time herbicide applications and grazing seasonality and intensity. To assess our questions, we collected seed bank samples from four deserts (Chihuahuan, Colorado Plateau, Great Basin, and Sonoran) and seed germination rates were evaluated in greenhouse emergence trials. To understand timing to germination in our different deserts, we counted individual seedlings emerging from the replicate seed bank samples by functional group on a weekly basis. Initial observations have shown that annuals, regardless of desert, are much faster to germinate as an entire group. Alternatively, perennials, while some had a short time to germination, others had a much more extended time to germination rate than expected. The results from this project can assist rangeland managers to better understand the timing to germination of the functional groups, which can inform management goals including; timing of target grazing, timing of prescribed burns, and timing of reseeding for restoration projects.

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IMPACT OF DEFOLIATION ON AXILLARY BUD ACTIVITY IN SMOOTH BROME (*BROMUS INERMIS* LEYSS.)

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ABSTRACT

Smooth brome (*Bromus inermis* Leyss.) is an introduced cool-season perennial grass that invades rangelands in the Northern and Central Great Plains. Anecdotal data suggests smooth brome may be less abundant when grazed. However, the morphological stage at which grazing can have the greatest impact on smooth brome abundance is unknown. Therefore, we designed a study to determine the impact of defoliation on specific morphological stages of smooth brome. Treatments were 1) defoliated at the 1 or 3 leaf vegetative stage once (V1); 2) defoliated at the 1 to 3 leaf vegetative stage twice (V2); 3) defoliation in the elongation stage (E); 4) defoliation in the reproductive stage (R) and 5) a non-defoliated control (C). Ten smooth brome plants were randomly located and permanently marked in each of 4 non-grazed exclosures at the Northern Great Plains Research Laboratory (USDA-ARS) near Mandan, North Dakota in May 2018. In September, each of the tillers were dug up and taken to a laboratory at Chadron State College, Chadron, Nebraska. Each tiller was dissected, all crown positions were identified as 1) axillary bud, 2) tiller, 3) rhizome, 4) leaf scar or 5) missing. Tillers were placed in stains to determine activity. Active meristematic tissue would stain red in 0.1% TTC, dead meristematic tissue would stain blue and if meristematic tissue did not stain in either solution, they were considered dormant. There were fewer active rhizomes per tillers in the V2 treatment than in the C, E and R treatments (0.33 vs 0.96, 0.94 and 0.96 respectively). Total outgrowth (rhizomes and daughter tillers) per tiller was less in the V2 (1.3) than in the R (1.9) treatment. Additional data is being collected but defoliating smooth brome tillers twice in the vegetative stage appears to best strategy to reduce potential recruitment in this invasive grass.

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COMPLETION AND ANALYSIS OF A TIME-SERIES OF FRACTIONAL COMPONENT COVER ACROSS WESTERN U.S. RANGELANDS

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ABSTRACT

Monitoring temporal dynamics of rangelands to detect and understand change in vegetation cover and composition provides a wealth of information to improve management and sustainability. To this end, western U.S. rangelands were quantified with a series of new annual maps over the Landsat 5-8 archive (1984-2018). These 30-m resolution maps consist of the fractional percent cover of six rangeland components, including of shrub, sagebrush (*Artemisia* spp.), herbaceous, annual herbaceous, litter, and bare ground. Training data for these fractional cover maps were derived from circa 2015 "base" maps completed over the Western United States. We use an automated method to identify change between each year in the Landsat archive and the 2015 base. Next, we use the unchanged portion of the base map to train regression tree models predicting component cover in each year. Cover variability and trends were strongly related to disturbance and climate trends, especially the widespread trend of increasing minimum temperature. Spatial and temporal variation in component cover were robustly related to that observed in the field from 2008-2017 at 134 plots in southwest Wyoming. Interannual variation in climate resulted in similar responses between the field observations and remotely sensed predictions. Moreover, we found strong temporal correlations ranging from an R-squared of 0.42 for herbaceous cover to 0.80 for shrub cover between component cover and predictions derived from a series of high-resolution imagery resampled to 30-m. The results can be used to answer critical questions regarding the influence of climate change and the suitability of management practices in rangeland ecosystems. While some error does exist in the mapping products, we propose that this is a reasonable tradeoff given the extensive spatial and temporal coverage which field data cannot provide.

MONITORING PLANT COMMUNITY CHANGE AT THE JORNADA EXPERIMENTAL RANGE: 100 YEARS OF QUADRAT SAMPLING

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ABSTRACT

The importance of long-term observational data sets as records of ecosystem responses to climatic variation and directional change continues to increase. Ecologists and land managers use such records to ask questions about how ecosystems responded to past climatic variation and perturbations, in order to understand mechanisms behind increase/decline of species of interest, and to inform predictions about future scenarios. Sampling using chart quadrats was a common method in the early 20th century as a means to track availability of perennial grasses and other species as forage for livestock. At the Jornada Experimental Range in southern New Mexico, chart quadrat sampling began in 1915 and continues through the present, with permanent quadrat locations being resampled approximately every 5 years. Using this detailed record we can not only investigate trends in grass cover, but also track variation in other plant community properties (e.g. species richness, species turnover, abundance distributions) as the system experienced severe droughts, variation in quantity and timing of yearly precipitation, and an overall trend of shrub encroachment over the past 100 years. Like many desert rangelands in the southwest, cover of perennial grasses such as black grama (*Bouteloua eriopoda*) has declined dramatically since the early 1900s. In recent samples, there is some evidence that cover of *B. eriopoda* has increased slightly on the quadrats where it has remained, likely the result of new recruits rather than existing individuals increasing in size. We also found that while species richness has remained fairly constant during the past 20 years, rates of turnover were also high, with rates of 50% turnover on average during each 5-year sampling interval. These results contribute to the broader picture of ecosystem dynamics at the Jornada Experimental Range and demonstrate the value of long-term consistent sampling initiatives.

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EXPLORING UTILITIES OF SPECTRAL DIVERSITY FOR REPRESENTING PLANT DIVERSITY AND ITS SPATIAL PATTERN AFTER PRESCRIBED FIRES IN THE EDWARDS PLATEAU

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ABSTRACT: Ph. D STUDENT

Patterns of spatial heterogeneity in vegetation are essential in pyric-herbivory studies, potentially influencing the patterns of burn, vegetation regeneration, livestock performance, and subsequent burns, but have rarely been explored. In this study, we examine the utilities of spectral diversity for representing the plant diversity and its spatial pattern. Airborne hyperspectral imageries with 120 bands (381.9nm to 998.6mn; 5.2nm bandwidth) and 0.5-m resolution were acquired on two research ranches (~5000 acres each) in the Edwards Plateau of Texas. Herbaceous plant composition and cover were sampled in randomly located 1mX1m quadrats stratified by representative soil types and vegetation classes, areas dominated by bare ground, grasses, small and large woody. We examined the relationship between spectral diversity, in Shannon's diversity and evenness indices calculated based on the hyperspectral data, and the field data-based plant richness, Shannon's diversity and evenness indices at the sample locations. Our preliminary results showed a significant correlation between the spectral- and field-based Shannon's indices ($r=0.3584$, $p=0.0064$). When examined for different vegetation classes, the relationship between the spectral- and field-based Shannon's indices was statistically significant only in the areas dominated by grasses ($r=0.3808$, $p=0.0456$). The spectral information related to the bare ground or woody vegetation might have introduced noise for the relationship. There was also a significant correlation between spectral-based Shannon's index and herbaceous plant richness ($r=0.3952$, $p=0.0021$), differences ($p<0.0001$) between treatments in spectral diversity before and after winter burns. We are currently exploring subsets of the bands and their transformations that may be more relevant to the herbaceous vegetation and its diversity, as well as other variables influencing spectral diversity before and after a prescribed fire. Findings of these explorations can potentially help to improve spectral diversity measurements that can meaningfully represent the herbaceous plant diversity and its spatial patterns during the application of pyric herbivory within complex ecosystems.

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PREDICTING WOODY PLANT ENCROACHMENT RISK ON SONORAN DESERT RANGELANDS

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ABSTRACT: Ph. D STUDENT

Rangelands are characterized by mixtures of herbaceous and woody plants that sustain populations of various wildlife and livestock. Over the past century, rangelands have been experiencing land cover shifts with native and exotic shrubs displacing grasses and forbs. Increases in the type and abundance of woody plants, collectively termed woody plant encroachment (WPE), can thwart the management objectives set by public land management agencies and private landowners. Brush management via mechanical, herbicidal, cultural, and/or burning treatments is often used to reduce woody plant cover with the aim of promoting herbaceous cover. However, brush management is costly and the treatments often short-lived with shrubs often returning within 5-15 years. Here, we present a preliminary modeling effort that determines the extent to which sites may be at their bioclimatic maximum potential woody cover for assessment of WPE risk (e.g., sites well-below their potential = highest risk; sites near their potential = lowest risk). The model is being developed at the 21,000 ha Santa Rita Experimental Range (SRER) near Tucson, AZ. The heterogeneous landscape of the SRER with contrasting geomorphic, soil, and vegetation types across elevation (900 to 1400 m asl) and climatic gradients (mean annual precipitation = 275 to 450 mm), and its well-documented history of WPE make the SRER an ideal testing location for predicting landscape-scale risks to WPE. Using topo-edaphic and climatic variables coupled with current (May-June 2016) vegetative cover, ~45% of the SRER was classified as being at moderate (~35 %) to high (~10 %) risk for continued WPE. This modeling technique allows for a spatially explicit evaluation of WPE risk within individual pastures/allotments to aid land managers prioritize the type, location, and timing of brush management treatments. Refinements of this initial approach are aimed at enabling the model for use with satellite remote sensing data for regional-scale assessments.

Poster Session Monday 2: Poster Pod 16, Poster 95

SPECTRALLY-DERIVED COMMUNITY LEAF DRY MATTER CONTENT LINKS COMPOSITIONAL SHIFTS TO CHANGE IN GRASSLAND PRODUCTION

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ABSTRACT

Leaf traits link environmental effects on plant species abundances to changes in ecosystem processes but are a challenge to measure regularly and over large areas. We used measurements of canopy reflectance from grassland communities to derive a regression model for one leaf trait, leaf dry matter content (LDMC). Partial least squares regression (PLSR) analysis was used to model community-weighted (species abundance-weighted) values of LDMC as a function of canopy reflectance in visible and near-infrared (NIR) wavebands. The PLSR model then was applied to airborne measurements of canopy reflectance to determine how community LDMC interacts with inter-annual variation in precipitation to influence aboveground biomass production of restored grassland during spring over 4 years. LDMC was well-described by a PLSR model that included reflectance measurements located primarily in red edge and NIR portions of the spectrum. Community LDMC decreased as annual forb species became more abundant and was negatively correlated with aboveground production in spring, as indicated by maximum values of the normalized difference vegetation index (NDVI). Decreased precipitation reduced biomass both by increasing community LDMC (LDMC response) and reducing the slope of the NDVI-LDMC relationship (LDMC effect on biomass). We find that grassland LDMC is well-described by a regression model using canopy reflectance in red edge and NIR wavebands. Our results demonstrate the utility of spectral estimates of LDMC for discerning shifts in grassland composition and predicting consequences for productivity-related ecosystem functions.

FEATURES OF DEVELOPMENT OF THE SALSOLA ARBUSCULA PALL. IN CONDITIONS OF THE DESERT KARNABCHUL

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ABSTRACT: UNDERGRADUATE STUDENT

Introduction. The Karnabchul desert covers an area of more than 500,000 hectares and is one of the largest breeding regions of Karakul sheep and goats. The pastures of Karnabchul belong to the semi-shrub – ephemeral type and, in the vegetation cover, the main edificator is – Artemisia diffusa Krasch. One of the promising species of fodder plants is Salsola arbuscula Pall., A representative of the family Chenopodiaceae. Halophilic shrub 50-80 (120) cm tall. The leaves and young shoots of Salsola arbuscula eat sheep well in the fall and are nutritious plants of medium quality. **Material and methods of research**. The aim of our research is to study growth and development, the formation of a crop of fodder phytomass and the survival of individuals of Salsola arbuscula Pall in the conditions of the wormwood-ephemeral desert of Karnabchul. Features of seasonal development. Salsola arbuscula belongs to the plants of spring-summer and autumn vegetation. In nature, the growing season of boyarlie begins in the second decade of March and is 230 days. Taking into account the productivity of the aboveground plant phytomass showed that Salsola arbuscula under the conditions of Karnabchul can form a fodder mass exceeding 2-3 times the yield of natural pastures. So, in the first year of life, the harvest of the aboveground phytomass Salsola arbuscula amounted to 0.51 t/ha, while the yield of natural pastures was 0.32 t/ha. In the second year of life, the yield of dry aboveground phytomass was 1.83 t / ha, while the yield of natural pastures was 0.37 t/ha. In dry 2018, the yield of aboveground phytomass was 0.14 t/ha, while the yield of natural pastures was 0.21 t/ha. **Conclusion**. Thus, the results of the studies indicate that Salsola arbuscula has adaptive potential in the conditions of gypsum deserts, it can be successfully grown as a component in the creation of artificial multicomponent and high-yielding pasture agrophytocenoses in degraded areas of the Karnabchul desert.

Poster Session Monday 2: Poster Pod 17, Poster 97

POST-FIRE ECOLOGICAL RESILIENCE ACROSS FIVE SOUTHWESTERN US DESERTS

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ABSTRACT

Southwestern US deserts have divergent post-fire recovery times due to their unique vegetation compositions, distinct climates, and even dissimilar historic fire return intervals. While these differences are well documented, quantifying ecosystem recovery after fire through a systematic cross-desert comparison study further enhances our understanding of ecological resiliency and can direct future dryland fire management actions. For this study, we use a time-since-fire comparison approach across five U.S. deserts. Within each of our five deserts (Chihuahuan, Colorado Plateau, Great Basin, Mojave, and Sonoran) we chose representative sites that had experienced fire both 15 and 30 years prior and also had associated unburned controls. From these sites, we sampled vegetation cover and composition using core Assessment Inventory and Monitoring (AIM) protocols. We also collected biological soil crust field data to examine biocrusts' resiliency to fire in conjunction with vegetation metrics. The abiotic sampling we conducted included assessing soil nutrient concentrations across the different time-since-fire sites within each desert. Results of these efforts illustrate that, while some deserts may have a faster recovery rate in a portion of their biotic components, such as vegetation cover, this does not necessarily match up with the observed abiotic resiliency after fire. This work demonstrates the complexities of ecological resiliency and provides a valuable comparison of how different deserts and their associated abiotic and biotic components recover from fire over time. The work gives insight into future management of these systems focused on enhancing recovery and improving overall health and function.

Poster Session Monday 2: Poster Pod 17, Poster 98

THE PURPLE PLAGUE: EFFECTS OF GRAZING POST FIRE ON PURPLE THREEAWN AND PRAIRIE DOG RESPONSES

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ABSTRACT

Purple threeawn (*Aristida purpurea)* is a native warm-season bunchgrass quickly gaining attention in western Kansas on The Nature Conservancy's Smoky Valley Ranch. Upon reaching maturity, grazing/clipping pressure decreases for this bunchgrass due to poor forage quality and extreme unpalatability for cattle (*Bos Taurus*) and Black-tailed prairie dogs (*Cynomys ludovicianus*). This decrease in grazing/clipping has led to near monocultures which cause negative impacts to the prairie ecosystem including decreases in forage quality and suitable habitat for prairie dogs; a keystone species. This directly affects many species on the ranch that rely on prairie dogs for habitat including the Black-footed ferret (*Mustela nigripes*), North America's most endangered mammal. This study aimed to determine a large-scale management strategy using natural processes such as fire and grazing to decrease purple threeawn cover and reproductive effort. Treatments investigated the effects of high intensity grazing by cattle, at short duration and season long, as well as the effects of clipping by prairie dogs, post burn. Through two grazing seasons, purple threeawn percent cover did not changed. However, reproductive ability decreased in both short and long duration grazing treatments, by means of decreased live purple threeawn crowns and increased dead purple threeawn crowns, as well as decreased purple threeawn seedstalk densities. A larger decline was seen in the short duration grazing treatment from 2017 to 2018 than in the long duration grazing treatment. With this decrease in purple threeawn reproductive ability, prairie dog densities increased within both short and long duration grazing treatment plots, with the greatest increase in the short duration treatment. These results will help inform management of purple threeawn to increase forage quality and associated economic benefits, while creating better quality habitat for prairie dogs and the organisms that rely on them.

Poster Session Monday 2: Poster Pod 17, Poster 99

INFLUENCE OF GRAZER-TYPE ON FLOWER AND POLLINATOR ABUNDANCE IN FORMER-CRP FIELDS MANAGED WITH PATCH-BURN GRAZING

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ABSTRACT: MS STUDENT

Grazing lands, due to their large expanse are an integral component of biodiversity conservation, encompassing millions of acres of potential habitat for grassland fauna. However, livestock management influences the extent to which grazing lands can provide resources for native species. We compared how livestock species -- sheep or cattle, under moderate stocking (~178 AUM) -- affected floral resources and bee and butterfly communities in low-diversity, post-Conservation Reserve Program (CRP) pastures managed with patch-burning. We sampled bees and butterflies three times per season 2017-2019 and counted all flowering stems within 1 m of transects. Despite a gradient of precipitation across sampling seasons from severe drought in 2017 (14 cm below average rainfall), to near-average rainfall in 2018 (25 cm), and a wetter than average year in 2019 (+8 cm), pastures grazed by sheep consistently had fewer flowering stems and lower forb richness than cattle pastures. In 2017, we detected 34 forb species and 28,468 flowering stems in the cattle pastures, but only 12 species and 3,567 flowering stems in the sheep pastures. In 2018, we counted 43,117 flowering stems and 47 forb species in cattle pastures, while sheep pastures had 2,470 flowering stems and 17 forb species. In 2019, cattle pastures had 95,152 flower stems and 63 flowering forb species, and sheep had 8,362 flowering stems and only 26 forb species. Native bees were three to sixteen times more abundant in cattle pastures compared to sheep. Butterfly species richness and abundance were similar across grazer treatments. The butterfly community was predominately agriculture-tolerant species, with grassland-obligate butterflies comprising only 2% of observations. The dearth of grassland-obligate butterfly species and low overall native bee abundances suggest that post-CRP fields, especially those grazed by sheep, do not provide sufficient floral resources for native bees and imperiled butterfly species.

Poster Session Monday 2: Poster Pod 17, Poster 100

INDIRECT RELATIONSHIPS BETWEEN INVASIVE GRASSES AND BEE COMMUNITIES IN THE NORTHERN GREAT PLAINS

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ABSTRACT: Ph. D STUDENT

Disruptions to natural fire and grazing processes, paired with other human activities, have resulted in prevalent Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*) invasions across the Northern Great Plains (NGP). Cool-season invasive grasses serve as unstable forage for cattle and can decrease native plant richness. Native bees are responsible for the pollination of many rangeland plants and are highly dependent on the availability of native forb species. Past investigations into the influence of invasive plants on bee communities has been restricted to invasive forbs. We first seek to investigate the relationship of Kentucky bluegrass and smooth brome abundance and forb diversity across North Dakota as part of a statewide survey of plant and bee communities. In addition, we will investigate whether invasive grass abundance affects the composition of bee communities. We collected cover estimates of Kentucky bluegrass, smooth brome, and forb species at 38 grassland sites in North Dakota while simultaneously collecting bees using two different methods from 2017–2018. We will test the relationship between forb species diversity and both invasive grass species individually with simple linear regression. Similarly, we will test invasive grass species cover and bee diversity but expand our analyses to determine if community composition varies with invasive grass cover using nonmetric multidimensional scaling ordination methods. Kentucky bluegrass and smooth brome are widely established in the NGP grasslands and raise concerns for both ranchers and wildlife. Exploring their effects on a functionally significant species group increases our understanding of invasive grass impact on NGP grassland systems.

Poster Session Monday 2: Poster Pod 17, Poster 101

FORAGE FOR BEES: EXPLORING HOW SIZE, SEED MIX, AND SURROUNDING LANDSCAPE OF POLLINATOR PLANTINGS SUPPORT BEES IN MINNESOTA TALLGRASS PRAIRIE

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ABSTRACT

Declines in managed bee health and wild pollinator populations have prompted numerous government and non-government groups to promote pollinator habitat throughout the United States. Rangelands and grasslands can provide critical forage for pollinators while serving other management goals, yet research gaps remain in how to do this effectively and economically. We established a landscape-scale experiment to rigorously quantify how local and landscape factors influence the success of pollinator plantings for honey bees and native bees. In fall 2018, we installed plantings of differing sizes, seed mixes, and landscape contexts at 38 sites across 12 counties in southwest Minnesota. Locations were chosen to fit a low (1-9%), medium (10-29%), or high (>30%) amount of surrounding natural area. Plots at the locations were seeded with one of two seed mixes and were small (1 to 4 acres), big (8 to 16 acres), or control sites with no planting. Each treatment category was replicated three times. We sampled the floral community and native bee community during 4 visits to each site in summer 2019, and maintained seven honey bee colonies at over half of the locations to monitor honey bee health and mortality metrics. We collected over 7,000 specimens of native bees and harvested 5,600 lbs of honey from managed colonies. There were 88 species of flowering plants observed in our plots, including both intentionally seeded and weed species. Rangeland managers will take away from this poster important local and landscape factors to weigh for both native and managed bees if considering pollinator enhancement projects on their land.

Poster Session Monday 2: Poster Pod 17, Poster 102

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COMPARING GPS POSITION AND FECAL DENSITY COUNTS AS METHODS FOR TRACKING LIVESTOCK SPACE USE

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ABSTRACT: MS STUDENT

Two methods used to track grazing livestock spatial utilization patterns are Global Positioning Systems (GPS) position data and fecal pat counts. We used both methods to determine space use in patch-burn grazing projects in the Norther Great Plains. Fecal pat counts assume the points or transects accurately represent the degree of utilization by the livestock within the sampled area. Here we address two questions: (1) What are the spatial utilization patterns of livestock in patch-burn grazing pastures based on GPS position data? (2) Do fecal pat counts correlate well with the data collected with GPS collars? Data were collected in 2018 at two experimental rangeland locations in southwestern, and south-central North Dakota. We attached GPS collars to randomly selected animals in each pasture at the start of the grazing season and changed batteries monthly. We counted fecal pats within a 5-meter radius of forage quality sampling points in each pasture monthly to determine fecal pat density. We compare the fecal pat density from the designated forage sampling points with number of GPS fixes within 25 meters of the forage sampling point the week sampling occurred. Cost is a major factor inhibiting the use of GPS systems for tracking livestock movement and fecal counts are a cheaper alternative for gathering spatial utilization data. Comparing the accuracy of these methods can aid in determining which method would best be suited for specific situations.

Poster Session Monday 2: Poster Pod 18, Poster 104

VEGETATION SELECTION OF HERITAGE VS. CONVENTIONAL BEEF COWS GRAZING CHIHUAUAN DESERT RANGELAND

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ABSTRACT: Ph. D STUDENT

We examined vegetation selection patterns of mature Angus crossbred (AH) and Raramuri Criollo (RC) cows grazing Chihuahuan Desert rangeland during the growing and dormant seasons for 3 consecutive years (2015-2018). Breeds grazed two adjacent pastures (12A=1190ha, 12C=1165ha) separately in a crossover experiment for 4 weeks per trial. Plant species included honey mesquite, soap-tree yucca, broom snakeweed, fourwing saltbush, broom dalea, ephedra, black-grama, dropseeds, threeawns, tobosa and burrograss. GPS locations of animal grazing points logged with Lotek 3300-LR GPS collars deployed on 7 to 9 cows per breed were overlaid on a vegetation map classified on the basis of the two dominant species of each mapping unit. Ivlev's electivity index (E) for each vegetation class was calculated for a herd within each pasture (n=24). During the growing season in pasture 12A, RC showed higher preference than AH for bare ground areas (ERC = 0.61; EAH = -1.0; P=0.07), and higher avoidance of ephedra/mesquite dune (ERC = -0.59; EAH = -0.04; P=0.02). During the dormant season, RC showed higher preference for ephedra/mesquite (ERC = 0.26; EAH = -0.73; P<0.01), lower avoidance of mesquite/black-grama (ERC = -0.21; EAH = -0.99; P=0.06) and mesquite-dune/fourwing saltbush (ERC = -0.19; EAH = -1.0; P=0.05), and higher avoidance of mesquite-dune/threeawn areas (ERC = -0.87; EAH = 0.39; P<0.01). During the growing season in pasture 12C, RC showed lower avoidance (vs. AH counterparts) of mesquite/black-grama areas (ERC = -0.21; EAH = -1.0; P=0.06), whereas during dormant season, RC showed higher preference for mesquite-dune/burrograss (ERC = 0.72; EAH = -0.12; P=0.08), mesquite-dune/fourwing saltbush (ERC= 0.29; EAH= -0.55; P=0.07), and mesquite-dune/black-grama areas (ERC = 0.08; EAH = -0.90; P<0.01). Relative to AH, Criollo cattle appeared to prefer bare ground areas in summer, possibly seeking annual forbs, and shrub-dominated areas in winter, possibly including more browse in their diets.

NEAR INFRARED SPECTROSCOPY OF LIVER TISSUE FROM GOATS DIFFERING IN GENETIC PROPENSITY TO CONSUME JUNIPER

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ABSTRACT

A population of domestic goats (*Capra hircus*) has been selected for their propensity to consume above (H) or below (L) the herd average for proportion of juniperus species (i.e. *J. asheii* or *J. pinchotii*) in the diet of free-ranging animals. Near infrared reflectance spectroscopy (NIRS) has been used to determine a variety of chemical characteristics in multiple biological materials but has not been applied to a significant extent in animal tissues. Our objective was to determine the ability of NIRS of liver tissue to discriminate between H and L goats (2 to 5 years of age) on rangeland containing juniper. In June of 2019, 20 animals (10 H, 10 L) were slaughtered at the Angelo State University Meats Lab. Liver samples were collected at harvest, stored in whirl-pac bags at -20o C and later thawed to ~24o C for NIRS analysis. Spectra (400-2500 nm) were obtained on liver tissue with an ASD Field Spec using a contact probe directly through the whirl-pac sample bag. Principal component, linear discriminant analysis, and chi-square procedures were accomplished in SAS. Discriminant analysis identified 8/10 H (80%) and 7/10 L (70%) correctly. Young (2-year-old) and old (3 to 5-year-old) goats were both correctly identified at 60% (6/10). For juniper consumption, correct identification was 3/5 H (60%) and 4/5 L (80%) within the older group, and 2/5 H (40%) and 3/5 L (60%) within the younger group. There were no differences in the proportion of correct/incorrect identifications for any of the above comparisons. Preliminary results indicate that NIRS was successful in discriminating between liver tissue from male goats differing in age and apparent propensity for juniper consumption. Portable NIRS analysis of liver tissue may be useful as a post-mortem diagnostic technique to complement existing NIRS analysis of feces. Further research will explore this capability.

Poster Session Monday 2: Poster Pod 18, Poster 106

IMPACT OF ALTERNATIVE GRAZING MANAGEMENT PRACTICES ON ARTHROPOD COMMUNITY

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ABSTRACT: UNDERGRADUATE STUDENT

Alternative grazing managements have been shown to impact herbaceous community structures, leading to changes in ecosystem biodiversity. Due to their reliable response to changing environments, arthropods are commonly used as an indicator to assess biodiversity. The objective of this study was to evaluate the impact of patch-burn grazing (PBG) and winter-patch grazing (WPG) on arthropod community richness, abundance, composition, and diversity. Arthropod samples were collected from three patches of typical mixed-grass prairie. Each patch had been subjected to either PBG, WPG, or season-long grazing (CG). Three pastures were used as replicates. Sampling was conducted through sweep-netting with the intention of collecting samples from the greatest number of arthropod orders. Sampling occurred twice over the summer season in 2018 and 2019. Results indicated that the order Hemiptera ranks most abundant in all treatments across all sampling events. Diptera was consistently second most abundant in both CG and PBG treatments with one seasonal variation. The third most abundant order fluctuated over season, year, and treatment between Coleoptera, Hymenoptera, Aranea, and Diptera. The top three orders comprised over 80% of abundance in all treatments. We found no significant difference in order richness among treatments. However, we found PBG treatments significantly increased the arthropods abundance by 2 to 3 folds and reduced Shannon-Wiener index and evenness compared to WPG and CG treatments. Arthropods make up a large portion of the ecosystem's secondary trophic level. Their role as both primary consumers of vegetation, and the main source of food for insectivorous birds makes arthropods a valuable part of functioning ecosystems. Furthermore, arthropods that serve as pollinators are essential to preserving many plant species. The information from this study could aid in the development and promotion of management practices that preserve natural arthropod communities.

Poster Session Monday 2: Poster Pod 18, Poster 107

75-YEARS OF NO BURNING OR GRAZING IN THE SOUTHERN PLAINS: EFFECTS ON THE VEGETATION AND SOIL

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ABSTRACT

In 1941, soon after USDA acquired the Southern Plains Experimental Range (SPER), 25 permanent exclosures were established and another was established in 1947. Of those exclosures, 16 are still maintained. A set of 10 exclosures were chosen for sampling in autumn 2015 and summer 2016 based on ecological site characteristics, no prior cultivation, and size. With few exceptions, these exclosures had not been grazing by livestock, burned, or received any mechanical of herbicidal treatments for 75 years in summer 2016 when sampling was completed. We sampled inside and outside the exclosures to characterize vegetation and soils. In autumn 2015, soil samples were collected from 10 locations at 3 depths (0 to 15 cm, 43 to 58 cm, and 85 to 100 cm) inside and outside each enclosure and were analyzed for C and N, roots were removed and classified into size classes, and the 2 dominant types of vegetation was described for each quadrat (1 m x 0.5 m) as being composed of warm-season tallgrass, warm-season mid grass, warm-season short grass, warm-season annual grass, cool-season perennial grass, cool-season annual grass, forbs, or shrubs. In summer 2016, we returned to each area and sampled vegetation from 20 quadrats when the standing crop was near peak. We harvested vegetation in the quadrats and separated standing dead and current year's growth of the 3 most abundant species and all other. We also identified all species present and estimated their foliar cover. Soils inside exclosures are softer than outside. The loamy sand soils contain little organic matter, but in the 0-to 15-cm depth interval exclosure soils contain about 20% more C and N than soils outside. Vegetation has generally shifted inside exclosures away from the presumed historic plant community and the grazed areas. Short and mid grasses are less abundant, and shrubs are more. In 2016, the current year's production was about 30% more inside than outside the exclosures. The grazing protection afforded the exclosures have resulted in benefits to the ecosystem in terms of productivity and sequestered carbon, but the shift in the composition is of questionable benefit.

Poster Session Monday 2: Poster Pod 18, Poster 108

SPRING EPHEMERALS: THE ECOLOGY OF NATIVE PERENNIAL FORBS OF THE PACIFIC NORTHWEST BUNCHGRASS PRAIRIE

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ABSTRACT

The Pacific Northwest Bunchgrass Prairie (PNB) is one of the most endangered grasslands in North America. Current knowledge of vegetation dynamics in the PNB is based primarily on bunchgrasses, yet most of the species richness within PNB ecosystems comes from native perennial forbs (NPF). Many NPFs are also culturally important to Native American peoples of the region. Currently, there is a paucity of information related to the PNB's diverse NPF communities, particularly spring ephemerals. Consequently, the community status, dynamics, and trends of these ecologically and culturally important resources are largely unknown. We sampled 29 plots (154 m2) within the Starkey Experimental Forest and Range, at three different times during 2016 (April, May, July) to: (1) identify important environmental/biotic/abiotic correlates of NPF community variation and (2) describe intra-annual variation in NPF composition. Non-metric multidimensional scaling (NMS) and cluster analysis was used to describe three NPF community groups that were strongly related to slope, soil Phosphorous and Potassium, and soil depth. NMS axes were strongly associated with a suite of NPF species (e.g., *Cammassia quamash*, *Saxifraga nidifica*) as well as with bunchgrasses, Non-native annual grass (*Ventenata dubia*) cover was not associated with NPF cover or richness. NPF richness was highest in April and decreased by 40% in July. Many dominant species (e.g., *Lomatium cous*, *Triteleria grandiflora*), were sparse to absent by July. Flower richness and density decreased by a factor of 6 and 20 respectively from April to July. Our results suggest that conventional timing of vegetation sampling in our study area will not accurately measure NPF abundance, and that knowledge of broader community gradients coupled with site-specific factors (i.e., small-scale changes in soil characteristics) are important for understanding NPF distributions in the PNB.

Poster Session Monday 2: Poster Pod 19, Poster 109

UNDERSTORY PLANT COMMUNITY AND STRUCTURE IN WARM-DRY, MIXED-CONIFER FORESTS

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ABSTRACT

Dry mixed-conifer forests in the Southwest occupy an important ecological and hydrological role in upper watersheds particularly as it relates to soil and water conservation. In the absence of reoccurring fire and silvicultural treatments over the last 50 years, we quantified understory structure and composition on prevailing north and south aspects of a dry mixed-conifer forest in southcentral New Mexico using mixed models and ordination analysis in preparation for an experiment in ecological restoration. Results indicated understory cover on north aspects was characterized by a mosaic of grasses, forbs, cryptogams, and various woody plants while south aspects were characterized by a near homogeneous layer of litter. We will further present ordination results based on species composition and structure between north and south aspects to characterize important biotic and abiotic variables effecting understory vegetation. Understanding contemporary understory structure and composition is important when managing for grazing allotments and for desired future conditions that are to be achieved through ecological restoration using silvicultural techniques designed to foster resilience.

Poster Session Monday 2: Poster Pod 19, Poster 110

FORAGE BIOMASS REDUCTION BY EASTERN RED CEDAR TREES IN GRASSLANDS OF SOUTHCENTRAL SOUTH DAKOTA

Alexander J. Smart*, Robby J. Schaefer, Lan Xu; South Dakota State University, Brookings, SD

ABSTRACT

Over the past 10 years, eastern red cedar (*Juniper virginiana* L.) tree cover has increased at a rate of 100 hectares per year over a four county region along the Missouri River in southcentral South Dakota. Grasslands affected by cedar tree encroachment are at great risk for loss of plant diversity, decreased wildlife habitat, and loss of forage for livestock. The objective of this study was to evaluate the amount of forage biomass reduction of individual eastern red cedar trees. We marked five random individual trees in each of five height classes: <1 m, 1-2 m, 2-3 m, 3-4 m, and >4 m tall and five grassland control plots on two ranches located in Gregory County, SD along the Missouri River in 2019. Height, diameter breast height, basal diameter, and canopy diameter (in two perpendicular dimensions) were measured for each tree. Herbaceous forage biomass was estimated by clipping two 0.25 m2 quadrats adjacent to the trunk of each tree and in 10 open grassland control plots at each ranch in late-July. Analysis of variance and regressions were conducted on forage biomass and tree class, height, diameter, and volume. Average forage biomass reduction was 70% across all tree classes compared with grassland controls (P<0.01). There were no significant differences detected among the tree height classes <2 m tall. Tree height was the best predictor (r2=0.59, n=60, P<0.0001) among all variables we measured. There was a linear decrease in forage biomass (kg/ha) across tree height classes expressed by the equation Y = 3200 – 6 x tree height (in cm). Our results suggest rangeland managers should monitor tree height and apply appropriate tree removal before it reaches critical height (>1m) to avoid large forage biomass reduction.

Poster Session Monday 2: Poster Pod 19, Poster 111

ONE SEED JUNIPER SAPLING CONTROL: EFFECTS OF SIMULATED BROWSING ON SOIL-PLANT WATER DYNAMICS IN RELATION TO SAPLING SIZE AND DENSITY

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ABSTRACT: Ph. D STUDENT

This study sought to understand how simulated targeted grazing impacts soil moisture redistribution between saplings and understory grass and whether this creates windows of opportunity for juniper seedling recruitment. The objective of our study was to determine whether: 1) sapling defoliation frees up detectable amounts of soil moisture for understory growth and new seedling establishment; 2) the effects of defoliation are contingent on sapling size and stand density; and 3) sapling survival and understory response depend on frequency of defoliation. Four defoliation treatments: a) single clipping in year 1; b) single clipping in years 1 and 2; c) herbicide application in year 1 (completely removed); and d) untreated (control) were applied on twelve sapling-infested rangeland plots at NMSU's Corona Range and Livestock Research Center in the summer of 2019. Soil volumetric water content was measured using CS655 probes buried in the superficial soil layer at 0.15-0.25 m under sapling drip lines. We also tested the effects of defoliation (single clipping year 1) & untreated on xylem pressure potential of saplings using a Scholander pressure bomb. We hypothesized that soil volumetric water content would increase over short term (weeks) with defoliation of one seed juniper saplings compared to control plots. The magnitude of the response would decrease with increasing sapling size and density. Short term increase in soil volumetric water content is expected to be highest in completely removed plots (herbicide) followed by defoliated plots. In addition, we hypothesized that sapling xylem water potential would decrease (become less negative) with defoliation. We will present first year study results reporting the effects of defoliation on soil moisture and sapling xylem water potential in sapling defoliation plots compared to control plots. We expect that our findings will help refine current targeted grazing prescriptions for one seed juniper saplings.

CURRENT CONDITION AND USE OF PASTURES OF FOOTHILL DISTRICTS OF UZBEKISTAN

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ABSTRACT

Introduction. An increase in the number of livestock and an increase in the productivity of sheep depend almost entirely on the state of the pasture grassland and the nutritional value of the forage vegetation. Methods and object of research: Identification of types of pastures and determining the yield of fodder mass in the trial plots according to the seasons of the year. Assessment of the degree of degradation of the vegetation cover of the trial plots. **Research results**. In the Zamin district of the Jizzakh region, pasture productivity is 0.3-0.4 t/ha. Pasture vegetation may be suitable for grazing in late autumn and winter due to Alhagi, Climactoptera, as well as dried ephemerid grass. Due to the low feed supply in this pasture in the spring and summer seasons, grazing of farm animals is not practiced. The vegetation cover is mainly represented by forbs, dominated by various species of annual plants, mainly Hordeum leporinum, Hordeum murinum being widespread and plentiful. Despite the great load on the pastures, such valuable fodder species as Poa bulbosa, Bromus tectorum are present in the vegetation, and Carex pachystulis, Agropyrum orientale are found in some places. Saline spots are commonly found on pastures where vegetation consists mainly of annual Salsola such as Climacoptera lanata and others. The total productivity of such pastures is 0.26 t / ha of air-dry mass, in which the bulk (62.7%) falls on Hordeum Leporinum and Hordeum mueinum. From forage plants, such species as Alchagi pseudalhagi, Cousinia resinosa, Capparis spinosa are found on pastures. Species such as Papever pavoninum, Taraxacum officinale, are also recorded in the vegetation cover. **Conclusions:** Desert and semi-desert pastures are characterized by relatively low productivity (0.25-0.32 t / ha) and are an ecologically fragile ecosystem. Due to the irrational use of pasture ecosystems, there is currently a degradation of vegetation over more than 40% of the territories used. The rational use of desert pastures, the preservation of biodiversity, the consistent increase in pasture productivity and the introduction of technologies to improve pasture productivity and the introduction of promising varieties of fodder plants is the main objective of pasture rehabilitation.

Poster Session Monday 2: Poster Pod 19, Poster 113

ANIMAL AND PLANT FACTORS WHICH AFFECT LARKSPUR TOXICITY: SEX, AGE, BREED, AND PLANT CHEMOTYPE

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ABSTRACT

Larkspur (*Delphinium* spp.) poisoning is a long-term problem for cattle grazing on rangelands of western North America. Recent research has shown that both plant and animal-based factors are critical in understanding and mitigating larkspur poisoning in cattle. Non-toxicological factors including sex, age, cattle breed, and plant chemotype affect cattle responses to larkspur. For example, Angus heifers are more susceptible to larkspur intoxication than are steers or bulls. Young cattle appear to be more susceptible to larkspur poisoning than mature animals. Beef breeds of cattle are more susceptible to larkspur intoxication than dairy breeds. In addition to animal factors, plant alkaloid composition (chemotype) affects the potential toxicity for cattle because of differences in the ratios and concentrations of highly toxic *N*-(methylsuccinimido) anthranoyllycoctonine (MSAL)-type alkaloids compared to less lethal non-MSAL-type alkaloids. Animal- and plant-based factors can provide substantial information to inform livestock producers on management to reduce risk and cattle losses to various larkspur species in western North America.

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Poster Session Monday 2: Poster Pod 20, Poster 115

DO PLANT SECONDARY METABOLITE-CONTAINING FORAGES INFLUENCE SOIL DYNAMICS IN PASTURE SYSTEMS?

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ABSTRACT

Grazed pastures are susceptible to N loss from manure additions, which increases eutrophication and ultimately affects the global N cycle. Plant secondary metabolites (PSMs), such as condensed tannins (CTs) and terpenes, influence soil dynamics in forest systems by generally decreasing N mineralization. We investigated whether cattle-grazed pastures of non-traditional grass-legume forages including CT-containing sainfoin (*Onobrychis viciifolia* Scop.) and tall fescue (*Festuca arundinacea* Schreb.; TF) influenced soil dynamics compared with "traditional" grass-legume forages of non-tanniferous alfalfa (*Medicago sativa* L.) and TF. Throughout the study, CTs in sainfoin averaged 58.9 g kg-1 whereas saponins in alfalfa averaged 5.7 g kg-1. We observed greater soil microbial respiration ($p = 0.01$) in TF, indicating greater microbial activity in TF than legumes, and between legumes we found greater soil NO3 ($p = 0.01$) in alfalfa than in sainfoin, although aboveground biomass and N differences were negligible. We also conducted a laboratory soil-feces incubation study to determine if feces from cattle foraging diets of legumes with CTs, and without, influenced soil dynamics. Both feces treatments showed lower NO3 ($p < 0.001$) than the control, and between treatments dehydrogenase activity (DHEA) was lower ($p = 0.03$) in sainfoin than alfalfa, suggesting these PSMs may affect soil processes. To our knowledge this study is the first considering whether pasture forages produce enough PSMs to influence soil dynamics by assessing general differences in soil parameters between CT-containing and non-tanniferous grass-legume systems. More research is needed to determine whether PSMs mitigate N loss in pasture systems by slowing N mineralization.

Poster Session Monday 2: Poster Pod 20, Poster 116

LANDPKS SOILID: A SMARTPHONE-BASED SOIL IDENTIFICATION TOOL FOR RANGELAND MANAGEMENT

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ABSTRACT

Accurately identifying soil class at a specific point-location or position within a landscape is critical for implementing sustainable soil management. Soil classes (e.g., soil components) are information carriers that allow land managers to infer a general range of soil behavior in response to management actions and disturbance effects. Recent advances in information technologies, in particular the global ubiquity of smartphones, has made it possible to create mobile decision support tools that can inform rangeland management decisions. The Land Potential Knowledge System (LandPKS) is one such example, providing a complete mobile computing platform for assessing land potential and informing management activities. Here we present the development of a global soil identification modeling framework (SoilID) implemented within the LandPKS mobile app. SoilID leverages smartphone-based data acquisition and information delivery, with cloud-based computing to determine the most probable soil class at a user specified point. SoilID makes it possible for non-soil scientists to describe and identify soils in the field using limited, simple soil observations. Additionally, SoilID provides information on Ecological Sites based on the most probable soil class matched to the user's soil. Our presentation will describe the details of SoilID and its implementation in the LandPKS mobile app and provide examples of its utility for rangeland management.

Poster Session Monday 2: Poster Pod 20, Poster 117

BISON GRAZING AND FIRE IMPACTS TALLGRASS PRAIRIE SOIL MICROBIAL DIVERSITY AND DISTRIBUTION AS WELL CARBON AND NITROGEN CYCLING POTENTIALS

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ABSTRACT: MS STUDENT

Maintenance of tallgrass prairie is driven in part by the disturbances of fire and large herbivore grazing, and interaction between the two. However, less is known about prairie soil microbial characteristics and responses to fire and grazing, despite the importance of microbial activity in mediating carbon (C) and nitrogen (N) fluxes from the ecosystem. We asked how direct and interactive long-term fire treatments (annual vs. 20 year burning) and bison grazing treatments (grazed vs. ungrazed) affected soil microbial diversity and ecosystem cycling across watersheds. From samples collected in a log-distance design, bacterial and archaeal community composition and key soil factors related to carbon and nitrogen cycling were measured.

Overall, we found that watershed scale management treatments explained more microbial community variation than soil factors, had different microbial communities, and different C and N cycling potentials. Specially, annually burned and ungrazed watersheds had the highest soil microbial richness and grazed and annually burned watersheds had the weakest change in microbial community composition with distance, indicating that both fire and grazing might promote microbial dispersal. Measurement and 2-way ANOVA of plant above- and belowground biomass and soil C and N cycling parameters showed higher C inputs and losses in the unburned treatment, and lowest C inputs and losses in the grazed and annually burned treatment. Soil N availability was higher with bison grazing, but soil nitrification potential was enhanced by both N availability and low fire frequency, and denitrification potential was highest in ungrazed, unburned watersheds (where C availability was highest). Therefore, the cessation of fire in tallgrass prairie could still result in significant N losses by leaching or denitrification, rather than volatilization by fire. Our work shows that land management influences soil microbial structure and function and emphasizes that plant and microbially mediated C and N cycling are linked.

Poster Session Monday 2: Poster Pod 20, Poster 118

SOIL RESPONSES TO EASTERN RED CEDAR ENCROACHMENT AND PRESCRIBED FIRE IN SOUTH-CENTRAL SOUTH DAKOTA

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ABSTRACT: MS STUDENT

Eastern red cedar (ERC) encroachment is converting grasslands into shrublands and forests in the Great Plains. What used to be areas characteristic of diverse grasses and forbs exposed to sunlight are now areas generally comprised of ERC needles and other organic material under dense ERC canopies. The primary objectives of this study are to evaluate impacts of ERC tree size on soil microbial communities and soil nutrients compared to adjacent grasslands and assess each in response to vegetation succession one, two, and three years post fire. Five class sizes (tree height) were designated as < 1m, 1-2m, 2-3m, 3-4m, and > 4m. Three trees were randomly selected for each class size on each of two ranches. Multiple soil cores (2-cm dia. X 15cm depth) were extracted under each tree to form one composite sample as well as in three adjacent grassland areas for comparison. Further, soil cores were taken from six randomly selected locations within each of the following five treatment areas located on one ranch: one, two, and three years post fire; grassland control; and ERC forest control. Phospholipid fatty acid (PLFA) and soil nutrients will be analyzed for all samples to assess soil community structure and abundance and soil nutrient availability. This study aims to provide insight into the questions: Will soil microbial communities differ between grasslands and areas encroached by ERC? At what tree height does ERC significantly impact soil microbial communities under canopy compared to grasslands? Will soil microbial communities change as vegetation succession occurs following fire disturbance?

Poster Session Monday 2: Poster Pod 20, Poster 119

LAND RESOURCE UNITS AS SOIL SYSTEMS

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ABSTRACT: Ph. D STUDENT

The National Resource Conservation Service (NRCS) Land Resource Hierarchy (LRH) attempts to classify ecologic regions from coarse to fine scale. A meso-scale unit of this hierarchy is the Land Resource Unit (LRU), which previously has been inconsistently and vaguely defined in the literature. We propose using a soil systems approach to help define and delineate LRU's more clearly. A soil system is a recurring group of soils that occur within a similar geomorphic environment (e.g., lacustrine, eolian). Delineating soil systems could be done by finding repeating soil morphologic and geomorphologic patterns across the landscape in existing soil survey databases (e.g. SSURGO). These patterns could be used in combination with climatic boundaries to help delineate LRU boundaries. Establishing soil systems as the basis of LRU's could provide a scientifically sound foundation for consistent meso-scale land management decisions and could facilitate the integration of connectivity in understanding management response. LRU's defined as soil systems could also become the 'home' of the block diagram.

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Poster Session Monday 2: Poster Pod 21, Poster 121

CROSS COMPARISON OF SOIL MICROBIAL COMMUNITY IN THREE RANGELANDS ACROSS CONTINENTAL UNITED STATES

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ABSTRACT

Soil microbiology is vital to the overall soil health of a community, region or ecological system. Previous research has suggested that management practices in rangeland settings such as: burning, and cattle grazing effect nutrient pools. If nutrient pools are affected by these management practices it would be plausible to hypothesize that the soil microbial community responsible for nutrient cycling would also be altered. A study conducted at the USDA-ARS Grazinglands Research Laboratory in El Reno, OK on perennial tall grass prairie and non-native Old World Bluestem, Buck Island Ranch, Archbold Biological Station, Venus, FL and the USDA-ARS Central Plains Experimental Research location, Nunn, CO assessed the effects of cattle, burning and grazing on microbial community. We used poly lipid fatty acid profiling (PLFA), soil characterization, latitude and longitude and temporal data to determine if microbial community structure was altered in relation to management practices over three seasons of the sampling. Our results showed that cattle grazing mostly altered fungal and actinomycetes populations when soil was dry. Applications of burning alter bacterial populations in the short-term but they are quick to recover. Further research and analysis must occur to determine if specific groups of bacteria (pathogens) are hindered more than others or if these systems are carbon starved which leads to the changes experienced in this study.

SOIL CARBON UNDER DIFFERENT GRAZING MANAGEMENT ACROSS THE NORTHERN GREAT PLAINS

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ABSTRACT

Could management of grazing lands be a tool for climate mitigation? Globally, grazing lands make up ~25% of total land area and ~20% of total soil organic carbon stores. Prior research suggests improved grazing management could further increase soil carbon storage. Yet there is considerable variability in soil carbon and its responses to management, making it unclear how and where improved management could increase carbon stocks. Here we assess soil carbon under different grazing practices – from intensive rotational grazing to continuous season-long grazing – across a rainfall gradient in the northern Great Plains. We used a space-for-time approach, where we identified nearby site pairs of working ranches that had used contrasting grazing practices for at least 10 years. In summer 2018, we visited 28 sites across Montana, Wyoming, North Dakota, South Dakota, and Nebraska. Sites ranged in both mean annual temperature and precipitation from 4.4-8.8 C and 259-609 mm. At each site, we sampled a pasture with relatively level topography and loamy soils (e.g. loam, silty loam, clay loam, etc.). We sampled soils for carbon concentration (total carbon % if <7.2 pH, organic carbon % if >7.2 pH), bulk density, texture, and pH and vegetation for percent cover of different plant functional groups and species richness. Finally, we characterized management practices using a survey of participating landowners. Across sites, carbon concentration varied over 20x (from 0.3% - 7.3%). We assessed differences in soil carbon content and stocks with grazing practices, after accounting for variation in soil texture and climate, and did not find evidence for difference by broad management category. We present additional results on management differences and discuss implications for management influence on soil carbon stocks across the northern Great Plains.

Poster Session Monday 2: Poster Pod 21, Poster 123

STREAMLINED PROCESS OF MAP UNIT COMPONENT EVALUATION & ASSESSMENT FOR PROVISIONAL ECOLOGICAL SITE CONCEPT DEVELOPMENT

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ABSTRACT

In 2015, the Natural Resources Conservation Service (NRCS) began an effort to assign provisional ecological site concepts to every component mapped in the soil survey maps of the continental United States. This effort, known as the Provisional Ecological Site National Instruction (PES) aimed at producing a seamless coverage of ecological site concepts (ESC) (with corresponding State-and-Transition Models) within the US by 2020. In practice, this effort has been stymied in many areas due to inconsistencies in soil surveys of differing vintages (i.e. before and after Keys to Soil Taxonomy) within a single sampling dataset. Many historic soil surveys are broader in scale or lack data elements that are required for a modern soil survey. Developers working on the PES often spent inordinate amounts of time trying to develop ESC for map unit components lacking key data or being too inclusively broad to be reliable. To address these issues, a process was developed to evaluate soil surveys and determine where there is adequate data to develop PES's. This evaluation protocol quickly identifies problematic soil map units, removing them from the sampling set, which enables ecological site specialists to prioritize areas with suitable data to support ESC development. By prioritizing areas that meet current soil survey standards, the PES products developed using this process will be more useful for conservation planning. This protocol is the result of the collaborative efforts of California NRCS and Soil and Plant Science Division Region 2 staff in consultation with Steve Campbell, NRCS West National Technology Support Center. We present the main steps in this evaluation protocol here, using a dataset from the northern California Coast Range that overlaps ten soil survey areas and eleven EPA Level 4 Ecoregions.

Poster Session Monday 2: Poster Pod 21, Poster 124

PREDICTING SOIL CARBON STOCKS USING NIR SPECTROSCOPY IN SASKATCHEWAN NATIVE MIXED GRASSLANDS

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ABSTRACT: MS STUDENT

Grasslands have high carbon (C) sequestration potential, and yet little is still known about how their soil C dynamics and sequestration capacity vary along gradients of space and management intensity. Due to this spatial heterogeneity, effective modeling of management impacts on soil C stocks requires a high rate of sampling and creates a trade-off between accuracy/sample numbers and the cost of sampling. Near-infrared (NIR) spectroscopy has been promoted as an inexpensive and reliable assay method to estimate soil C stocks, and to measure changes for trading or monitoring. The objective of this study is to determine the accuracy with which NIR can predict field soil C values in Saskatchewan native grasslands, and how NIR soil C levels corresponded with live plant biomass. Spectral data was obtained for all samples through FOSS NIR XDS analysis, and a subset was selected for combustion analysis to determine total C (TC). We developed a model using partial least squares regression and local equations and selected a further subset for model validation by combustion analysis. NIR was able to predict TC with a high degree of accuracy in low-carbonate soils, and levels of C correlated with live plant biomass, though the curve did not appear to be strictly linear. This study confirms that NIR can accurately predict TC of native Saskatchewan grassland soils, but further research is required to confirm the precision of measurements, soil-plant community interactions, and the influence of carbonates.

Poster Session Monday 2: Poster Pod 21, Poster 125

SOIL NUTRIENTS AND MICROBIAL COMMUNITIES ON PATCH-BURN GRAZING PASTURES IN THE NORTHERN GREAT PLAINS

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ABSTRACT: Ph. D STUDENT

There is a perception that use of fire with or without grazing is detrimental to soil nutrient availability in grasslands despite some evidence that their collective impacts do not negatively affect soil nutrient availability. Previous patch-burn grazing research has largely overlooked how soil nutrients and microbial communities respond to the combined use of fire and grazing in this context. We investigated soil nutrient availability and microbial communities vary across the time since fire gradient created in patch-burn grazing pastures in southwestern North Dakota. We collected soil samples during the 2018 and 2019 grazing seasons in three patch-burn pastures grazed by cow-calf pairs and three patch-burn pastures grazed by sheep. We sampled four points per patch for sixteen points per pasture. We measured plant available nitrogen (ammonium and nitrate) monthly from June – September of each year and calcium, magnesium, phosphorous, potassium, total carbon, and total nitrogen in July of each year. In 2019, we surveyed microbial abundance and composition of broad taxonomic groups in June and measured relative decomposition activity using litter bags buried from June – September. We compare nutrient availability, microbial abundance, and microbial activity between patches using mixed-effect regression models and Tukey post-hoc comparisons. We compare the microbial community composition with nutrient availability, time since fire, and soil type using canonical correspondence analysis. In 2018, ammonium and nitrate concentrations in recently burned patches were either increased or not different when compared to unburned patches over the grazing season in the cow-calf and sheep treatments. In 2018, calcium, magnesium, phosphorous, potassium, total carbon, and total nitrogen in recently burned patches either increased or were not different when compared to unburned patches when measured in July in the cow-calf and sheep treatments. This work is ongoing but results thus far indicate that patch-burn grazing does not reduce nutrient availability to plants.

Poster Session Monday 2: Poster Pod 21, Poster 126

HABITAT DIFFERENCES FOR NATIE GROUND-NESTING BEES BETWEEN RESEEDED OLD FIELDS AND NATIVE PRAIRIE IN THE PACIFIC NORTHWEST BUNCHGRASS PRAIRIE

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ABSTRACT: UNDERGRADUATE STUDENT

Pollinators serve an important role in ecosystem services (Kimoto et al. 2012) and are recognized as a key component of any healthy rangeland ecosystem (Black et al. 2012). While honeybees are making headlines due to their population declines and are more closely studied, native ground-nesting bees are less studied and are found to be more effective in pollination for rangelands. Furthermore, conserving habitat for native bees is important for the health and longevity of grasslands because these species pollinate important native plants (Black et al. 2012). Disturbance effects on important floral resources have been well documented to impact population structure in bees, but less research has been conducted on the role of nesting habitat (Potts et al., 2005) even though most species of bees nest in the soil (Cane 1991). Therefore, understanding how to protect nesting habitats is a small but essential part of conservation (Cane et al., 2007; Potts et al. 2005). The Pacific Northwest Bunchgrass Prairie is part of a large grassland system that spanned over 8 million hectares across much of Oregon, Washington, Idaho, and Montana (Tisdale 1982). 64,000 ha remains and is known as the Zumwalt Prairie Preserve (ZPP), located in Northeast Oregon and is home to a large variety of pollinators and is comprised of native prairie sites and reseeded old fields. However, there is currently no published study examining the implications of reseeded old fields for native ground-nesting bee habitat. Three soil surface (top to 20cm) characteristics stand out including; bare ground, soil moisture, and soil compaction (soil hardness) between native prairie and reseeded old field sites. This study found that soil moisture was not significantly different between the sites, soil compaction between the depths of 0-15cm was significantly different and little difference was found between 15-20cm. Bare ground higher in reseeded old fields compared to native prairie sites.

Poster Session Monday 2: Poster Pod 22, Poster 127

EVOLUTION OF CONSERVATION EASEMENTS IN CALIFORNIA'S SIERRA VALLEY

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ABSTRACT

The 120,000-acre Sierra Valley is rich in wildlife and is widely viewed by conservation groups as a unique ecological resource. At the same time, the valley maintains a strong ranching culture virtually unchanged for generations with commercial family ranches comprised of irrigated meadows and seasonal cattle grazing. The valley is also a key part of the Pacific Flyway and located at the headwaters of the Middle Fork of the Feather River that contributes to the California State Water Project, providing water to millions of Californians and irrigation water for Central Valley agriculture. Thus, there is a strong interest in providing conservation easements to maintain this special landscape. The first conservation easement was completed in the Valley in the 1990's. Since then, various funding sources have provided a consistent flow of funds to acquire easements, preventing habitat fragmentation and preserving the ranching culture in perpetuity. Recently, easements required approval of deeded terms by the local Board of Supervisors. Therefore, creating questions amongst elected officials, county department staff and the ranching community on the terms included within the most recent easements proposed in comparison to easements recorded over the past two decades. The analysis of the conservation easements in the Sierra Valley will assess: 1) Evolution of deeded restrictions placed on working ranches over the past quarter of a century, specifically agricultural and ecological terms; 2) Deeded terms dependent on specific conservation easement funding programs (e.g. US Department of Agriculture, California Cap and Trade: Sustainable Agricultural Land Conservation Program) and easement holders; 3) Landowner perceptions and opinions on conservation easements in the region. The outcomes of this project provide insight for ranchers interested in conservation easements, easement funding entities and local government.

Poster Session Monday 2: Poster Pod 22, Poster 128

PRIVATE LANDS STEWARDSHIP: A MODEL FOR LANDSCAPE-LEVEL CONSERVATION IN THE WEST

Jennifer Perkins*[1], Lauren Connell[2], Angela Dwyer[2]; [1]Bird Conservancy of the Rockies, Steamboat Springs, CO, [2]Bird Conservancy of the Rockies, Fort Collins, CO

ABSTRACT

Bird Conservancy of the Rockies has conserved birds and their habitats for 30 years through an integrative model of science, education, and private lands stewardship. Private lands stewardship is vital to bird conservation, as more than 70% of land in the U.S. is privately owned. Our network of 12 Private Lands Wildlife Biologists are strategically located throughout the Intermountain West in partnership with state and federal wildlife and agricultural programs to deliver voluntary restoration, enhancement, and conservation of critical bird habitat on private lands. Collectively, our stewardship team has conserved and enhanced 1.2 million acres of wildlife habitat since program implementation in 2008 through improved management, infrastructure development, and education in our local communities, leveraging more than $24.5 million in Farm Bill funding, and reaching thousands of people with our conservation message. We present an innovative approach to landscape-level conservation through examples of successful conservation of critical habitats on private working lands across six states in grass- and shrub-lands, wetlands, and forested ecosystems. We also focus on project challenges and lessons learned to facilitate future interdisciplinary landscape conservation efforts on private lands through public-private partnerships.

Poster Session Monday 2: Poster Pod 22, Poster 129

USING REMOTE SENSING TO PREDICT SAGE GROUSE CONSERVATION CREDITS

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ABSTRACT

The Nevada Conservation Credit System is an innovative system that ensures habitat impacts from man-made disturbances are fully compensated by long-term enhancements and protection of Sage-grouse habitat. Because not all landscapes are high value Sage-grouse habitat it can become very costly to assess land for credits with the possibility that the lands assessed do not produce any credits. One way to overcome this issue is to use remotely sensed cover data to determine where Sage-grouse credits are and more importantly where they are not before committing to expensive on-the-ground assessments.

Poster Session Monday 2: Poster Pod 22, Poster 130

LANDSCAPE IMPACTS OF UNMAINTAINED SOIL AND WATER CONSERVATION STRUCTURES

Mary Nichols*; USDA-ARS Southwest Watershed Research Center, Tucson, AZ

ABSTRACT

Water development has been crucial to population expansion into the western US, and the rangelands within have been fundamentally altered by the construction of wells, stock tanks, water spreader berms, and diversion channels to support agriculture and livestock production. In addition, structures to control erosion, such as contour berms, check dams and lateral channel protection berms can be found in many rangeland watersheds. Once built, soil and water conservation structures are a primary control on drainage pathways that are altered intentionally to detain, redistribute, or store runoff, or unintentionally as re-organized runoff creates incised channels, exacerbates erosion and sedimentation, and creates gully knick points. Soil and water conservation features were identified and mapped within the 72 km long Altar Valley in southern Arizona. A spatially explicit database of the structures and their condition was populated by visually interrogating imagery from 2016 within Google Earth complimented with 1m digital elevation models created using aerial LiDAR data. Many of the structures experienced either a breach through the structure or scour around the structure that concentrates runoff and causes incision. Almost half of 59 identified lateral channel protection berms (41%) have been breached and 17% have experienced lateral scour; 15% of 667 shorter earthen water spreader berms have been breached and 29% have experienced lateral scour. Topographic modifications associated with conservation structures are influencing runoff patterns and geomorphic processes within the valley. These findings are not unique to the Altar Valley and have application to rangelands managed for livestock grazing in semiarid regions throughout the world where failure to incorporate the impact of manmade structures can lead to fundamentally misunderstanding of the drivers of both landscape evolution and restoration potential.

Poster Session Monday 2: Poster Pod 22, Poster 131

FIELD ESTABLISHMENT OF LITTLE BLUESTEM IN A DROUGHT YEAR

Tim Springer*; USDA, Woodward, OK

ABSTRACT

Drought is the leading cause of plant establishment failure. This research investigated the percentage field emergence of seven little bluestem, *Schizachyrium* scoparium, populations (NU1, NU2, UC1, UC2, UO1, UO2, and UO3), three selection generations (C0, C1, and C2), and two cultivars (Aldous and Cimarron). Recurrent selection was used to develop seven cycle 1 (C1) and seven cycle 2 (C2) lines from seven cycle 0 (C0) lines creating 14 lines selected for increased seed germination in water of potential –0.8 MPa. Plots of the 23 lines were planted at Enid and Woodward, Oklahoma and Knox City, Texas in a randomized block design replicated four times. Plant counts were collected 30, 60, 90, and 365 days after planting (DAP) using a frequency grid. Data were analyzed separately by site with line, DAP, and their interaction as fixed effects. Random effects were block, block in line, and block in site × DAP interactions, and DAP as a repeated measure. Moderate to extreme drought occurred during the establishment period across all sites in 2018. The percentage field emergence decreased from 30 to 90 DAP at Knox City but increased across the same period at the other sites. For all sites, percentage emergence varied with line ($P < 0.05$), and except for Enid, varied with DAP ($P < 0.05$). Approximately 6% of the seed that did not germinate in 2018 germinated and produced a plant in 2019. Lines selected for increased germination had 58% greater establishment compared with non-selected lines. At Enid and Knox City, line UO2-C2 had field emergence comparable to Cimarron, but greater than that of Aldous after 365 DAP. At Woodward, line UO2-C2 had significantly greater field emergence compared to either cultivar. Thus, selection for increased seed germination in little bluestem populations resulted in better field establishment during a drought year.

Poster Session Monday 2: Poster Pod 22, Poster 132

BULLETS, BISON AND BIG BLUESTEM. JOINING ARCHEOLOGY AND RANGE SCIENCES TO RECONSTRUCT A HISTORIC ECOSYSTEM

Tyler Bain[1], Caitlin Gillespie[1], Hunter Hamel[1], Keegan Lancaster[1], William Purdy[1], Kyrsten Wolterstorff*[1], Clayton B. Marlow[1], John Fisher[1], Raymond Schell[2]; [1]Montana State University, Bozeman, MT, [2]Montana Fish, Wildlife and Parks, Decker, MT

ABSTRACT: UNDERGRADUATE STUDENT

A challenge facing rangeland managers is identification of an appropriate baseline for evaluation of ecological health. Most often this challenge has been met through use of ecological site descriptions (ESD's) with associated state and transition models. Even though ESDs have been constructed from years of monitoring data, the resulting information may not represent ecological conditions prior to the advent of range monitoring. This is illustrated by the effort to develop an ecological baseline for managing natural and historic resources at Montana Fish, Wildlife and Parks (MFWP) historic Rosebud Battlefield State Park. The primary goal of MFWP is to preserve and protect historic artifacts and resources while promoting a healthy ecosystem. In addition to being the site of the 1876 battle between Lakota and Cheyenne forces and the US military and allies, the park also protects a bison procurement site or *pisskan* that was used on multiple occasions as far back as 3,000 years ago. To preserve the historical setting of this landscape park managers, want *viewshed* conditions as close as possible to conditions that existed during both pre-contact bison hunting and cavalry battle periods. Because ESD's were not developed to reconstruct earlier plant community complexes we sought help from archeology to examine landscape and soil features at the *pisskan* to determine the historic extent of pines and sagebrush within the Park. In the process range scientists were able to share information on seasonal plant community features that would attract and sustain bison herds. Earlier archaeological investigations revealed periods of bison procurement interspersed by times when bison were not harvested. Insights from range scientists could contribute explanations about these bison harvest fluctuations through time. This project opens a new door for collaborative efforts between archeologists and range scientists that can yield more accurate views of the state of rangelands over time.

Poster Session Monday 2: Poster Pod 23, Poster 133

ENHANCING IRRIGATED PASTURE FOR MULTIPLE ECOSYSTEM BENEFITS

Danny J. Eastburn*[1], Grace E. Woodmansee[2], Josh Davy[3], Morgan Doran[4], Betsy Karle[4], David Lile[5], Daniel K. Macon[6], Carissa Koopman Rivers[7], Tracy Schohr[8], Laura K. Snell[9], Kenneth W. Tate[10], Leslie Roche[2]; [1]UC Davis, Woodland, CA, [2]UC Davis, Davis, CA, [3]UC Cooperative Extension, Red Bluff, CA, [4]UC Cooperative Extension, Woodland, CA, [5]UC Cooperative Extension, Susanville, CA, [6]University of California Cooperative Extension, Auburn, CA, [7]UC Cooperative Extension, Yreka, CA, [8]UC Cooperative Extension, Quincy, CA, [9]University of California, Alturas, CA, [10]Plant Sciences Department, UC Davis, Davis, CA

ABSTRACT

California's irrigated pastureland includes valley, foothill, and mountain meadow pastures and accounts for nearly 500,000 acres across the state. Irrigated pasture is 3rd among agricultural water users statewide and is increasingly scrutinized. Irrigated pastures are a critical resource for livestock producers. As a key component of California's annual forage calendar, they provide high quality forage, management flexibility, and short-term alternatives in drought. Enhancing adoption of sustainable management strategies and efficiency of inputs on irrigated pasturelands is critical to farming and ranching economic viability, and environmental quality. Our irrigated Pastureland Enhancement Project aims to provide research and resources for irrigated pasture operators. We are conducting a field survey of irrigated pastures and working with cooperators to develop on-ranch demonstration sites and field-workshops to highlight collaborative research findings, manager expertise and experience, and best management practices. This project is deployed a cross-sectional survey of on-ranch management strategies and a manipulative defoliation experiment nested across 35 sites with the cooperation of 23 producers (4,000 acres total) across California. Across these sites we were able to capture a gradient of irrigation (wild flood – pivot), grazing (set stock – rotation/haying – stocking rates), and nutrient (none – annual fertilization) management intensity. We collected data on forage productivity and utilization, forage composition and quality, soil fertility and moisture, and the soil microbiome. We also nested a forage defoliation experiment across these 35 sites in 64 ft2 caged exclosures. This consisted of defoliating the heights of plants to the soil surface, 2", 4" and 6" at permanently marked 1 ft2 plots at multiple timesteps throughout the grazing season to simulate grazing intensity. We measured the response of forage composition, basal cover, and harvest biomass. Our preliminary results suggest a decline of productivity with the lower vegetation defoliation heights, but this was dependent on initial plant community and irrigation system.

Poster Session Monday 2: Poster Pod 23, Poster 134

ARTIFICIAL FLOATING ISLANDS AS A TOOL TO IMPROVE WATER QUALITY FOR LIVESTOCK

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ABSTRACT

Elevated water-soluble sulfates are implicated as a cause of reduced productivity and sudden death in range cattle after ingestion of reservoir water. Sulfates may be reduced by expensive water purification systems (i.e. reverse osmosis) and potentially other systems (e.g. bioreactors and artificial floating islands [AFI]) known to control excess nitrogen. AFI's are made up of layers of a non-woven, non-toxic durable matrix of polyethylene terephthalate fibers (BPA free recycled plastic bottles) and are fitted with planting pockets for growing advantageous plants. Using islands to reduce sulfate in reservoir stock water has not been previously researched. The aim of this study was to determine conditions needed for establishment of sown and naturally occurring plants on islands. Seven 5'x10' Biohaven® Islands were located in 2 reservoirs in eastern Montana. As a first step in evaluating the efficacy of AFI for sulfate management, we measured the ability of sulfur (S) accumulating plants to establish and grow on AFI. We planted *Stanleya pinnata*, a native mustard, in two years (2018, 2019).   In 2018, *S. pinnata* seeds were sown on AFI. In 2019, we propagated plants in a greenhouse and included other S-accumulator plant species such as *Astragalus racemosus, Helianthus maximilliani* and *Brassica oleracea*. Plants were germinated in March and transplanted to AFI in June. We measured survival of seeds sown (2018), transplants (2019), and natural recruits (2018, 2019). In 2018, few *S. pinnata* plants established and none overwintered. In 2019, *S. pinnata* transplant survival varied from 23% to 67% per reservoir. In September 2019, the total number of established plants (transplanted and naturally established) ranged from 649 to 976 plants. These preliminary results indicate the difficulty of having (terrestrial) S-accumulator plants establish and grow on AFI. Transplanting seedlings, however, increased establishment compared to sowing seeds.

Poster Session Monday 2: Poster Pod 23, Poster 135

SOIL WATER CONTENT AND WATER POTENTIAL INTERACTION OF FOUR REPRESENTATIVE PLANTS FROM A CONSERVATION WETLAND

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ABSTRACT: MS STUDENT

Plant water potential (WP) and volumetric water content (VWC) are particularly significant parameters to understand soil moisture and water dynamics on plants. Therefore, determining their interrelationships is important to understand soil and vegetation dynamics in wetlands. Our objective is to understand the effect of VWC reduction on the WP of four plants from a conservation wetland in the Willamette Valley during the dry season. We are interested in the correlation between VWC and WP. We hypothesize that some plants are more tolerant to VWC reduction. Results of this study contribute to wetland management practices in terms of ecosystem conservation and restoration. Target plant species were *Juncus patens* (grooved rush), *Juncus effusus* (soft rush), *Typha latifolia* (cattail), and *Scirpus microcarpus* (panicle bulrush). Fifteen plots were established based on their locations in the wetland, with 3 plots for each plant species. WP was measured from three samples of each species during pre-dawn and midday. VWC was measured at 20cm below the surface once per month using a HydroSense II soil moisture meter. Data was analyzed using a two-way ANOVA and a post-hoc Tukey test analysis. Our results showed that all four species responded differently to the changes in VWC. Statistically, *J. patens* and *J. effusus* were the most stressed plants while *T. latifolia* and *S. microcarpus* were the least stressed during the dry season. These results correlate to the VWC in the soil as *T. latifolia* and *S. microcarpus* had a higher VWC whereas *J. patents* and *J. effusus* had a lower VWC. Results suggest that plant responses to soil moisture reductions were species dependent as other environmental conditions remained uniform.

PROPER FUNCTIONING CONDITION ASSESSMENT OF THE NORTH TAMIR RIVER, MONGOLIA

Rentsenkhand Munkhbat*[1], Sherman R. Swanson[2], Sukhbaatar. Tsogt[1], Mookhor Khishigjargal[1], Myangan Orgilbold[1], Tuulaikhuu Baigal-Amar[1], D. Bulgamaa[3]; [1]Mongolia University of Life Science, Ulaanbaatar, Mongolia, [2]University of Nevada, Reno, Reno, NV, [3]Green Gold, Ulaanbaatar, Mongolia

ABSTRACT: UNDERGRADUATE STUDENT

In Mongolia, nomadic culture of herding livestock is the main livelihood. During the warm season herders usually live closer to neighbors near surface waters. This study sought to understand how riparian functions apply to the specific plants, soils, and hydrology of places on the Tamir River and some of its tributaries in Mongolia. To adapt management, managers need to understand the nature of the local problem and processes of recovery to prioritize areas for management, set realistic and important objectives, prescribe management, and select monitoring methods that focus upon the mechanisms of recovery and objectives. We did PFC assessment at established study sites. Ideally, we would have assessed reaches delineated to reflect homogenous reaches. The North Tamir River is a low gradient channel in a very wide valley. The lack of confinement leads to a potential for a Rosgen DA (stable braided low gradient (<0.5%) channel with islands stabilized by riparian vegetation). At present, channel incision has led to a foreseeable future closer to a C channel with many islands. Some tributary streams have an E potential (very poorly entrenched, low gradient narrow channel with high sinuosity). Enlarged width has increased channel size and decreased floodplain access. Their lack of sinuosity will take a very long time to correct and a stable channel with less bank erosion and more floodplain access on a smaller floodplain inside an incision is a more near-term potential. Riparian areas were functional at risk with a central theme of overgrazing. Control of timing of grazing is needed to enable riparian herbaceous plants to recover and trees to establish and escape the height of browsing animals.

Poster Session Monday 2: Poster Pod 23, Poster 137

BRINGING RANGELAND TAXONOMY INTO THE 21ST CENTURY

Austin R. Kelly*; S.M. Tracy Herbarium & Texas A&M University, Sidney, TX

ABSTRACT: UNDERGRADUATE STUDENT

With the advancement of DNA sequencing technology, it is easier than ever to determine the relationships between different species of plants and compare previous morphological taxonomic systems to new evolutional knowledge we have by comparing genetic material. How these molecular relationships relate to practical rangeland management, however, has mostly been overlooked. New geneticists are being hired in universities around the country, yet our college courses in agrostology and rangeland taxonomy have remained relatively unchanged for several decades. Herbarium collections continue to be made the same way as they have since the first botanists explored the United States. Science is advancing through new types of research conducted using the data held in herbaria, including genomics and biogeography. This research is not efficiently implementing into our range science departments for future rangeland professionals to readily access. Genomics, though underutilized in our field, can distinguish traits in plants like invasiveness and palatability. Taxonomy and systematics are changing very rapidly with modern technologies, so it is important to keep as many practical skills previously taught in rangeland curriculum as an integral part of what students learn. These may include accurate plant identification, understanding of wildlife and livestock utilization, and being able to use taxonomic knowledge as an efficient tool. Easily accessible herbaria databases are growing, and so are large-scale citizen-science projects, like iNaturalist and Pl@ntNet. Delineating these databases can develop more accurate local inventories. This would allow managers to make more accurate plant identifications for surveys, enhance data collections, and make more informed decisions on plant selection for various restoration or seeding projects. Learning to convert molecular knowledge into practical, shareable tools is becoming increasingly necessary. Translating a modern view of plant taxonomy into a format that rangeland managers can use will require long-term transformation, but it starts with the illumination of these ideas.

Poster Session Monday 2: Poster Pod 23, Poster 138

GEOGRAPHICAL AND SEASONAL VARIATION IN WATER HEMLOCK (*CICUTA MACULATA*) TOXINS

Clint Stonecipher*[1], Kevin D. Welch[2], Stephen T. Lee[2], Daniel Cook[3]; [1]USDA-ARS-PWA-PPR, Logan, UT, [2]USDA-ARS-PPRL, Logan, UT, [3]USDA ARS Poisonous Plant Research Laboratory (PPRL), Logan, UT

ABSTRACT

Water hemlock (*Cicuta maculata*) plants are found in wet areas including small stream beds, river banks or marshy areas and are toxic to all species of livestock. The variation in toxicity between plant populations from different geographical locations is unknown. In this study, the variation in cicutoxin and total polyacetylene compounds in different water hemlock populations across the Great Basin of North America and the concentration of the toxins in the various plant parts over the growing season was evaluated. Water hemlock plants were collected from six locations in Colorado, Idaho, Utah, and Wyoming in July 2016. Plants were also collected in Utah during 2017 at five different plant phenological stages (early vegetative, vegetative, flower, green seed, and dried seeds). Cicutoxin and total polyacetylene concentrations were determined on all plant samples using reversed phase high performance liquid chromatography. Cicutoxin was highest at the Gunnison, CO (P = 0.035) location and similar between the other five locations. Total toxin concentrations were similar between the six locations (P > 0.05). However, there were large differences in the cicutoxin and total toxin concentrations between plant parts (P < 0.001). The highest concentrations were found in the tuber with lower concentrations found in the stem, leaf, and seeds. Cicutoxin was highest in the stem at the early vegetative stage and decreased over the season. Total toxin concentrations present in the stems and leaves remained constant throughout the season. Total toxin concentrations of the seeds were high and there was no difference between green and dried seeds. The toxic compounds are found in all plant parts, with tubers posing the greatest risk. Results from this study suggest that water hemlock plants across the Great Basin present a similar poisoning risk to livestock and caution should be taken when plants are found within grazing areas.

Poster Session Monday 2: Poster Pod 24, Poster 139

USING AREAL COMPOSITION OF RIPARIAN VEGETATION COMMUNITIES TO IDENTIFY THRESHOLDS IN PRAIRIE STREAMS

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ABSTRACT

Riparian areas often have multiple plant communities that may change rapidly due to seasonal hydrological shifts, and variation of those plant communities may not necessarily indicate transitioning ecological status. Thus, while plant communities are often used to assess land ecological status in upland systems, applying that principle to riparian systems may not be appropriate. Geomorphic parameters may be better indicators of a transition in ecological status, but they cannot be understood separately from plant community dynamics. This research assessed stream geomorphology and riparian plant communities along 34 reaches of 8 streams in North Dakota, USA. The area of three plant community components (PCC) associated within riparian complexes were mapped, and stream cross-section and longitudinal profile data were collected to classify Rosgen stream channels into stable (E and C channels), stabilizing (B channels), and unstable (F, and G channels) states. The area of PCC1, the community nearest the stream bank consisting of wetland obligate species, was similar among stable and unstable streams, but PCC2 and PCC3, transitional plant communities, had greater area along stable reaches than along unstable reaches. Thus, the proportion of PCC1 in stable reaches was much lower (≈25%) than in unstable reaches (≈75%). Entrenchment ratio was the only stream parameter that was a good predictor of PCC areas, likely due to its relationship with floodplain connectivity. These findings may be valuable in developing riparian complex ecological site descriptions, specifically identifying potential thresholds between the unstable and stable states.

COMPARISON OF UNMANAGED WILD HORSE AND MANAGED CATTLE GRAZING ON TWO RIPARIAN SPRINGS

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ABSTRACT

There is sometimes skepticism regarding the negative influence of wild horse overpopulation on natural resources. Cattle grazing is often villainized as the origin of poor ecosystem health and is the first factor to be removed in an attempt to alleviate disturbance. However, when proper management is implemented, cattle grazing can have minimal impacts. This study took place within the Devil's Garden Wild Horse Territory, a semi-arid sage steppe ecosystem managed by the Modoc National Forest located in northeastern California. Horse populations have significantly increased beyond the appropriate management level and expanded outside of the designated territory. Our objective was to compare the effects of wild horses and cattle on springs and riparian health. Two uniquely located springs about 450 feet apart were selected for data collection. While their close proximity reinforced similar soil types and topography, they were divided with a fence which allowed for side by side comparison between the two management types and distinguished between private and public land. Streambank alteration, vegetation stubble height, water quality (temperature, pH, turbidity, dissolved oxygen), and macroinvertebrate presence were recorded at each spring every 20 feet starting at the headwaters for a total distance of 140 feet. Our assessment also included a review of 4 years of vegetation data history at the public spring. Approximately 300 horses were gathered from the allotment over the past 3 years. The results from our data collection indicate that the spring impacted by wild horses was in lower ecological condition than the one on private land. However, based on historical stubble height data, it seems to be in a state of recovery.

Poster Session Monday 2: Poster Pod 24, Poster 141

DURATION AND INTENSITY OF LENTIC MEADOW USE BY FERAL HORSES, LIVESTOCK AND WILDLIFE ACROSS NEVADA

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ABSTRACT: MS STUDENT

In Nevada many lentic meadows on public lands are non-functional or functionally at risk, threatening the stability of these valuable riparian areas. Native wild ungulates, domestic cattle (*Bos taurus*), domestic sheep (*Ovis aries*) and federally designated wild horses descended from feral stock (*Equus ferus caballus*) all use and benefit from functional meadows. When overpopulated or mismanaged they may also contribute to meadow degradation. We used time-lapse trail cameras in 2016, 2017 and 2018 to establish the timing, duration and number of grazers using 12 meadows across Nevada where both cattle and wild horses graze. We determined what opportunity for recovery was available to the plant community in each meadow and how each ungulate species contributed to these patterns of use and recovery. The intensity of use was determined by examining two short term indicators of use, stubble height and hoof-alterations. Two cages per meadow were used to see what stubble heights were possible at each meadow given a full growing season of rest. The relative contribution of each species of grazing animal to the reduction in stubble height at each meadow was determined based on camera data use and standardized by animal unit equivalents. All meadows were determined to be functionally at risk. Few meadows had substantial recovery periods (periods with light or no grazing) during the growing season. Stubble height reductions were severe by the end of the growing season and stubble heights remained low during the entire growing season for most meadows. Hoof alterations were high for many meadows. Under current management, the intensity and duration of grazing by wild horses, livestock, and wild ungulates is negatively impacting the functionality of many meadows in Nevada, especially where wild horse numbers are high and where livestock graze meadows for long periods of the growing season.

Poster Session Monday 2: Poster Pod 24, Poster 142

WILD HORSE AND CATTLE USE OF NEVADA SPRING MEADOWS: HYDROLOGIC GRADIENTS DRIVE VEGETATION RESPONSE

Jacob M. Burdick*[1], Sebastian A. Tsocanos[2], Sherman R. Swanson[1]; [1]University of Nevada, Reno, Reno, NV, [2]University of Nevada Reno, Reno, NV

ABSTRACT: MS STUDENT

Nevada spring meadows are less water limited than the surrounding cold desert ecosystem. Abundant water supports stabilizing wetland plants that capture sediment, reduce overland flow energy, and prevent erosion. Enhanced forage and available water also attract grazing animals that can degrade riparian vegetation through prolonged overuse. We recorded ungulate use at 12 Nevada spring meadows in overlapping public land grazing allotments and wild horse territories (Forest Service) herd management areas (Bureau of Land Management). Wild horses used study sites most intensely followed closely by cattle. Native ungulate use was negligible. Higher intensity of use resulted in more hoof print alterations and greater bare ground along the wettest parts of perennial spring sites where monitoring was most informative. We noticed significant vegetation degradation due to inadequate rest and recovery time between grazing events.

Poster Session Monday 2: Poster Pod 24, Poster 143

GRAZING OF FREE-ROAMING HORSES ON AQUATIC MACROPHYTES IN THE SALT RIVER, ARIZONA

Thomas M. Krebs*; Brigham Young University, Provo, UT

ABSTRACT: Ph. D STUDENT

The interactions between free-roaming horses and desert river systems are not well studied. Horses located in close proximity to the Salt River in Mesa, Arizona graze freely between upland and aquatic habitats. The purpose of this research is to assess the behavior of horses grazing on aquatic macrophytes in the Salt River and to evaluate the importance of the river to the diet of the horse population. In December 2018, and in March, June and September 2019, I observed horses for 30 hours each month and observed the selectivity for specific aquatic plants, the seasonality of aquatic grazing and the depths to which horses will wade and submerge their head. I used a Chi-square goodness-of-fit test to determine the seasonality of horse grazing and collected upland and aquatic forage plants to conduct a nutrient analysis. Results show that horses strongly favor grazing on aquatic macrophytes during the Fall (88.5% of all observations) when upland forage is limited. Qualitative descriptions of the grazing behavior show that horses graze within the river submerging over half the abdomen. Horses will plunge their heads over their eyes routinely to bite vegetation. However, horses were not observed submerging their ears in the 131 total observations. Horned pondweed (*Zannichellia palustris*), sago pondweed (*Potamogeton pectinatus*), leafy pondweed (*Potamogeton foliosus*) and tapegrass (*Vallisneria americana*) were the dominant macrophytes consumed and contained similar amounts of protein, more calcium, less carbohydrates, and an order of magnitude more iron and sodium than upland plants. This preliminary work shows that horses in this desert landscape may obtain a large percentage of their nutrition from aquatic sources in the Summer and Fall. Prudent strategies to manage free-roaming horses along the Salt River should at a minimum account for the amount of the horses' nutritional requirements met from within the banks of the river.

Poster Session Monday 2: Poster Pod 24, Poster 144 – Poster Withdrawn

HARMFUL CYANOBACTERIA BLOOMS AND THE ROLE OF NUTRIENTS ON DES LACS NATIONAL WILDLIFE REFUGE, ND

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ABSTRACT

The lakes on Des Lacs National Wildlife Refuge (NWR) in North Dakota are known to experience elevated nutrient concentrations and poor water quality with severe cyanobacteria blooms during the summer growing season. Livestock grazing is an important grassland management practice for Des Lacs NWR. Unfortunately, cyanotoxins in Des Lacs Lakes have been linked to livestock deaths on the refuge. In 2014, a cooperator lost 24 head of cattle that were grazing on the refuge. Tests from local veterinarians concluded that cattle had ingested cyanotoxins from their water source on Des Lacs NWR and were to blame for the die-off. In 2016, a cooperative project between USFWS and the North Dakota Department of Health Division of Water Quality was initiated to characterize water quality and assess cyanobacteria and cyanotoxin risk to wildlife, livestock and human health. In 2018, North Dakota State University (NDSU) also joined as a project partner. Water quality samples were collected weekly from June-October in 2016-2019 at five sites on Des Lacs NWR. Thus far, data indicates that phosphorous appears to be primary driver of chlorophyll levels and ammonia tends to spike at the end of the season after the bloom begins to die off. Changes in nitrogen levels do not appear to follow chlorophyll changes, suggesting growth is not dependent on nitrogen levels. Additional data collected to be analyzed in the fall of 2019 include the remaining water samples, phytoplankton identification and sediment samples. Results from this study will be utilized to help improve water quality and management of cyanobacteria blooms at Des Lacs NWR as well as other sites in the Midwest.

Poster Session Monday 2: Poster Pod 25, Poster 145

VALUING U.S. CATTLE RANCHING BASED ECOSYSTEM SERVICES

Anna T. Maher*[1], Kristie Maczko[2], David "Tex" Taylor[3], Nicolas E. Quintana Ashwell[4], John A. Tanaka[3]; [1]University of Wyoming, Portland, OR, [2]Sustainable Rangelands Roundtable - University of Wyoming, Laramie, WY, [3]University of Wyoming, Laramie, WY, [4]Mississippi State University, Stoneville, MS

ABSTRACT

The 2017 Census of Agriculture estimated that there were over 640,000 agricultural operations classified as beef cattle ranches and farms in the U.S. Discussions about the societal contribution of beef cattle ranching have recently expanded beyond the value of beef production in order to acknowledge less commonly quantified values from ecosystem services, including those associated with the conservation of land use for beef cattle production. Rangelands that support beef cattle ranching provide habitat for wildlife, recreation and open space amenities, spiritual values, and sustain a way of life. A 2019 study that used primarily 2012 data considered the value of ecosystem service flows from forage production, general ecosystem services (estimated from Conservation Reserve Program payments), and wildlife recreation—finding the combined value at the national level to be $14.8 billion; that is $726.01 per beef cow or $0.86 per pound of retail beef. This is thought be an underestimated value for two reasons: 1) 2012 was a relatively low cattle production year due to the state of the national economy and wide-spread drought conditions and 2) the study focused on ecosystem services from private acreage (no public land acres were considered). According to the Bureau of Land Management (BLM) website, the BLM issues nearly 18,000 permits and leases for grazing livestock on an estimated total of 155 million acres—that is approximately 60% of the 274 million acres designated as private pasture and range as estimated in the 2012 Agriculture Census. This information suggests that the value of these ecosystem services may be significantly greater than current estimates. This poster presentation provides preliminary results of a current valuation study of cattle-based ecosystem services that includes 2017 Census of Agriculture data and ecosystem services flows from both private and public grazing lands.

ECONOMIC SUSTAINABILITY OF A PERENNIAL GRASS SYSTEM GRAZED BY STOCKER CATTLE

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ABSTRACT: MS STUDENT

Farm diversification in Nebraska has decreased over the last two decades. In 2000, 3.4 million ha were planted to corn (*Zea mays* L.) but increased to 4.0 million ha by 2018. This increase was due to conversion of perennial grasslands to row-crop production when grain prices increased. Historically, grasslands have existed on marginally productive land. Corn prices have since moderated and planting row crops on marginally productive land is not as profitable. One solution to increase net return is to diversify farm enterprises. Converting marginally productive cropland back to perennial grassland is an opportunity to integrate grazing animals into the production system to increase economic and environmental resiliency. A field-scale experimental site was established in Eastern Nebraska on marginally-productive, poorly drained cropland. In 2018 and 2019, 18 yearling steers grazed 4-ha of 'Newell' smooth bromegrass (*Bromus inermis* L.) in spring and autumn (87 kg beef ha-1). During summer, the herd was equally divided prior to grazing 4-ha of 'Liberty' (72 kg beef ha-1) or 4-ha 'Shawnee' (107 kg beef ha-1) switchgrass (*Panicum virgatum* L.) for 3 months. This was compared with 8-ha of continuous corn (8,222 kg grain ha-1). Compared with corn, both perennial grass systems had negative net return when rented based on forage supply calculated as animal unit month ($39 AUM-1). Neither corn nor either perennial grass system had positive net return in 2018. However, all systems had positive net return when land opportunity cost was ignored. Corn returned $193.23 ha-1. Alternatively, when yearling steers were purchased and sold at the conclusion of grazing, both perennial grass systems had positive net returns. Shawnee switchgrass returned $247.49 ha-1 and Liberty switchgrass returned $130.48 ha-1. Data from this research can be used to make informed decisions for integrating livestock on marginally-productive cropland to increase economic and environmental resiliency.

THE WATER FOOTPRINT OF BEEF CATTLE RAISED ON NEW MEXICO RANGELAND

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ABSTRACT

New Mexico (NM) has been identified as the state in the US that will likely be most adversely impacted by climate change and associated water stress. Roughly 92% of NM is considered to be rangeland most of which is grazed by beef cows. We calculated the blue (surface and ground water) and green (water from precipitation used by plants) water footprints (WF) of the NM beef cattle industry (cow-calf, backgrounding, and feedlot). Annual feed requirements for each animal unit (AU) in cow-calf operations was calculated using 2% of their body weight as their daily dry matter requirement. Aboveground net primary production (ANPP) was predicted as a function of mean annual precipitation (MAP) as ANPP = -34+0.6*MAP. Calves were assumed to be 0.4 AU at weaning, then backgrounded until 0.6 AU, and finished in feedlot at 1.3 AU. A 65% dressing percentage was used at all stages. Each AU was assumed to require 1.36 kg of supplement/day during the cow-calf stage and that cattle were supplemented for 2, 3 and 4 months/year on good, average, and drought years, respectively. Drinking water demand in the cow-calf operation was calculated following the literature. Feed conversion ratios of 8:1 and 5:1 were used for backgrounding and feedlot, respectively. Calves were assumed to graze on irrigated winter wheat and alfalfa pastures during backgrounding, and feedlot ration was assumed to be 12% alfalfa hay, 60% corn, 8% distiller grains and 20% other feed crops and minerals. Drinking water consumption for backgrounding and feedlot was calculated as 4 L/kg DMI. This analysis indicated that the weighted average WF of NM beef cattle was 28,203 L/kg meat. Blue WF was 18% of the total WF (i.e. 5,077 L/kg meat) which is relatively low compared to the blue WF of urban users and staple irrigated crops grown in NM.

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DEVELOPMENT AND CHANGING POLICIES TRANSFORMING THE FACE OF RANGELANDS IN BHUTAN

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ABSTRACT

Rangelands in Bhutan are poorly defined. The equivalent term in Bhutanese language is *tsamdro,* which literally translates to pasture and covers alpine and sub-alpine meadows, to temperate and sub-tropical grasslands, shrublands and forests' understory. It is difficult to provide exact area of the pastures as these have not actually been surveyed because of the expanse. The acreages are based on the guess taken from a vantage points during the cadastral survey and land registration process. Taxes were then calculated based on this guestimate. Forest use and agricultural systems have evolved as an inalienable part of a holistic agricultural system in Bhutan. Some 20 - 24% of the total dry matter requirement for cattle is estimated to come from forest grazing. The age old integrated system is often criticized by the foresters viewing as damaging to the environment. Pastoralism was widespread in the Himalayan range by the eight century. It is plausible to suggest transhumant ago-pastoralism as the predominant system, perhaps formed the primary vocations of earlier Bhutanese. The first signs of people herding cattle in the mountains and gradually moving down to fertile valleys were noted as early as 4000 years ago in Bhutan. Transhumant yak and cattle system also formed the main sector early theocratic and initial monarchic governance systems relied on for maintenance of the state system. Pastoralism and transhumance in the Himalayan region occur in areas that are remote and forested and in open highlands where cropping lacks comparative advantage. Early forms of recording and awarding entitlements occurred since the 1800s. Grazing land titles were incorporated with area measurements only during 1960s and 1970s . Number of subsequent reforms and land use policies consistently tried to centralise and make these rangelands state land and discourage inter-district transhumant movement. Today rangelands continue to decline owing to competing uses in the name of development and as a consequence of changing policies. Many infrastructures have come up in the rangelands, including local government offices, community centres, agriculture and livestock extension offices, forest range or park offices, gates, schools, village banks and farm shops, etc. Open rangelands have also reduced due to spread of rhododendron shrubs. Traditional rangeland management practices meant clearing these bushes and being burnt to allow grasses to grow. The forest policy of 1969 banned use of fire which resulted in spread of rhododendron shrubs thus reducing area with open grassland.

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PROFITABLE GRAZING SYSTEMS FOR IMPROVED LANDSCAPE CONDITION AND SUSTAINABILITY REPORTING

Mick J. Taylor*; Rangeland management, Brisbane, Australia

ABSTRACT

Feedbase Four – grassroots pathways to a profitable grazing system
The Meat and Livestock Australia (MLA) Australian Feedbase Investment Plan (FIP) provided a $50 million five-year research project to address season feed gaps in a changing environment/climate. The research successfully identified key knowledge gaps and opportunities for Australia red meat producers. Critical analysis of the research revealed that nearly 80% of Australia's grasslands are underperforming, with a potential fivefold productivity increase in above-ground dry matter (DM) available if farmers addressed root and plant disease, nitrogen fixation/modulation, soil pH issues and improve feedbase utilisation. Over 75% of Australian grazing enterprises able to greatly improve profitability and productivity by simply increasing their skills /capacity to manage pasture quantity, quality and utilisation. Additionally, research identified a limited awareness of natural indicators of declining plant health and rundown in land condition. Cost benefit analysis found a minimum 20% improvement in productivity can be achievable by simply following grazing best management practices. Lack of uptake of grazing best management practice are compounded by gaps in core skills/extension opportunities arising from the current user pays extension system in southern Australia. The grazing best management strategy is based on four core elements. The Feedbase Four (F4) - drive awareness, actions and adoption of pasture best management practices. These are: Healthy and productive soil, Productive and persistent pasture, Pasture weeds, and more pasture N. To deliver these initiatives MLA has established the Profitable Grazing System program where groups of producers work together with a leading producer or trainer (a coach), to build a tailored plan to implement grazing best management practice on their individual business. Successful delivery over the next five years will assist deliver our 2030 carbon neutral vision.

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WHAT IS THE FUTURE FOR MONGOLIA'S RANGELANDS?

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ABSTRACT

Encompassing 1.56 million square kilometers, Mongolia is twice the size of Texas. About 75 percent of Mongolia is classified as grazing-land; ranging from desert to steppe to alpine meadows which provide forage for livestock, habitat for wildlife and deliver important watershed functions. Mongolia has a long history of livestock grazing; large mound graves and "deer stones", constructed 3,000 years ago by early nomads and found across Mongolia, are evidence of complex social organizations that once existed on the rangelands. Traditional nomadic pastoralism that existed for millennia was transformed during the socialist period (1921-1990) and especially with organization of collectives in the 1960s – 1980s when livestock production was centralized on state farms. In 1991, with the transition to a market economy, Mongolia experienced another change in land use as state-owned livestock were privatized to individuals and, with the demise of centrally-provided services and markets, the livestock population increased. In 1991, there were 22 million head of livestock; now there are about 70 million head. The increase in livestock numbers has led to widespread overgrazing, range degradation, conflicts with wildlife, disputes over land use, and concerns about the sustainability of current livestock production practices. About 58 percent of Mongolia's rangelands are now considered degraded to some degree. What is the future for Mongolia's rangelands? Can new livestock systems be designed that build on traditional knowledge and age-old practices in order to meet emerging markets for livestock products while sustaining the rangelands? Can rural enterprises be developed to strengthen livestock value chains? What is needed to change herders' thinking to become better stewards of the rangelands? What opportunities can be created for herders to supplement livestock-based incomes? Out-of-the box thinking is needed by range professionals and policymakers to devise innovative approaches to better manage some of the last, un-fenced rangelands in the world.

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Arizona Section: Society for Range Management Excellence in Range Management Award

Philip Bravo, Peach Springs Livestock Association

Grazing on public tribal lands is different than typical public land grazing. Grazing Districts (re: allotments) have multiple producers sharing and utilizing the same resources. Philip Bravo is president of the Peach Springs Livestock Association (8 members) on the Hualapai Indian Reservation and has gained the cooperation of the members to work together to achieve common goals. Through Bravo's leadership, the Association is active in installing range improvements, creating new pastures and flexibility, and increasing grassland forage opportunities through grassland restoration and rotational grazing. Proper grazing and sound drought management have increased carrying capacity from 425 AUMs to 810 AUMs.

Philip Bravo
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Colorado Section: Society for Range Management Excellence in Range Management Award

Oswald Cattle Company – Ranching in Sync with Nature

The Oswald Cattle Company is operated by Steve Oswald and his wife Nancey. Together they are committed to carrying on the heritage of the ranch in a changing world and preserving a legacy for future generations to come while having fun. The ranch is located near Cotopaxi, CO, and consists of foothill and mountain ecological sites on the north end of the Sangre de Christo mountain range. They are a multi-faceted operation, which includes marketing natural grass-fed beef and promoting sustainable, profitable agriculture. The ranch utilizes high stock density and short duration grazing strategy to make their land work for them. The Oswald's have a holistic, three-tiered approach to their ranching business: healthy land, healthy animals, healthy beef. "Ranching in sync with nature" is an underlying management principle of the Oswald's.

Oswald Cattle Company
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Nebraska Section: Society for Range Management Excellence in Range Management Award

Broken Box Ranch's Rangeland Stewardship

The Broken Box Ranch has been owned and operated by four generations of the Sundstrom family in Lincoln County. Russ and Angela Sundstrom are raising the fifth generation to manage their rangeland to promote ecosystems that are productive, restorative, and sustainable in the Loess Canyons Biologically Unique Landscape region of the state. The Sundstrom's emphasize the proactive use of prescribed fire, matching their livestock to the environment, natural habitats for all species of wildlife and quality of lifestyle for their community. Sundstrom's place high priority on sharing their experience with neighbors on invasive species management, grazing strategies, and wildlife.

Broken Box Ranch
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Oklahoma Section: Society for Range Management Excellence in Range Management Award

Open Range Management: Achieving Their Goals

An Oklahoma State University graduate of both rangeland management and wildlife management, former research station assistant superintendent, certified professional in rangeland management and SRM member started up a land management company with goals of making a measurable difference in the Central Great Plains. Since its inception in 2015, Open Range Management has restored degraded rangeland on the 2,500 he leases in Kansas. He has restored over 9,150 acres of tallgrass prairie or cross timbers ecoregions, applied prescribed fire to over 16,000 acres, provided wildlife consulting on 25,000 acres and has worked with over 55 landowners.

Open Range Management, LLC
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Texas Section: Society for Range Management Excellence in Range Management Award

Treadwell Cattle Company: 132 Years with 5 Tools

Treadwell Cattle company in West central Texas adopted all 5 of Aldo Leopold's basic tools, with selective hand cutting and mechanical removal of invasive brush, the plow for improving forage and creating firebreaks, the hoof and grazing impact of rotationally grazed sheep and cattle, fire in a rotational burning program, and the gun (bow) for intensively managed low fence hunting as a model for holistic ranching. As the 4th and 5th generation on the family ranch, the Treadwell's are fire-landscaping the ranch back to its 1st generation potential.

Treadwell Cattle Company
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