2022 Society for Range Management Annual Meeting: ABSTRACTS

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Ecosystem nitrogen stocks in response to western juniper encroachment and control in semiarid watershed systems of central Oregon, USA

Mohamed Abdallah, Ricardo Mata-González, Jay Noller, Carlos Ochoa

Oregon State University, Corvallis/OR, USA

Poster

Abstract

In the Oregon of USA, the control of western juniper (*Juniperus occidentalis*) is an accepted rangeland management practice to restore sagebrush steppe habitats of importance to wildlife and livestock. The effects of juniper cutting on ecosystem nitrogen, however, have not been well addressed although woody plant control has important implications for local watershed management and regional nitrogen pools. We quantified ecosystem nitrogen stocks in two adjacent watersheds, comprised of a treated watershed (most juniper removed) and an untreated watershed (juniper not removed). Thirteen years after juniper removal, we measured aboveground nitrogen stocks for juniper trees, shrubs, grasses, and litter in both watersheds. We also measured belowground nitrogen stocks (roots and soil) in both watersheds at two soil depths (0–25 and 25–50 cm). Aboveground nitrogen stocks were 6.9 times greater in the untreated than in the treated watershed considering the much larger aboveground biomass. However, root nitrogen stocks were 3.1 times greater in the treated one due to the gain of understory root biomass associated with juniper cutting. Soil nitrogen stocks at both 0–25 and 25–50 cm depths were not affected by juniper removal. Overall, total ecosystem nitrogen stocks did not differ between the treated (9536 kg N ha^{-1}) and untreated (9456 kg N ha^{-1}) watersheds. The greatest ecosystem nitrogen accumulation (at least 95% total ecosystem nitrogen) resided belowground (soil 0–50 cm and roots) in both watersheds. This study provides evidence that the benefits of juniper removal can be attained without significantly affecting the capacity of ecosystem nitrogen storage.

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Nutritive potential of native forages in arid rangelands of Tunisia

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Poster

Abstract

Rangelands of Tunisia show a great indigenous species diversity with considerable potential as forage for livestock. However, information on their fodder yield and quality is scanty and restricted to few species. The objective of the study was to evaluate the nutritive values of selected key perennial species based on their biomass yield, chemical composition, in vitro organic matter digestibility (IVOMD), and mineral composition. The species evaluated included four grass species (*Stipa lagascae* Roem. and Schult., *Stipa tenacissima* L., *Stipagrostis plumosa* (L.) Munro ex T. Anderson, and *Stipagrostis pungens* (Desf.) de Winter.) and eight shrub species (*Anthyllis henoniana* Coss. ex Batt., *Argyrolobium uniflorum* (Deene.) Jaub. and Spach., *Echiochilon fruticosum* Desf., *Gymnocarpos decander* Forssk., *Helianthemum kahiricum* Delile., *Helianthemum lippii* (L.) Dum. Cours., *Plantago albicans* L. and *Rhanterium suaveolens* Desf.). Results showed that shrub species contained higher concentrations of the crude protein (CP), acid detergent lignin (ADL), but lower neutral detergent fiber (aNDFom) and acid detergent fiber (ADFom) concentrations than grasses. The greatest concentration of CP was 135 g/kg DM for *R. suaveolens*. The greatest aNDFom concentration was found within the grasses with maximum of 744.5 g/kg DM in *S. plumosa*. The shrub species *E. fruticosum*, *A. uniflorum*, *P. albicans*, *G. decander*, *R. suaveolens*, and *A. henoniana* had the highest IVOMD with over 500 g/kg DM and have the potential to supply energy to livestock. Overall, the moderate to high protein, low fiber, and high in vitro digestibility measured for shrubs, suggest they have high nutritional values and can be used to enhance local livestock production.

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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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Poster

Abstract

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 objectives of our study were 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 (plant situation). Four defoliation treatments: a) single clipping in year 1 (G1); b) single clipping in years 1 and 2 (G2); c) herbicide application in year 1 (H); and d) untreated (control C) 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 (SVWC) was measured using CS655 probes buried in the superficial soil layer at 0-10 cm depth and at 20-25 cm depth under sapling drip lines. SVWC at 0-10 cm was affected by time over the year and its interaction with defoliation treatment ($P < 0.0001$); however, the defoliation treatment had no effect on SVWC, nor did the plant situation. At 20-25 cm depth, SVWC was affected by the levels of defoliation and by the plant situations ($P = 0.047$ and 0.003, respectively); furthermore, SVWC was also affected by the time and the interaction of treatment and time ($P < 0.0001$). Regardless of the plant situation, the mean of SVWC in both soil depths was higher in the H treatment plot (10% and 11%, respectively) during the study period, compared to other treatments. Herbicide treatment and sapling size appear to have a greater impact on the amount of soil moisture at 20-25 cm soil depth. Our results suggest that the levels of defoliation and the sapling's situations would promote increasing water availability in the soil.

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Evaluating Root Sprouting Ability of Yellow-flowered Alfalfa for Persistence in Semiarid and Arid Regions

Abdulallah Alomair, Arvid Boe, Lan Xu

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Poster

Abstract

Forage crops are the foundation of livestock and dairy enterprises in the USA and worldwide. Alfalfa is called the queen of forages because of its high-quality protein and ecological importance of nitrogen fixation. However, alfalfa stand establishment and persistence limit its use in the arid and semi-arid rangelands. Development of new alfalfa cultivars to enhance stand persistence is greatly needed. We conducted a greenhouse experiment with thirteen yellow-flowered alfalfa (*Medicago sativa* subsp. *falcata*) populations from the National Plant Germplasm Core Collection to screen and identify root sprouting ability as potential breeding parental materials in comparison with one commercial cultivar (Final Answer, *Medicago sativa*). One hundred uniform and intact seeds were selected for each entry. Seeds were scarified and inoculated with *rhizobium* before planting in plastic cone-containers filled with potting soil in a greenhouse. After first year dormancy, plants were excavated from soil and the main roots were cut into two six-centimeter root segments at one and seven centimeters below the cotyledonary node. Root segments were planted in Miracle- Gro® potting soil under greenhouse conditions for 16 weeks. Adventitious shoot emergence was recorded during the experimental period. At the end of the experimental period, the number of adventitious shoots, shoot survival and flowering status were recorded. Not all root segments regenerated, and their fate varied among populations. Final Answer, PI 452460, and PI 634106 had zero percentage root sprouting, and PI634133 had the highest frequency (64.86%) root sprouting and survival (29.4%) regenerated shoots from root segments, while PI 634114 root sprouting initiated quicker and continued sprouting was longer than other populations. Results support the value of testing to identify additional populations in the National Plant Germplasm Core Collection which express these traits. Additionally, evaluation under field conditions should precede any selection effort.

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Assessing Precipitation-Vegetation-Groundwater Relationships in a Rangeland Watershed of Northern Mexico

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Contributed Oral Presentation

Abstract

Properly conducted soil and water conservation practices can bring degraded rangelands to a more productive state by helping with water capture and distribution throughout the landscape, resulting in improved vegetation cover and groundwater recharge. The study objective was to characterize precipitation-vegetation-shallow groundwater (<30 m) relationships in a restored 500-ha rangeland watershed in northern Mexico, in the Chihuahuan Desert. Conservation practices such as gabions, grade control structures, small basins, and planting of native shrubland species (*Atriplex canescens*) and (*Prosopis glandulosa*) were conducted during 2012-2015. Hydrologic variables (e.g., precipitation and groundwater) were monitored starting in 2016. Changes in vegetation cover were evaluated using Normalized Difference vegetation Index (NDVI) values calculated from Landsat 8 images. During 2016-2020, the highest and lowest annual precipitations were 367 and 81 mm, recorded in 2019 and 2020, respectively. The yearly difference between peak and lowest groundwater levels ranged from 0.8 m (2020) to 1.9 m (2016). The lowest maximum annual NDVI value was obtained in 2020 (0.2548), and the maximum of maximums (0.4231) in 2019. Correlation analyses showed a strong positive and significant Pearson correlation coefficient between annual precipitation and maximum annual NDVI (R^2=0.916, P=0.029) and between maximum annual NDVI and seasonal aquifer response (R^2=0.96, P=0.009). Annual precipitation and aquifer response showed a strong correlation (R^2=0.915, P=0.029). A regression analysis to compare accumulated monthly precipitation and groundwater level variability showed rise in groundwater level occurred after an accumulated precipitation of 100 mm (R^2=0.72). Study results indicate strong ecohydrological connections exist, and vegetation cover is strongly associated with groundwater recharge at this study site. Findings from this investigation add to the understanding of precipitation, vegetation, and shallow groundwater dynamics in summer precipitation-dominated rangeland ecosystems.

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Targeted Grazing of Common Teasel (*Dipsacus fullonum*) with Sheep in Oregon

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Contributed Oral Presentation

Abstract

Targeted grazing as a vegetation management tool in conservation areas is growing in popularity in both upland and riparian ecosystems. A rotational grazing trial with dry ewes was conducted to evaluate biomass production, vegetation composition, and soil water content in a CREP (Conservation Reserve Enhancement Program) riparian area and Regularly grazed pasture. Grazing in the CREP riparian area was targeted at the invasive biennial forb, common teasel (*Dipsacus fullonum)*. There is limited research on the effects of targeted grazing on teasel. Dominant desirable forage species included meadow foxtail, tall fescue, velvet grass and common vetch. Vegetation composition in the CREP area consisted of 40% grasses, 30% common teasel, 20% rushes and sedges, 7% legumes and 3% dead material. Due to higher soil water content in the CREP area, quality forages persisted longer throughout the year and annual biomass production in the CREP area was higher than in the Regularly grazed pasture (4288 vs 3360 kg DM/ha). This allowed for three grazing rotations in the CREP area, compared to two rotations in the pasture. Two stocking densities were tested, with the higher density treatment achieving greater control of teasel. Grazing while the target species was in early vegetative growth also played a factor to successfully control teasel growth. Palatability of teasel decreased in late summer months and was no longer selected. The results of this study show the potential for effective targeted grazing of common teasel, with sheep and opportunities for stakeholders to bring CREP riparian areas back into production following livestock exclusion. Further long-term monitoring studies are of interest to document changes in species richness and the effect on riparian ecological functioning.

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Outcome Based Grazing: A Suite guide to Open Range Consulting's remotely sensed products

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Contributed Oral Presentation

Abstract

Open Range Consulting (ORC) specializes in remote sensing across Rangelands of the western US, creating products that fulfill the management needs of private ranchers and federal or state agencies. In 2016 ORC mapped upland and riparian plant functional groups across select allotments in the Burns BLM district at a 1 meter scale. Furthermore 30 meter products were developed from the afore mentioned data to address Juniper stands, their understory and The Threat-Based State and Transition Model (TBSTM) regarding sage grouse (*Centrocercus urophasianus)*. Juniper and threat-based mapping was carried out temporally using historical imagery. Juniper phases were determined and partitioned according to canopy densities outlined in The USGS Western Juniper Field Guide 2007. Doherty et al 2021 was used to inform Threat based State and Transition Model mapping (TBSTM). These products were all created with the intent to provide relevant information to on the ground managers and in doing so create a feedback loop to continue effective management into the future.

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Opportunities and Challenges of Grass-finishing on Desert Pastures

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

We are applying survey and modeling approaches to understand the potential for grass finishing beef cattle in desert agroecosystems under future climate expectations. First, we sought to understand the characteristics of current operations and how climate change may impact grass-finishing in the region. We inventoried and surveyed grass-fed beef operations in nine states in the Southwest and Southern Plains and created a web-based map to evaluate their spatial distribution. Survey results showed that: a) grass-fed producers market their cattle in a diversity of ways, although freezer beef was the most ubiquitous, b) producers perceive a number of benefits and challenges involved in raising grass-fed beef and c) some types of decision support tools are clearly preferred over others. The most commonly indicated need for information was regarding drought adaptation and management. Based upon these survey results and key informant interviews, we have initiated two follow-up surveys to better understand the key practices, economics, and market factors influencing viability of grass finishing in the region from the perspective of both producers and processors. Survey data will help parameterize regional socioecological models that characterize current and future grass-finishing potential in western U.S. rangelands, and the role that grass-finishing may have in climate adaptation. A first step in modeling has entailed a preliminary ranch-level economic optimization model that can estimate the profitability of ranching operations under climatic change in New Mexico, with downscaled climate projections used to estimate profitability across cattle genetics and climatic conditions.

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Influence of hide color on the grazing behavior of range fed Raramuri Criollo cattle during five seasons in Southeastern Arizona

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Contributed Oral Presentation

Abstract

Many breeds of beef cattle have a fixed color pattern because selection pressure has been placed on the color to maintain these characteristics. Since the beginning of the 21st century, the western United States and northern Mexico has been experiencing a megadrought. The Criollo breed, originally from North Africa and Spain, and naturalized throughout the Americas for the past 500 years, is a type of cattle which seems to be well adapted to the drought conditions currently prevalent in the region. The objective of this study was to analyze the differences in the grazing behavior, and landscape use of Criollo cattle with different hide colors. This study was conducted on the 47 Ranch / Cross U Cattle Company, in Cochise County, Southeastern Arizona where all-natural range raised beef is produced; and was conducted from 2017 to 2020. We collared cattle for 6 months at a time with Knight GPS (Global Positioning System) tracking collars. From September 2017 to February/March 2020, we collared 148 head of cattle (48 Black, 40 Red, 10 Brindle, 9 Solid color with white face, 27 Spotted, 14 Yellow/Cream). Each year was separated in five seasons (Spring, Pre-monsoon, Monsoon, Fall, and Winter). Time spent near the well-water drinkers and run-off water catchments were affected by the hide color ($P = 4.33E^{-02}$, $P = 3.11E^{-02}$, respectively). The maximum distance from water was affected by the hide color ($P = 1E^{-03}$). The time spent resting and grazing were affected by the hide color ($P = 9E^{-04}$, $P = 2.3E^{-03}$, respectively). Hide color did not affect the elevation or slope use. This type of study can help understand grazing behavior of cattle with different hide colors, and maybe help ranchers with their genetic selection.

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Seven years of riparian vegetation response across ungulate herbivory treatments following stream restoration along Meadow Creek, northeastern Oregon.

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Contributed Oral Presentation

Abstract

Riparian restoration is a high priority in the interior Pacific Northwest because of threatened salmonids. Despite large labor and monetary investments, restoration effectiveness monitoring is rare, challenging our understanding of how management activities such as livestock grazing and wild-ungulate disturbances influence recovery. Here, we report 6-7 (2014 & 2015 to 2021) years of riparian vegetation responses to cattle, elk and deer disturbance along Meadow Creek, a tributary of the Grande Ronde River in northeastern Oregon following intensive stream and riparian restoration. Livestock grazing practices were designed to minimize grazing in riparian areas and ungulate exclosures allowed for testing of effects across four herbivory treatments (Cattle & Wild-ungulates; Cattle; Wild-ungulates; and No ungulates). Cover of deciduous woody species increased over the entire stream reach (~ 11km); primarily due to growth/recruitment of naturally existing, less preferred (by ungulates) species (predominately *Alnus incana*) and not the (>50 k) riparian enhancement plantings (installed during 2013 & 2014), and did not differ significantly across ungulate herbivory treatments. Willow (*Salix* spp.) cover increased subtly along the restored reach and was significantly higher in ungulate exclosures compared to areas exposed to both cattle and wild ungulates. The average as well as the tallest (90^{th} percentile) heights of preferred (e.g., willows and cottonwoods) woody species did not change over time and still remain below the browse line of ungulates, exposing them to ongoing heavy browse pressure. We will also share stream-side vascular plant species composition trends and relationships to herbivory treatments and livestock compliance metrics over time. Despite meeting grazing compliance metrics designed for recovery of cold water fish, vegetation recovery has been slow, particularly for preferred woody species following restoration regardless of ungulate herbivory treatment; additionally, suppression of desired riparian shrubs may be substantial with only a small number of browsing events.

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CAN LIGHT TO MODERATE CATTLE GRAZING STOCKING RATES IMPROVE BOBWHITE HABITAT?

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Poster

Abstract

Northern bobwhite (*Colinus virginianus*) populations have been declining across its geographic distribution due to expansion of urban areas, industrial-scale clean farming and high-density pine plantation silviculture. Dense stands of undisturbed grasses such as false Rhodes grass (*Trichloris crinita*) and buffelgrass (*Pennisetum ciliare*) result in low plant diversity and limited bare ground. Bobwhites require a diverse plant composition and arrangement of woody, herbaceous and bare ground cover for nesting, brooding, feeding, resting, and roosting. Cattle grazing reduces aboveground biomass and in return can create a patch-mosaic vegetation structure of different plant successional stages. The objective of this research is to assess habitat for bobwhites under a grazing regime that is flexible with stocking rates to maintain proper stubble height. We will monitor forage height and cattle will be removed to maintain a stubble height of 25 cm, which is optimal bunchgrass height for bobwhite nesting. We will deploy 15 GPS collars on cows to follow cattle herd movements and distribution within the pasture. We will trap quail and deploy ~75 telemetry collars on bobwhites to estimate covey home range. We will use unmanned aerial vehicle imagery from 6 flights in grazed and non-grazed pastures to assess vegetation structure and spatial heterogeneity within the pasture. We will focus on the spatial arrangement of the vegetation at the pasture scale, evaluating the abundance of bobwhite under the effects of a proper grazing regime. With these data we will be able to answer if cattle grazing distribution is spread evenly across the pasture, and if quail follow cattle herd movements along the pasture as grazing continues. This research will help land managers to create the spatial and temporal heterogeneity in vegetation structure needed to improve bobwhite habitat while maintaining income from livestock.

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Feeding profile and forage balance of steers grazing Setaria sphacelata cv Nandi

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Contributed Oral Presentation

Abstract

Pasture production throughout the year is irregular in quantity and quality; thus, knowing the supply and demand of nutrients in these systems allows farmers to make correct grazing management decisions. We evaluated the forage productivity of *Setaria sphacelata* cv. Nandi and its capacity to satisfy the nutritional demand of grazing steers. The study was carried out in the high tropics of Peru during the dry, rainy and rainy seasons between 2019 - 2020. We evaluated pasture growth rate, forage availability, diet quality and forage intake of growing steers; with the data obtained we elaborated and constructed a dietary profile and the forage balance of the system. Grass growth rate ranged from 12.9 to 25.8 kg DM/ha/d; forage availability ranged from 1935.2 to 2810.7 kg DM/ha, with minimum values corresponding to the dry season and maximum values to the rainy season ($p<0.05$). Diet quality, crude protein (CP) ranged from 13.23 to 13.26%, metabolizable energy (ME) from 11.41 to 11.58 MJ/kg DM, in vitro digestibility of organic matter (IVODM) from 71.3 to 72.36% and neutral detergent fiber (NDF) from 63.89 to 66.02%; only NDF showed significant differences. Intake to live weight (IMS) was similar in the three seasons ($p>0.05$) ranging from 2.81 to 2.83%. The dietary profile and forage balance revealed that there is a forage surplus in the early rainy and rainy seasons, sufficient to guarantee the feeding of 15 additional steers weighing 350 kg. *Setaria sphacelata* has a productive and nutritive potential with the capacity to satisfy the nutritional demands of steers during the dry, early rainy and rainy seasons.

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Extreme Drought: Physiological and Anatomical Responses in a Dominant Grass

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

Current climate models project an enhanced risk of drought in the tallgrass prairie over the coming century; which will alter productivity, ecosystem functioning, and may promote woody encroachment. To understand the role of reduced precipitation, rainout shelters were constructed at Konza Prairie LTER, to simulate an extreme multiyear drought (50% rainfall reduction). We measured species composition, aboveground net primary productivity (ANPP), species-specific physiology and microanatomy during the 2016-2020 growing seasons. Results indicate that prolonged drought will negatively impact species’ leaf physiology and microanatomy, decrease productivity, and alter species composition.

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Soil heating in grassland systems: The effect of fuel load on air and soil temperatures

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Contributed Oral Presentation

Abstract

Fire is a primary driver for the maintenance and restoration of rangeland systems. However, varying management strategies in rangeland systems have led to variable fuel loads resulting in a wide range of fire intensities (Wm^{-2}). While it is known that high fuel loads with their greater energy release lead to increased air temperatures, the effects of fuel loads on soil heating and subsequent impact on belowground tissues of native species has received less study in grassland and shrubland systems than forested systems. To understand how native soils and belowground plant tissues respond to increased air temperature, soil cores (12 in diameter) with intact native species were extracted from both Thunder Basin National Grassland (WY) and Buffalo Gap National Grassland (SD) during the spring of 2018. To simulate a range of fuel loads, cores were heated in a kiln to one of three experimental temperatures simulating 0.25, 1, and 3 tons of fuel per acre. Using thermocouples and a flux meter, we measured the following: soil surface heat flux, above ground temperature measurements within the fire environment (e.g., air, soil surface, etc), and temperatures at multiple soil depths (1 cm, 2 cm, and 5 cm). Initial results indicate that while air temperatures may be extremely high, there is a precipitous decrease in temperature at the soil surface and subsequent depths which reflect minimal soil heating even at high fuel loadings. Future analyses will focus on comparing the soil flux to soil temperatures at the different depths and considering how well grassland metrics match Campbell's soil heating model designed in forested systems. The small amount of soil heating for all treatments indicate that differences in post-fire responses of grassland and shrubland vegetation with different fuel loads is due more to the biology of the plants rather than differences in soil heating.

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Rangeland Recovery in Northwest South Dakota Post-Dormant Season Wildfire

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Poster

Abstract

Dormant season wildfires can lead to devastating ecological effects on rangelands such as loss of livestock and wildlife, critical habitat, and grazing forage. Native rangelands have evolved with wildfire and are able to tolerate burns with quick recovery under proper circumstances and environmental conditions. Two of the main environmental conditions that drive post-wildfire rangeland recovery include health of the rangeland ecosystem prior to the fire, and climatic variables such as rain or drought after the fire. Due to drought conditions in northwest South Dakota, two dormant season wildfires occurred during winter and early spring of 2021, burning over 25,000 acres. An applied study was established to evaluate rangeland recovery after the wildfires to help producers make informed decisions about grazing management during a drought. Photo points, forage production, and plant species composition changes were measured to evaluate overall rangeland recovery and health on burned and unburned sites. Initial results indicate that burned sites had lower forage production when compared with unburned sites; however, desired plant species composition changes tended to favor the burned sites as a decreased amount of invasive grass species were recorded. Despite the dormant season wildfires occurring during drought conditions, all sites recovered and produced adequate forage for livestock grazing the following fall, providing much needed relief for South Dakota producers.

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EXPERIENCES AND OPPORTUNITIES FOR MONITORING LIVESTOCK GRAZING MANAGEMENT

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Short-term evaluations of grazing management, especially grazing distribution concerns, have relied on vegetation measures such as forage utilization studies and use pattern mapping. These techniques are labor intensive and typically only used at the end of the grazing period, so the data must be applied the following year. Real-time tracking can monitor livestock spatial movement patterns and show hot spots and other concentrated use areas as well as identify areas receiving little or no use. We have evaluated several tracking systems at ranches in New Mexico, Arizona, and Queensland. In areas with sufficient coverage, cellular-phone technology based tracking collars have successfully monitored cattle grazing patterns even in areas with rugged topography. We are evaluating a long-range wide area network (LoRa WAN) based tracking system that can monitor cattle locations, but we are working though technological issues with the vendor. Tracking systems that use satellite technologies to transfer positions to the internet have great potential to track cattle in mountainous or remote areas with no cellular service. Hotspot analyses of tracking data show that livestock congregate near water and other loafing areas. Areas next to man-made water tanks and loafing areas should be considered if tracking data are to be used to monitor forage utilization patterns across the pasture. Additional research is needed to establish quantitative relationships between cattle use measured by tracking systems and forage utilization levels

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Defining Sustainability in an Era of Sub-Optimal Metabolic Health

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Contributed Oral Presentation

Abstract

Approximately 90 percent of adult Americans do not enjoy optimal metabolic health, indicating increased risk for numerous noncommunicable diseases (NCDs). The cost of obesity-related diseases in the US is estimated to be equivalent to 9.3% of Gross Domestic Product. Worldwide, NCDs are the leading causes of death. This situation is unsustainable. The Dietary Guidelines for Americans (DGA) are based upon the hypothesis that restricting consumption of animal-sourced foods (ASF) will decrease the incidence of NCDs. The DGA's recommended dietary patterns are not, however, intended for the treatment of disease nor for those that have them. If discussions of sustainability include a consideration of NCDs, they are typically informed by the conventional wisdom of diet and health promoted by the DGA, not from a perspective informed by the concept of metabolic syndrome. Dietary advice has been dominated by a single, controversial discipline – Nutritional Epidemiology of Chronic Diseases (NECD). Based upon weak evidence of minor-to-nonexistent associations, reductions in the consumption of ASF have been promoted while the nutritional superiority of ASF has been ignored. The influence of researchers within NECD has now extended to recommendations concerning sustainable food systems (e.g. EAT-Lancet). An effort is needed to bridge the knowledge gaps between the significant silos of expertise that exist in diverse scientific disciplines from the agricultural, ecological, medical, and social sciences. Its objectives should include: (1) what constitutes a "healthy" diet for the metabolically well and ill, (2) the vital role that ASF play in human development and health, (3) the causes of CD, (4) the essential role ruminant animal agriculture plays in sustainable food systems, (5) a science-based assessment of environmental impacts of the burden of CD as well as ASF production. In addition, a fresh perspective and approach toward communicating this information to the public is urgently needed.

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Managing for Woody Plant Encroachment within the Central Great Plains: A Prairie Project Syndication

Alexander Barnes, Laura Goodman, Samuel Fuhlendorf

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Contributed Oral Presentation

Abstract

Woody vegetation has expanded into grassland and savanna ecosystems worldwide through a process called woody plant encroachment (WPE). WPE is exacerbated by changes in climate, disturbance, overgrazing, and introduction of invasive species. The Central Great Plains has documented WPE over 150 years and has noted an alarming decline of native plant and animal biodiversity associated with encroachment. Grass biomass, density, understory, and cover decline as woody plants encroach into grasslands which can reach a threshold that makes management impossible. Management techniques for WPE within the Central Great Plains include herbicide applications, grazing and/or mechanical removal, and fire which all have varied success. However, the coupling of different types of herbivory (i.e. grazers vs browsers) has been suggested to reduce woody plant encroachment due to their different dietary selections. Our study used a combination of fire and grazing—pyric herbivory— by single and multi-species to manage for woody plant encroachment. We built exclosures (n=432) to examine the effects of single and multi-species pyric herbivory (outside exclosure) in conjunction with no herbivory (inside exclosure). Single and multi-species pyric herbivory declined woody plant cover and increased grass cover across all pastures compared to no herbivory. These results suggest that pyric herbivory has the ability to decline the rate of woody plant encroachment while increasing grass production. Single and multi-species pyric herbivory has the potential to be utilized within the Central Great Plains as a plausible management technique for WPE.

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Review of the influence of mulch on water retention, soil health, and vegetation in dryland restoration efforts.

Amberly Barry, Akasha Faist

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Poster

Abstract

Restoration seeding attempts in dryland systems are seeing variable success as temperatures increase and precipitation becomes less predictable. With this increased variability there is a need for restoration techniques, particularly in drylands, that prevent water loss, maintain rangeland health, and ultimately promote plant development. Mulching – materials spread on the ground to protect the soil surface and plants – may provide an avenue to reduce environmental variability and thus improve restoration success. To best understand the influence of mulch in semi-arid and arid systems, we conducted a systematic review of the peer-reviewed literature on three distinct categories: 1) Water retention, 2) Soil health, and 3) Vegetation. Water retention and soil health variables were categorized by each study on whether they helped, or hindered, standard restoration objectives (positive, negative, no effect). Vegetation response to mulch was categorized by total growth, or biomass changes (increase, decrease, or no change). Results showed that mulch generally improved water retention by having a positive effect on infiltration, prevention of runoff, soil moisture content, and water storage. Mulch also provided mostly positive soil health responses by regulating temperature and increasing soil organic matter. Soil nutrient factors, however, were variable in their outcomes, with most publications resulting in positive effects on soil phosphorous and carbon, but no effect on nitrogen. Numerous papers monitored vegetation growth via physiology, yield and aboveground biomass, germination, richness, and cover. Most of the species within all functional groups increased in biomass yield under mulching treatments. The results from this review indicate that mulch, while variable in some of the metrics observed, may have an overall positive increase restoration success in drylands by improving water retention and preventing water loss, improving soil health, and promoting vegetation growth.

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Integrated livestock production systems support grazing management and positive conservation outcomes

Sheila Barry

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

Grazing by domestic livestock can be manipulated to manage vegetation and habitats. Applied at the landscape scale to support conservation reliant species and reduce fire fuels, it exemplifies the value of land sharing as a conservation strategy. An assessment of threats to listed species in California reveals a critical role for livestock grazing in combating impacts of invasive species and other anthropogenic threats such as nitrogen deposition and land use change. The production systems that support grazing management and positive conservation outcomes are defined by rangeland resources and beef production. A description of the beef production system from inspection data, direct observation, interviews, and surveys reveals the extent to which ranchers in California rely on saleyards to facilitate the movement of cattle and integrate their production with intensive production systems to create value. Ranchers indicate that cattle movements result from changes in forage quality and quantity, and support their desire to manage for conservation objectives, including reducing fire fuels, controlling weeds, and maintaining wildlife habitat. Saleyards and cattle buyers drive beef production efficiency by sorting, pricing, and moving cattle and matching them to feed resources in more intensive production systems. For ranchers managing grazing and supporting conservation, this analysis highlights opportunities and constraints to provide positive conservation outcomes.

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Development of Habitat Suitability Models to Analyze Rio Grande Wild Turkey Survey Methodologies

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Poster

Abstract

Managing and identifying ideal habitat is crucial for species management. Habitat suitability models can help quantify the amount and spatial distribution of land cover that provides food, water, and cover for a specific species. The goal of this study is to develop habitat suitability models for Rio Grande wild turkey on two sites, Camp Swift (Post Oak Savannah ecoregion), and Camp Bowie (Cross Timbers ecoregion). Our specific goals are to: 1) develop a habitat suitability model that the Texas Military Department can use to determine which habitats are ideal for harboring wild turkey; 2) cross-validate survey methods with habitat suitability models to determine the most precise survey method. For each site, three models will be developed to identify food, water, and cover types for wild turkey. We used daily satellite imagery at high resolution (3-m pixels) and classified them into 5 cover types: woody, water, herbaceous, bare ground, and infrastructure. We are using a moving window analysis to quantify landscape metrics that describe wild turkey habitat: woody cover patch density, mean patch area, edge density, and percent cover. The landscape metrics will be then classified as either 1, suitable areas for wild turkey habitat, or 0, not suitable areas for wild turkey habitat. We will use the individually classified suitability indices to combine and create a habitat suitability model into three ratings: low, medium, and high. Once we have food, water, and cover suitability models, we will combine them to show an overall habitat suitability model for Rio Grande wild turkeys. The model will be validated using GPS points taken in the field. Results from road and roost surveys conducted in the winter season will be compared to the habitat suitability models and model precision will be assessed.

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Rate of gain during early gestation in beef heifers does not influence development, feed intake and behavior, puberty attainment, and concentrations of hormones and metabolites in female offspring

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Contributed Oral Presentation

Abstract

Despite the importance of maternal nutritional management of grazing cattle, little is known about the consequences of rates of gain during early gestation in beef heifers on offspring development and performance. Thus, our objectives were to evaluate the effect of rate of gain during early gestation on growth and development, feed intake and behavior, puberty attainment, and metabolic and hormonal profiles of heifer offspring. Forty-five beef heifers were fed either a basal total mix ration for gains of 0.28 kg/d (low gain [**LG**], n=23) or the basal diet plus an energy/protein supplement allowing for 0.79 kg/d gain (moderate gain [**MG**], n=22) for the first 84 days of gestation. After day 84, dams were managed as a single group grazing rangeland at the Central Grasslands Research Extension Center (Streeter, ND), where they calved in early March. Heifer calves grazed rangeland until weaning, at which point they were managed in an individual feeding facility. Heifers were fed a common hay-based diet and individual intake was measured. Calves were weighed at key timepoints between calving and day 84 of gestation. Serum samples were collected at calving, turnout, weaning, synchronization, d 42 and d 84 of gestation and analyzed for concentrations of IGF-1, insulin, NEFA, and glucose. Additional samples were collected throughout development and analyzed for progesterone concentration to determine puberty attainment. Our results show that calves from MG were heavier at birth ($P = 0.02$) than calves from LG dams. Weights, feed intake and behavior, hormones and metabolites, and puberty attainment did not differ between female offspring from LG or MG dams ($P > 0.12$). Overall, these results demonstrate the need for future research focused on the impact of maternal nutrition on conversion of consumed forages into energy for use by key metabolic organs, such as liver and intestine, in offspring.

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Can ranching practices impact wildfires?

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

California has seen some of the largest, most devastating wildfires in the state's history in the last ten years, prompting a search for solutions. We looked back at California's history of ranching for a possible solution. Can current ranching practices, including grazing and browsing, impact wildfires? We surveyed ranchers in three social-ecological regions in the state with properties of at least 500 acres of grassland/shrubland classification. We documented the grazing rate at each ranch (animal units per acre per year) and using pre-regression matching methods and mixed effects regression models, calculated the probability of wildfires occurring each year from 2001 to 2017 in each region and by three different land cover types, grasslands, shrub/scrublands, and forests. Grazing decreased the likelihood of wildfire probability as stocking rates increased across all three land types in the two social-ecoregions that have seen large wildfires in that time period, ranging from 31.0-76.5% reduction. However, our third social-ecoregion did not experience as many wildfires between 2001 and 2017 and the relationship between wildfire and grazing was less clear. From our ranch management data, 58% of respondents regularly perform mechanical shrub treatments and 28% perform prescribed fires. Ranches were more likely to perform shrub management if they had experienced a wildfire. While our survey did not tease out the exact relationships we had hoped, our results indicate that ranching practices, in particular livestock grazing, can effectively reduce annual burn probability in some regions and ecosystem types in California, providing the first large-scale assessment of this relationship and suggesting that expanded grazing on private and public land in California may reduce fire frequency in these social-ecological systems.

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Divergent population parameters signal losses in resilience driven by global change drivers in pronghorn, an iconic rangeland species

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Contributed Oral Presentation

Abstract

Conservation is increasingly focused on preventing species' population losses before they occur. This requires understanding changes in the resilience of animal populations in response to global change drivers before drastic declines occur in wildlife species. We use population productivity (late summer female: juvenile ratios) as an indicator of population resilience to global change drivers in 40 pronghorn (*Antilocapra americana*) populations across sagebrush (*Artemisia* spp.) steppe in eastern Wyoming, and the Wyoming Basin, one of the most intact rangeland ecosystems globally. Pronghorn are an iconic rangeland species that have been exposed to increasing levels of anthropogenic, climatic, and land-use change. Using data collected across the state of Wyoming, we (1) assessed long-term signals of population resilience and compared these to changes in population size, (2) identified patterns in large-scale global change drivers across pronghorn habitat, and (3) determined the relationship between global change drivers and population resilience over a 40-year (1984-2019) period. We found that while Wyoming hosts some of the most abundant and stable populations of pronghorn in North America, most herds are experiencing long-term declines in population resilience. These declines were not limited to smaller populations, but rather occurred in some of the largest and most productive populations. Long-term declines in population resilience were associated with significant increases in oil and gas development and woody encroachment. Although increasing across almost all herds, woody vegetation cover remains at low levels and is not currently identified as a major concern for rangeland management in the region, suggesting that pre-emptive management may help to prevent drastic losses in pronghorn populations. Our findings highlight the value of utilizing population demographics as an indicator of population resilience to support preventative conservation efforts in the face of rapid global change.

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Rohrbach Cattle Ranch South Dakota Society for Range Management Area III nominee

Heidi Becker[1], Emily Helms[2]

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Poster

Abstract

The Rohrbachs work together as a family managing a cow/calf operation near the town of Roscoe in Edmunds County, South Dakota. The ranch has been in the family since Jonathan's grandparents started it in 1923. They have approximately 2,100 acres of native rangeland to graze their cattle, plus 200 acres of native prairie hay, which, depending on the year, gets cut, rests, or gets grazed. They also have 500 acres of cultivated ground, of which 140 acres is a tame grass-alfalfa mix. They run 230 cow/calf pairs and 100 yearlings, of which they keep 40 as replacements.

The Rohrbachs made improvements to their grazing system through various programs beginning in 2006. Programs included Environmental Quality Incentives Program and Conservation Stewardship Program, administered by Natural Resources Conservation Service, and Grassland Conservation Reserve Program, administered by Farm Service Agency.

Improvements included installing cross-fences, water tanks, and approximately 30,000 feet of waterline. They also intensified their pasture rotation and consolidated their cattle into two herds.

As a result of this intensive rotational grazing system, plant diversity has increased, particularly warm-season grasses. Jonathan notes that Big bluestem has increased, and he noticed Switchgrass in the last three years where he had never seen it before.

By moving cattle often, the family has been able to keep the cattle ahead of the flies, and they have not used treatment for flies in the last eight years. Jonathan notes the dung beetle population has increased.

Improvements to cattle management include the elimination of vaccinations and the ability to run more cattle than before the adoption of this management.

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Ecological transformations in desert grasslands: resist, accept, or direct?

Brandon Bestelmeyer[1], Erica Christensen[1], Laura Burkett[1], Matthew Levi[2], Leticia Lister[3], Neeshia Macanowicz[1], Nick Webb[1]

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

The transformation of many rangeland ecosystems is inevitable, necessitating new frameworks to guide management decisions. We describe ongoing transformation in desert grasslands of southwestern New Mexico using century-long vegetation monitoring and climate datasets from the Jornada Experimental Range and monitoring of recent restoration actions. These datasets indicate undesirable, irreversible changes from historical benchmarks but include some potentially desirable outcomes. We use these datasets to consider management decisions via the resist-accept-direct (RAD) framework. Considering directional changes in climate and ecological thresholds, managers can respond to the trajectory of change by resisting (working to maintain or restore based upon historical or acceptable current ecosystem conditions), accepting (allowing an ecosystem to change without intervening), or directing (actively shaping ecosystem change toward preferred new conditions). We describe a logic for RAD decisions in rangeland management and restoration based on a consideration of climate and ecological processes.

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Assessing wetland, riparian, and mesic areas on BLM land across the western United States

Elin Binck

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

Water scarcity in semi-arid and arid regions of the world has always been influential to biodiversity and human settlement, but water availability is becoming more uncertain than ever due to changing climatic patterns and human extraction of water resources. These changes have the potential to impact the abundance, integrity, and distribution of wetlands. Wetlands perform valuable ecosystem functions that contribute to the health and resiliency of watersheds, and are critical to water supplies in regions like the semi-arid and arid western U.S. However, quantitative data is needed to develop appropriate management practices that can maintain and restore wetland health. The BLM manages almost one quarter of the land in the contiguous western United States, yet, to date, there has been no robust, agency-wide inventory or analysis of wetland, riparian, and mesic areas on their land. This research represents the first attempt to quantify and analyze wetlands sampled through the BLM's Assessment, Inventory, and Monitoring (AIM) program. I will present preliminary results of my research on wetlands that have been sampled with the ongoing Terrestrial AIM program, as well as analyses of the drivers of plant community composition on wetlands sampled with the newly developed, wetland-specific AIM program.

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The Prairie Project: Understanding and promoting decision making for sustainable rangeland management.

Andrew Birt

Texas A&M Transportation Institute, College Station, Texas, USA

Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

The Prairie Project is a collaboration among scientists from Texas A&M, Oklahoma State University, and the University of Nebraska. The goal of the project is to promote the economic, ecological, and sociologic sustainability of Great Plains rangelands in the face of threats from woody plant expansion, climate change, and wildfire. The core thesis of the project is that these goals can be achieved through the widespread adoption of new management paradigms centered on pyric herbivory and mixed-species grazing.

This presentation deals with the development of research models and decision support tools to support the Prairie Project's goals. Specifically, we discuss: 1) the development of models designed to understand socio-ecological barriers to the widespread adoption of rangeland management practices; 2) the translation of the data and knowledge obtained through the project into decision support tools that inform and promote sustainable rangeland management.

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Plant density and composition comparisons in four tallgrass prairie seed mixes

Emily Bishop[1,2], Tyler Wayland[3,2], Keith Pawelek[3,2], Sandra Rideout-Hanzak[1,2], Dustin Golembiewski[1,2], Brianna Slothower[1,2], David Wester[1,2]

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Contributed Oral Presentation

Abstract

The tallgrass prairie is a dynamic ecosystem comprised of a network of grasses and forbs. The extensive diversity of this declining ecosystem should be preserved through restoration efforts. The first step in this process is the selection of locally adapted seeds. We seeded four mixtures with 6 (2 mixtures), 10, or 11 named varieties of native releases of common tallgrass prairie species with the goal of choosing the best performing mix as a recommendation for future restoration in northeast Texas. These mixes were seeded alongside 13 grasses in monocultures on a retired farm in Fannin County. All grasses in the mixtures were also seeded in monocultures, and these monocultures will be used to make recommendations to mix composition. Two of the mixes also contained three forbs. Composition and density of these mixes have been monitored for two years. After two years, three of the four mixes are statistically similar in density and can currently be recommended for use. Further monitoring will continue to document changes in the density and composition of these mixes and will help us to make informed recommendations as needed for the most successful outcome.

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UAV mapping of exotic annual grass invasion into critical rare and endemic plant habitat

Tara Bishop

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Poster

Abstract

Invasion of exotic annual grass is a high priority issue in restoration, conservation, and management of rangelands. Species such as *Bromus rubens* and *Bromus tectorum* are leading to serious state changes in western drylands and eventual transitions from native shrublands to monoculture grasslands. Landscape level mapping using satellite imagery has been an increasingly successful tool for assessing large areas experience high impact from brome grasses. However, there is a middle ground of assessment needed where on the ground measurements by individuals are too time consuming and costly, and the satellite imagery is too coarse of resolution for assessing areas such as smaller nature preserves. In addition to the time and cost of human powered vegetation surveys, in certain habitats, the disturbance caused by humans on the biological soil crusts can actually exacerbate the invasion problem.

Here I use a DJI drone and accessory MAPIR camera to capture imagery in red, green, blue (RGB) and orange, cyan, and near-infrared (OCN) to asses the state of an 800-acre nature preserve in southwest Utah. This nature preserve, White Dome Nature Preserve (The Nature Conservancy) is the home to the endangered endemic, dwarf bear claw poppy (*Arctomecon humilis)* and Silar's pincushion cactus *(Pediocactus sileri),* with heavy gypsum soils covered in various communities of biological soil crusts. The impeding development of the surrounding area requires that surveys are done with the least amount of disturbance to both protect the preserve from furthering invasion fronts, and conserve it for these endemic plants to thrive. Using a small UAV, I was able to accomplish mapping bromes, in a particularly dry year, to inform the management of the status of the brome invasion into this habitat.

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Working Lands and Watershed Health

Claire Bjork[1], David Lile[2], Nicole Stevens[3], Laura Snell[1]

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Poster

Abstract

In 2014 California became the last state to formally regulate groundwater with the passage of the Sustainable Groundwater Management Act (SGMA). The Big Valley Groundwater Basin, which encompasses parts of both Modoc and Lassen counties in California's northeastern corner, was given a medium prioritization under SGMA. This medium prioritization designation requires the formation of a local Groundwater Sustainability Agency (GSA) and the development of a Groundwater Sustainability Plan (GSP). Big Valley is very rural with a population of 1046 residents and an economy that is heavily dependent on agriculture which is comprised predominantly of multi-generational cattle operations, pastureland, and high quality alfalfa and grass hay forage crops. Most of the surrounding landscape in Modoc and Lassen counties is federally managed high desert rangeland and conifer forest with elevations ranging between 4,500 - 6,500 feet. Some local producers have summer federal land grazing allotments in the surrounding mountains. The University of California Cooperative Extension (UCCE) offices of Modoc, Lassen, and Siskiyou counties have been working collaboratively with the local leadership throughout the development of the GSP. This process has highlighted the local communities' commitment to recognizing the services provided by working landscapes for groundwater recharge, water quality, wildlife habitat and rural economic vitality. UCCE and its partners have implemented applied research, monitoring, and comprehensive landscape inventory to support an array of basin recharge, range and forest health and irrigation management projects that contribute to effective landscape scale management for the enhancement of watershed health and water availability across the working lands within the Big Valley groundwater basin and its watershed. This poster showcases examples of these projects, including but not limited to outreach and education, water quality monitoring, grazing, groundwater level monitoring, restoration, juniper removal, and conifer thinning.

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Lidar derived overstory spatial patterns in relation to understory communities

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Poster

Abstract

Anthropogenic impacts have drastically increased the density of southwestern conifer forests resulting in altered herbaceous understory communities. Restoration treatments (i.e., forest thinning, prescribed burning) reduce tree density and alter overstory structure increasing herbaceous understory cover and shifting community composition towards remnant populations. Relationships between overstory structure (e.g., canopy cover, basal area) and herbaceous understory communities are well studied. However, tree spatial patterns may also influence herbaceous understory communities and have yet to be fully explored. Light detection and ranging (lidar) has proven to be an accurate method for quantifying overstory structure and provides an opportunity to implement monitoring of understory plant communities over broad areas. Individual tree detection (ITD) algorithms can be implemented across lidar acquisitions and be used to quantify spatial patterns. However, several algorithms exist, each with their own nuances and varying accuracies based on forest structure. In this study, we aim to 1) evaluate ITD methods and parameters for estimating overstory structure and spatial patterns, and 2) investigate the influence of lidar derived overstory structure and spatial patterns on herbaceous understory communities. We stem-mapped 164 0.04-ha plots across a gradient of canopy cover and structure and compared field measurements to lidar-derived tree maps using four different ITD algorithms. We will investigate the relationships of overstory structure (i.e., canopy cover, basal area, tree density) and spatial patterns (i.e., Clark and Evans aggregation index, mean directional index, neighborhood competition index) on herbaceous understory community characteristics (i.e., basal cover, species richness) across 84 quadrats (1-m^2). These results will provide insights into the intricacies of tree spatial patterns and herbaceous understory communities and may be used to model herbaceous understory communities across entire lidar acquisitions.

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Sage-Grouse Protection and Landscape Conservation through Threat-Based Mapping

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Poster

Abstract

Identifying sage grouse threats across the Western United states can be a monumental task. The vast landscape and various threats can be overwhelming for managers to identify and treat. Using a simplified threat-based model can be efficient and effective for identifying threats and critical habitat and can expediate management decisions and actions. Open Range Consulting has produced threat-based maps in Oregon, Montana and other areas over large landscapes in a cost and time efficient manner. These maps cover more than 34 million acres in Montana and Oregon alone. The Oregon Threat-based model has shown a well correlated lek occurrence in conjunction with habitat classifications produced by Open Range Consulting. This link of sage-grouse leks occurrence with habitat types has been published in a 2019 document in the Wildlife Society Bulletin.

Open Range Consulting has adapted the threat-based classification types to fit with different State's objectives and specifications. These landscape level maps can expediate the process from data collection to management decisions with and help to support real change and protection for sage grouse and other species. These landscape level maps can also quickly identify other critical threats on the west such as annual invasive grass and the threat of more frequent and large wildfires which continue to decimate the western landscape. Time efficient threat-based mapping techniques are adaptive to many landscapes and may become crucial for the wellbeing of the many ecological functions our wildlands support.

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DNA barcoding provides new insight into diet selection by pronghorn antelope across habitats within the shrub steppe biome

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Contributed Oral Presentation

Abstract

Foraging is one of the most fundamental activities contributing to the maximization of an animal's fitness. Information about food choice is crucial for understanding the nutrient demands of wildlife and quantifying functional habitat available to wildlife. Diets of pronghorn antelope (*Antilocapra americana*) vary spatially and temporally based on resource availability, seasonal nutritional demands, plant phenology, and plant chemical composition. We used plant DNA barcoding from noninvasively collected fresh fecal samples to quantify the diet of adult female pronghorn across different ecosystems (desert, agriculture, shrub-steppe, mountain valley) and sampling periods (pre-parturition, lactation, pre-migration), chosen to align with metabolically-important female life history stages. Forbs comprised a majority of the diets across all sampling periods (53.04%-61.11%), followed by shrubs (22.61%-24.39%), grasses (7.94%-14.78%), and legumes (4.88%-9.57%). Mean forb consumption showed the greatest annual difference within pre-migration sampling, followed by pre-parturition and lactation sampling periods. Even though habitats varied in forb composition, our results suggest that overall use of forbs by pronghorn may be greater than formerly believed. In addition, we were able to quantify seasonal dietary fluctuations at the resolution of plant genera. Agricultural crop species contribution to diets was lower than expected (<1%-30.82%), given their high availability in certain sites and high nutritional quality, suggesting factors other than plant nutritional composition contributed to forage use. Pronghorn in this study displayed plasticity in their foraging strategies and responded to seasonal changes in biomass and plant species composition, primarily by increasing consumption of forbs and legumes during lactation. Our demonstrated spatial and temporal importance of forbs in pronghorn diets, even in habitats largely dominated by agriculture, suggests this functional group a key component when designing management actions to improve pronghorn habitats.

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PRODUCTIVITY OF DESERT FORAGE PLANTS IN CONDITIONS OF INTRODUCED NURSERIES

Adiba Bobaeva, Bakhtier Rafiev

Research Institute of Karakul sheep Breeding and Desert Ecology, Samarkand, Uzbekistan

Abstract

Currently, it is important to involve plant resources growing in and around the Aral Sea basin in introduction studies. In this regard, in order to find new types of forage plants from the natural flora, it is necessary to develop scientifically based cultivation methods based on the study of their ecological and biological properties, test them in various environmental conditions and determine ecological optima and adapt them to local conditions. The gene pool of the species was collected in nature and tested in introduced nurseries in the conditions of the Karnabchul gypsum desert.

In the first year of vegetation of the studied species and ecotypes, the largest harvest of phytomass of 268.0 g was formed by *Halothomnus subaphylla Aellen.* In the second year of cultivation, the harvest of phytomass increased sharply and a harvest of 622.2 g of phytomass was obtained. In the control, this indicator was 240.0 g in the first year and -575 g in the second year.

The phytomass of individuals of the *Ceratoides ewersmanniana* in the first year of cultivation varied from 16.5 to 24.2 g, compared with 16.6 g in the control variety "Tulkin", while in the polyploid population this indicator was 20.7-24.2 g. It was noted that in the second year of vegetation the mass of plants was significantly higher in the polyploid population-105.5 g.

The yield of phytomass of the *Salsola arbuscula* plant in the first year of cultivation was 32.8 g and 525.0 g, in the second year it was found that it surpasses the samples of *Salsola orientalis* in yield.

Among the samples of the *Salsola Paletzkiana*, the largest harvest of phytomass in the first year was 260.3 grams, and in the second year, when this indicator was 760 g.

Thus, as a result of a comparative assessment of the gene pool of desert forage plants collected in the Aral Sea basin and comparison with zoned varieties, a number of promising samples can be selected

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Use of virtual fencing for managing livestock distribution on fire-prone sagebrush rangelands

Chad Boyd[1], Rory O'Connor[1], Julianna Ranches[2], David Bohnert[2], Jon Bates[1], Dustin Johnson[2], Kirk Davies[1], Todd Parker[3], Kevin Doherty[4]

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Wildfires are increasingly impacting ecosystem processes and ecological services provided by sagebrush rangelands in the western United States. Fire impacts short-term forage availability for livestock directly through the combustion of forage, but also through policies that limit post-fire grazing, even if only a portion of a pasture burns. Cattle may disproportionately utilize burned areas which can impede post-fire recovery. However, cattle can play an important pre-fire role in reducing herbaceous fuels, which can decrease the probability of fire ignition and spread, but managers need tools to focus distribution of livestock to those areas with excessive fuel build-up. We used two studies to assess the utility of virtual fencing (VF) in 1) excluding cattle from recently burned areas, and 2) using cattle to reduce herbaceous fuels in linear fuel breaks. In study 1, we placed VF-collared mature dry cows in 2.1 ha sagebrush steppe pastures and monitored animal locations for 14 days. Approximately 30% of each pasture had been burned the previous fall and VF-collars were set to exclude animals from the burn. Results indicate that VF collars were very effective in limiting utilization of burned areas (<3% utilization in burned compared to approximately 60% utilization in unburned areas). In study 2, we used VF collars to contain cattle (mix of cow/calf pairs and dry cows) within a 200-m wide by 3-km long fuel break over a 30-day trial period. End-of-trial utilization was 48.5 ± 3.7% and 5.5 ± 0.7% for areas within and outside of the fuel break, respectively. Percentage daily locations of dry cows and cow/calf pairs within the fuel break were 98.5 ± 0.5% and 80.6 ± 1.1%, respectively ($P < 0.001$). Our data indicate that VF technology can be effective in managing both post-fire cattle distribution as well as grazing to reduce pre-fire herbaceous fuel loading.

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New metrics for quantifying ecological drought and resistance-resilience in dryland ecosystems

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

Anticipating climate impacts is a recognized challenge for natural resource managers and policy makers working to sustain ecosystem services. Decision makers need a quantitative, systematic way to recognize how locations differ in their expected response to changes in both climate and disturbances. Resilience and resistance (R&R) frameworks have proven particularly useful for prioritizing conservation investments and management strategies. However, recent work identified opportunities for improving the foundational metrics used as indicators of R&R. We present a new set of indicator metrics for quantifying dryland ecological drought and R&R. These metrics focus on ecologically relevant conditions, represent multiple types of moisture limitation, are sensitive to variation in both space and time, including extreme events, and are structured to appropriately assess the impact of long-term changes in climate. Metrics include partitioning growing degree days into wet degree days and dry degree days to represent favorable conditions and stressful conditions, respectively, and include measures of soil water availability for plants, and climatic water deficit. We also develop metrics that quantify the magnitude of seasonal variability in these conditions, the seasonal timing of moisture availability, exposure to drought stress and extreme conditions, dry soil intervals, and conditions related to recruitment of perennial plants in water-limited dryland environments. Using ecosystem water balance modeling, we have quantified these metrics for drylands across the western U.S. and the results provide new insights about spatial and temporal drought dynamics. For example, the seasonal timing of soil water availability, wet degree days, and climatic water deficit are only weakly linked to the seasonal timing of precipitation. We hope that these metrics will be useful for understanding geographic patterns in dryland plant community structure and function. In addition, we are using these metrics to improve frameworks for assessing the impact of climate change on dryland R&R.

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From Clemensian's Quandary to Westoby's Wonder: Modeling the Ecology of Ecologists

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Poster

Abstract

State-and-Transition models, widely adopted in vegetation dynamics frameworks, provide an explanation for rapidly degrading ecosystem conditions and provide important insight into appropriate pathways for conservation and rehabilitation of plant communities and landscapes. In an elegant twist, recent research has demonstrated how these same steady state models have a similar and profound utility for determining the condition of the very ecologist who study and describe these modeled ecosystems. Similar to plant communities, an ecologist's resilience is measured by how much perturbation can be absorbed while maintaining the ability to return to pre-disturbance conditions. Surpassing an individual's resilience capacity is equivalent to crossing a threshold and starting down a degradation pathway whereby the ecologist is unable to maintain their previous state of employment. At a minimum, this likely leads to a change of industry affiliation (Public, Private, NGO) and potentially, even a shift to an alternative stable condition in a non-ecological profession. As with ecosystem dynamics, preventing such catastrophic changes is best achieved by focusing not so much on thresholds themselves, but on the at-risk phases and conditions of the professional lifestyle that proceed such transitions. The data driven model presented represents common conditions and challenges observed or encountered by the authors, and can ideally provide managers, ecologists and students of ecology a management tool to create more resilient and diverse working conditions across the professional ecology industry.

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Replacing the Rangeland Marginalization Narrative with One of Planetary Value

David Briske

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Extensive marginalization or devaluation of global rangelands has been documented in the recent United Nations sanctioned report entitled, 'A Case of Benign Neglect.' The report indicates that current information is insufficient to determine the status, needs and support required for pastoralists and rangeland stewardship in the future. The marginalization narrative has contributed to a substantial loss of rangeland ecosystem services, including biodiversity, because they are unrecognized or undervalued in policies and land use decisions focused on a few select provisioning services. The origin of the marginalization narrative has been traced to mid-19th century European scholars who inappropriately assumed that rangelands were a consequence of forest degradation by indigenous pastoralists, rather than climatic conditions. Unfortunately, this narrative of resource scarcity and variability has become deeply embedded in the global rangeland community as evidenced by rangeland definitions focused primarily on forage and livestock production, the need for rangeland development programs, and the omission of rangelands in the primary organizational structure of intergovernmental institutions. This narrative continues to be perpetuated even though rangelands are critical to planetary stewardship because their extent and heterogeneity make a significant contribution to global ecosystem services. Development and promotion of a powerful counter narrative that emphasizes the global value of rangelands to planetary stewardship and human well-being cannot be overemphasized. It could initiate transformation of intergovernmental programs, justify societal support of rangeland biodiversity, and empower pastoralists with greater self-governance. This outcome could represent a signature contribution of the IYRP that may have far reaching consequences for rangelands, pastoral societies, and planetary stewardship.

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Herbicidal Control of Red Bromegrass And Red Sprangletop In Desert Grasslands

John Brock

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Schladweiler-Reclamation and Restoration Issues in Arid Environments of the Southwestern United States

Abstract

Red bromegrass (*Bromus rubens*) a cool season annual invasive grass and red sprangletop (*Leptochloa filiformis*) a warm season native annual grass inhabit desert grasslands in central Arizona. Both species produce substantial production in years with adequate moisture and yield fine fuel loads to carry wildfires and reduce environmental resources for desirable plants. A study for annual grass control was started in the winter of 2016. The study site is near Cordes Junction, Arizona. Soils at the study site are cobbly clay loams and average annual rainfall of 16 inches distributed in a bimodal fashion. Herbicides for control of these species were applied in early winter of 2016, late autumn of 2016 and 2017. Herbicides in the tests were: indaziflam (Espalande), glyphosate (Roundup), rimsulfuron (Matrix) and imazapic (Plateau). All herbicides were broadcast sprays at 20 gpa, in water, with 0.25% vv surfactant to plots 12 X 36 feet with three replicates. Herbicide rates ranged from a low of 1.5 to 12.0 oz/ac depending on formulation. All herbicides gave good control of red bromegrass, normally exceeding 9o percent. Indaziflam provided multi-seasons control of red bromgrass. The summer annual grass, red sprangletop was also controlled with the herbicides, except in plots treated with glyphosate. In addition to assessing the vegetation community for mortality of the annual grasses, red bromegrass production was collected. The information from these treatments has shown red bromegrass and red sprangeltop can be controlled in a desert grassland for least 2 years following application, especially by indaziflam. Control of these plants can relieve annual grass competition with native perennial forages and reduce fine fuels that often contribute to wildfire spread.

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Habitat selection and survival consequences for greater sage-grouse during multiple reproductive life phases

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Contributed Oral Presentation

Abstract

Actionable science for species of conservation concern is enhanced by models that identify environmental factors linking resource selection and demographic responses during critical life-stages. Greater sage-grouse (*Centrocercus urophasianus*) provide a germane example given widespread population decline resulting from loss and degradation of sagebrush ecosystems from wildfire, anthropogenic disturbances (e.g., energy development), cheatgrass (Bromus tectorum) invasion, and increases in generalist predators (e.g., ravens). However, knowledge about the habitat requirements for reproductive life stages is limited when considering multi-scale landscape-level analysis. We evaluated factors influencing resource selection and demographic responses for greater sage-grouse during key reproductive phases (786 nests and 356 broods) across 19 sites within the Great Basin during 2009 – 2018. For each life stage, we fit macro- and micro-habitat covariates to selection and survival models while accounting for climatic conditions correlated with ecological productivity. For nesting, sage-grouse selected greater sagebrush cover and height, elevation, and herbaceous cover. We found that shrub cover increased nest survival while annual grass reduced nest survival. For brood rearing, sage-grouse selected areas with greater ecological productivity, greater proportion of shrub cover, and closer to streams and springs. Also during this brooding stage, burned areas elicited different survival responses to annual grass than unburned areas. At microscales, vegetation cover immediately surrounding the nest was most important to selection and survival, but functional composition varied between mesic and xeric sites. For broods, areas with greater grass and forb composition were selected. We further illustrate how application of this approach facilitates comprehensive multi-scale habitat assessment for reproductive sage-grouse. Preliminary findings are provided for best timely science.

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Applying Fecal Particle Size Analysis to Evaluate Forage Digestibility in Free-Roaming Horses

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[1]University of Wyoming, Laramie, USA. [2]Boise State University, Boise, USA

Poster

Abstract

Many methods have been used to evaluate diet composition, digestibility, and other aspects of nutrition for grazing herbivores, many of which require specialized feeding trials or expensive lab equipment. Fecal particle size analysis uses a wet-sieving method to distribute fiber particles in fecal samples among different-sized sieves. Distribution of the particles can be determined by the weight of fecal material on each sieve and mean particle size can be calculated from these measures as described by Fritz et al. (2012). Previous studies have compared results for mean particle size in different species and related it to important digestive measures such as chewing efficiency, intake, retention time, and fiber digestibility. In our research, we first employed a “low tech” version of fecal particle size analysis to see whether we could observe differences in free-roaming horses grazing in different environments using methods more amenable to those without expensive lab-based equipment. We collected fecal samples from free-roaming horses across 15 BLM Herd Management Areas across the western U.S. in summer 2020 and winter 2020/2021, and analyzed them for mean particle size. Secondly, when we detected differences in mean particle size, we then compared our results to information that was gathered on body condition as well as diet composition as identified by DNA metabarcoding. From this we hope to determine whether fecal particle size is related to the specific plant types consumed, and if any relationship between this or body condition warranted future investigation. Our comparisons provide much needed information about a cost-effective method that can be used to evaluate forage digestion *in vivo* for comparison to other measures of nutrition in rangeland herbivores.

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Evaluating Ungulate Usage of Rangelands with Black-tailed Prairie Dog Disturbance

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Poster

Abstract

Black-tailed prairie dogs (*Cynomys ludovicianus*) are considered ecosystem engineers due to their burrows facilitating soil ventilation as well as herbivory and vegetation clipping creating early successional habitat and shifting vegetation composition . Despite the important role prairie dogs play in structuring rangeland ecosystems, conflict with livestock has led to control efforts that have reduced the range of this species. Sylvatic plague (*Yersinia pestis*) has threatened prairie dog populations for the past century, and has further reduced prairie dog populations. This vector-borne disease can wipe out entire colonies and has detrimental effects on associated species including predators like black-footed ferrets (*Mustela nigripes*) and badgers (*Taxidea taxus*), as well as grassland birds including mountain plovers (*Charadrius montanus*). However, little research been published on native ungulate species use of prairie dog colonies or their responses to variation in prairie dog disturbance in space or time. In Thunder Basin National Grassland, we observed a decline of ungulate detections via camera trap after a major plague event in the system, so we decided to investigate the potential relationship between ungulates and prairie dogs further. In January 2022, we began deploying camera traps on and off prairie dog colonies across ecological gradients where prairie dogs, livestock, and native ungulates occur. Over the next year we will deploy cameras on colonies across a latitudinal and longitudinal gradient including sites in Wyoming and Oklahoma to determine whether ungulate responses vary across prairie dog range. We predict that native ungulates will prefer areas with active prairie dog colonies compared to areas without prairie dogs due to higher forage quality and increased predator visibility. Using the camera traps, we will evaluate the use of prairie dog colonies by native ungulate species. We hope to use our findings to influence multi-use rangeland management.

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Evaluating the effects of adaptive management on USFS Region 3 grazing allotments

Cameron Burleson, Aaron Lien, Laura Lopez-Hoffman, George Ruyle

University of Arizona, Tucson, USA

Contributed Oral Presentation

Abstract

Adaptive management is a popular management approach in the field of natural resources. This iterative, learning-based method to decision-making aims to reduce uncertainty in the face of environmental complexity to ultimately improve the ecological, economic, and social outcomes of an area; rangelands are one of these highly complex ecosystems. Adaptive management has been difficult to define and evaluate for natural resource managers, making doing so at a large-scale assessment even more challenging. In 2007, the United States Forest Service (USFS) implemented a policy requiring the use of adaptive management for all grazing permits on national forest lands in Region 3 (Arizona and New Mexico). There is little known about how this policy has been carried out in USFS Region 3 and how it has affected outcomes. We aimed to understand if and how adaptive management has been implemented in grazing allotments and how management has been changing by analyzing FS compliance documents from 1996-2017. Allotment management plans (AMPs) and annual operating instructions (AOIs) from selected districts in USFS Region 3 were coded to create a database with key elements from the documents that allowed for an analysis of the region. Preliminary analysis of our data shows that AM theory language can be observed in documents after 2007 and that certain management changes can be linked to social and ecological outcomes. These results will help inform future decision-making and policy implementation with the increased knowledge of how and where adaptive management is being carried out on Southwestern USFS rangelands.

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Honey mesquite (Prosopis glandulosa) shrubs alter soil nutrient distribution along a grassland to shrubland gradient in the Northern Chihuahuan Desert, U.S.A.

Daniel Burton, Ryan Schroeder, Molly Reichenborn, Erik Lehnhoff, Akasha Faist

New Mexico State University, Las Cruces, USA

Poster

Abstract

Globally, rangelands are experiencing woody plant encroachment into ecosystems historically classified as grasslands. This transition to shrub-dominated vegetation reduces relatively continuous grass cover and creates distinct bare soil interspace patches between the shrub canopies. In the Northern Chihuahuan desert, this transition is displayed in the reduction of black grama (*Bouteloua eriopoda*), a native stoloniferous perennial grass with high forage potential, and the encroachment and expansion of honey mesquite (*Prosopis glandulosa*). As shrub encroachment continues it is important to understand how this alteration in ecosystem structure and function effects the distribution of soil nutrients on the landscape. After water, soil nutrients are the most important factor contributing to plant production in drylands, and examining soil nutrient distribution across a gradient of encroachment severity can help guide future management efforts when attempting to reverse the impacts of shrubs. This study aimed to describe how mesquite shrub encroachment influences soil nutrient distribution across a grassland to shrubland gradient. To determine the soil nutrient status of shrub and interspace microsites, soil cores were taken from under the canopy of 102 mesquite shrub-islands and 102 paired interspaces across the encroachment gradient. These samples were analyzed for a common suite of soil nutrients, including soil organic matter, nitrate-nitrogen, phosphorus, potassium, and soil cation exchange capacity. Preliminary results indicated higher concentrations of soil nutrients under shrub canopies, especially soil organic material, nitrate-nitrogen, and phosphorus than their associated interspaces. Results also suggest that this effect is amplified along a shrub encroachment gradient. These findings correspond with previous research arguing that shrubs can create “islands of fertility”, or areas of high resource concentration and alter soil nutrient dynamics. With a redistribution of resources after shrub encroachment, restoration and management actions must address this before grasses can be returned.

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"A Lifetime of Rangeland Conservation Out on the Land" First became SRM member in 1973, continual member since 1983 or before. W.R. Chapine Stewardship awardee and other SRM honors. I offer to be a keynote speaker in opening general session with the following title. "A Lifetime of Rangeland Conservation Out on the Land". My career spanned from a GS-5 to a Senior Executive in SCS/NRCS in a 32 year career from field rangeland management specialist to position with national grazing lands technology responsibility, then as state conservationist for Texas. Since retiring in 2007, I have been a private consultant, national TV show creator, producer and host, and author. Something in this for everyone regardless of SRM tenure, professional discipline, etc, will be informative, enlightening, motivational, and entertaining.

Larry Butler

None (retired, self employed, Clarkridge, AR, USA

Contributed Oral Presentation

Abstract

"A Lifetime of Rangeland Conservation Out on the Land" Stories of conservation on the land with landowners, operators, agencies, and others. Author first became SRM member in 1973, and a continual member since 1983 or before. Received W.R. Chapine Stewardship Award and other SRM honors, including Section honors. I offer to be a keynote speaker in opening general session with the following title. "A Lifetime of Rangeland Conservation Out on the Land". My career spanned from a GS-5 to a Senior Executive in SCS/NRCS in a 32 year career from field rangeland management specialist to position with national grazing lands technology responsibility, then as state conservationist for Texas. Since retiring in 2007, I have been a private consultant, national TV show creator, producer and host, and author. Something in this for everyone regardless of SRM tenure, employment, professional discipline specialty, and more. This will be informative, enlightening, motivational, and entertaining.

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Methods being Utilized to Apply Microbial Seed Coatings to Improve the Establishment and Growth of Lupine Species

Bridget Calder[1], Curtis Drake[1], Alex Benedict[1], Joel Griffitts[1], Brad Geary[1], April Hulet[1], Kate Rubelmann[2], Kevin Gunnell[3], Danny Summers[3], Matt Madsen[1]

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Poster

Abstract

One of the biggest challenges in plant establishment and success is based on nutrient availability. Soil microbes can dramatically aid in the availability and uptake of necessary nutrients. One particular microbe is *Rhizobia,* a nitrogen-fixing bacteria that live in a symbiotic relationship with leguminous plants. *Rhizobia* collects atmospheric nitrogen and changes it to ammonia - a form that plants can use - in turn, the plant provides sugars to feed the bacteria that are housed in nodules on the plant roots. This presentation will describe the methods we are employing to coat native and commercial *Rhizobia* strains onto seeds to inoculate seeded species with these beneficial microbes. Two different lupine species (*Lupinus argenteus* and *Lupinus sericeus*) were selected as target species for the research. Lupines are beneficial to pollinators and can act as a pioneering species to build soils and help in the establishment of other plants. We have isolated native *Rhizobia* strains from three different lupine populations, cultured them in the laboratory, and coated the microbes onto lupine. In addition, we have coated seeds with commercially produced strains. We are evaluating *Rhizobia* seed coatings in growth chamber trials and in the field at two different mineland reclamation areas and a degraded rangeland site. We are monitoring these studies for plant growth and the establishment of *Rhizobia* within plant nodules. Preliminary findings from laboratory trials show that plant growth can be dramatically improved with a *Rhizobia* seed coating.

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Using Spectral Analysis and GIS Satellite Imagery to Conduct a Classification of the Precent Canopy Cover and Tree Density of Oneseed Juniper on the Pueblo of Santa Ana, New Mexico

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Schladweiler-Reclamation and Restoration Issues in Arid Environments of the Southwestern United States

Abstract

The Pueblo of Santa Ana (Pueblo) is located in north central New Mexico within southeastern Sandoval County, about 15 miles north of Albuquerque and 45 miles south of Santa Fe. The Pueblo Proper encompasses approximately 79,000 acres of trust lands and roughly 35,500 acres of oneseed juniper (*Juniperus monosperma)* savannah woodland. During the Summer season of 2020 the GIS Division of DNR conducted a classification and tree count analysis using high-resolution WorldView-2 multispectral satellite imagery (acquisition date 07-19-2020), and the ESRI ArcGIS software. The classification was conducted using the ERDAS Imagine software and a multispectral analysis transform that used Albedo (Mean Brightness), (NDVI) – Normalized Difference Vegetation Index, the Red Index (RI); and feature space mapping techniques within a GIS environment. The areal extent of individual tree canopies and clusters of trees across the Pueblo were mapped and converted to shape file polygons and point centroids. Juniper tree counts were summarized within the context of a pueblo-wide 1.0-acre grid. This allowed us to generate a pueblo-wide total juniper tree count and tree counts on a per 1.0-acre grid basis (point shape file). Percent Canopy Cover summations were also made on a 1.0-acre grid basis (using polygon shape files). The final analysis of the data included juniper tree density per acre, juniper tree percent canopy cover per acre, and a pueblo wide Juniper Woodlands classification Map.

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North Dakota Drought Calculator

Igathinathane Cannayen[1], John Hendrickson[2], Kevin Sedivec[3], Jeff Printz[4], Mark Hayek[5], David Archer[2]

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Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

The North Dakota Drought Calculator (NDDC) aims to answer the most common question of "*What can I expect this year for forage production?*" This is a tool that ranchers and conservation planners can use to help track and predict how much forage is being produced in the current year. The NDDC tool takes current and past years' precipitation datasets and forage growth curve data and compares them with long-term average precipitation data. The result shows a positive or negative % of normal forage growth expected for the year. Precipitation data can be entered by the user or obtained from the nearest weather station. NDDC is spreadsheet-based and features a rainfall probability tool, monthly forage growth potential graph, and percent of normal herd carrying capacity.

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Environmental footprints and economic impact of alternative beef supply chains

José Castaño-Sánchez[1,2], Alan Rotz[2], Cindy Tolle[3], Craig Gifford[4], Glenn Duff[5], Matthew McIntosh[1], Sheri Spiegal[6]

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

Beef production in the southwestern United States is projected to experience increasingly warmer and drier climate in the future. Adaptation strategies to these future conditions are needed without compromising environmental quality or profitability. Options include the use of desert-adapted beef cattle biotypes, such as Rarámuri Criollo cattle and Criollo crossbreeding with more traditional British breeds. Currently most calves raised in the Southwest are grain finished with feed often from irrigated crops produced in the sensitive Ogallala Aquifer region. A viable alternative may be grass finishing with rainfed forage in the desert rangeland of the southwest or in the temperate grassland of the Central Plains. We compared the environmental impacts and economics of current production systems using Angus cattle raised in the Southwest and grain-finished on feedlots in the Texas Panhandle with Criollo cattle and crosses (Criollo x Angus) finished on high-grain or high-grass diets. Current and alternative supply chain strategies were simulated using the Integrated Farm System Model to determine effects on farm-gate life cycle intensities of greenhouse gas emissions, fossil energy use, nitrogen losses, blue water consumption and production costs, using representative (appropriate soils, climate, and management) ranch and feedlot operations. Regardless of finishing options, Criollo x Angus cattle had the best environmental and economic outcomes, followed by pure Criollo cattle and then Angus. The crossbreed combined the desert adapted grazing behavior of Criollo cows and calves with heavier final carcasses from Angus genetics. Considering the combination of breed and finishing options, crossbred cattle with grass finishing in the Southwest or in the Central Plains outperformed on most environmental variables and production costs, mostly due to reduced external input requirements (primarily feed). A downside was greater carbon emission compared to grain finishing due to greater methane emissions from high forage diets and an extended time to finish.

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Using an experiential research project to teach high-school students about the importance of prairie range management and multi-species herbivory

Shannon Chatwin

Owasso High School, Owasso, USA. Prairie Project, College Station, USA

Contributed Oral Presentation

Abstract

Background:

Students with minimal knowledge of prairies and range management observed percent cover changes of four functional plant groups before and after the browsing of pygmy goats on our Owasso High School Outdoor Learning Lab (OHSOLL) prairie. The students' research culminated by comparing the biodiversity of three sites where data was collected: 1) an intact prairie 2) a managed pasture, and 3) a lawn. By combining field explorations with scientific literature reviews, students gained experience in fieldwork, record-keeping, and presenting findings in an evidence-based essay on the importance of prairie management worldwide.

Method:

In Fall 2020, two pygmy goats were added to a 300 square meter fenced area in the OHSOLL prairie. The goats were left to browse from September to December. The 300 square meter site was sorted into a randomized block design consisting of one square meter quadrants. Each student group was assigned 3 treatment quadrants and 2 total control quadrants where they measured the percent coverage of four functional plant groups (grasses, forbs, woody plants, and litter).

Results:

Following the introduction of goats in 2020, students observed a decrease in the percent cover and height of grasses in Year 1. In Year 2, the number of invasive and woody plants also decreased. The populations of graminoids and forbs appeared to concurrently increase, but Year 2 data is still being analyzed. For most students, this was their first research experience. Consequently, data accuracy was sometimes poor but sufficient for broad trends to emerge.

Conclusion:

Students were able to observe in real-time how large browsers (pygmy goats) impacted the OHSOLL prairie area with a noticeable decrease in woody and invasive species. This hands-on activity increased students' understanding of grasslands through research and the need to employ several management techniques, and the importance of rangelands around the world.

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Dashboard Development for Real-time Monitoring of Cattle Behavior

Huiying Chen, Trung Le, Shelemia Nyamuryekung'e, Santiago Utsumi, Huiping Cao, Matthew McIntosh

New Mexico State University, Las Cruces, USA

McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Precision livestock farming (PLF) technologies are becoming increasingly common in modern agriculture. They are frequently integrated with other new technologies in order to manage human-livestock interactions more efficiently, improve animal productivity and enhance the profitability and sustainability of modern farms. Multiple PLF systems have been developed for use in intensified animal farming operations using conventional and pasture-based farming practices. However, the implementation of a PLF system is less common on extensive ranches that have limited access to power supply and data connectivity. Furthermore, the monitoring of cattle behavior in real time could be applied to track changes in grazing distribution patterns, assess animal welfare and warn about potential livestock diseases. In this project, we designed a dashboard monitoring system that organically integrates a geographic information system (GIS) and Machine Learning (ML) algorithms to help ranchers monitor and track livestock in real-time. Specifically, the dashboard acquires and stores animal position and activity data logged and transmitted by high throughput sensors. Algorithms are being developed to preprocess heterogeneous data, minimize the effect of outliers and missing values, and enable visualization of basic statistics, prior to implementing ML algorithms to classify and predict animal activities, detect abnormal shifts of animal activities and provide insights of animal health and feeding patterns.

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Effects of different functional types and extreme rainfall events on the carbon flux, biomass and nitrogen mineralization in a Northern Great Plains mixed grassland

Zigeng Chen, Joshua Leffler

South State University, Brookings, USA

Poster

Abstract

Larger but fewer rainfall events are predicted to be more frequent in the Northern Great Plains. Rainfall event size and frequency, and vegetation functional group influence net ecosystem exchange, biomass and nitrogen mineralization rate (NMR). We examined each in a split-plot experiment with two distinct rainfall regimes (frequent/small and infrequent/large with constant total monthly rainfall size) and two functional groups (C3- and C4-dominated pastures) with five replications in western South Dakota during 2020 and 2021. We hypothesized that extreme rainfall would (1) alter carbon balance, (2) benefit plant growth in C4- but not C3-dominated pastures, and (3) reduce NMR due to higher soil moisture. We observed: (1) Extreme rainfall reduced carbon loss in the C3-dominated pasture in the early season but increased C loss in the late season. The C4-dominated pasture was a carbon source in 2020 but a sink in 2021. Both pastures were stronger carbon sinks in 2021 than in 2020, especially in the early season. (2) Biomass was higher in the early season than late season in both pastures and treatments in 2021, opposite to our observation in 2020, and overall biomass was much greater in 2021. (3) In both years NMR declined with the decreasing temperature (except the control groups in July 2021). We conclude: (1) extreme rainfall alters the timing of net C uptake and release in the C3 pasture by enhancing uptake during the growing season, (2) extreme rainfall does not influence plant growth following two years of treatment, (3) early season soil moisture is more critical for carbon flux and aboveground biomass than rainfall in the late season, and (4) NMR was influenced by temperature more than size and frequency of rainfall event.

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Oral History Folklore Style

Leisl Carr Childers

Colorado State University, Fort Collins, USA

Wilmer- (Ignite) Seeing the Southwestern Rangelands through the History, Art, and Culture

Abstract

Historians have long used oral history to collect the experiences of individuals often left out of the historical record. This type of oral history collection does not adhere to protocols of confidentiality or anonymity, nor does it seek to aggregate and generalize information. Rather this method of interviewing seeks to clearly identify and articulate the unique individual experiences of narrators using the shared authority model. This folklore style of oral history collection is particularly suited to making the invisible visible.

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Crested wheatgrass dominated grassland benefits from native species restoration in the Grand River National Grassland

Rachael Chistensen, John Hendrickson Hendrickson

USDA-ARS Northern Great Plains Research Laboratory, Mandan, USA

Poster

Abstract

The landscapes of the United States are ever changing, with none perhaps as great as our grasslands. During the drought of the 1930's large tracts of these grasslands were planted in crested wheatgrass (*Agropyron cristatum*), to reduce soil erosion. It is estimated that over 12 million acres of crested wheatgrass grow in eleven western states. However, there are concerns about crested wheatgrass's ability to invade native grasslands. Therefore, restoration efforts to rehabilitate existing crested wheatgrass stands has occurred. Our objective was to quantify the nutritive value of seeded species used to rehabilitate an existing crested wheatgrass stand on the Grand River National Grasslands in northwest South Dakota, USA. In 2008, native grasses were seeded into crested wheatgrass stands that were either seeded only or seeded and then sprayed with glyphosate. In 2009 and 2011 plots were sampled and plant biomass and forage nutritive values of all species were evaluated, including blue grama [*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths], little bluestem [*Schizachyrium scoparium* (Michx.) Nash], big bluestem (*Andropogon gerardii* Vitman), western wheat grass [*Pascopyrum smithii* (Rydb.) Á. Löve], while crested wheatgrass was collected as a comparison. Significant differences among the year of production and biomass by species were determined statistically. Responses included metabolizable energy, *In vitro* dry matter digestibility, acid and neutral detergent fiber and biomass. Biomass production was significantly affected by seeding treatment and influenced by species and year of production. Little bluestem and big bluestem were higher in digestibility ($P<0.001$) than crested wheatgrass. These findings are important for beef producers, range managers and public land use planners regarding which species to seed when attempting to rehabilitate rangeland to increase nutritive value to livestock, increase proportions of native species of grasses and determine how often to reseed to reduce dominance of crested wheatgrass.

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Digital Mapping and Description of Ecological Sites in the Andes of Peru

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Contributed Oral Presentation

Abstract

Spatial information technologies and mobile applications can be used to delimit and describe ecological sites and design strategies for the management and conservation of grasslands based on the potential of the soils. Our research objective was to identify and characterize ecological sites of high Andean grasslands based on the use of spatial information technology and hierarchical cluster analysis. The study was carried out in grazing areas of the Canchayllo Peasant Community, Junín region, Peru. Cartographic units were delimited in ArcGIS 10.5 by intersecting thematic maps representing soil formation factors. Landscape, vegetation and soil information was recorded in representative areas of the cartographic units using 4 transects oriented to the cardinal points using the LandPKS application and the Rapid Survey methodology. A group of 6 important qualitative and quantitative variables were selected by an expert panel to group the mapping units. A hierarchical cluster analysis and a Mantel correlation test were performed with RStudio 4.0.5 software. The intersection of the thematic maps resulted in 33 different soil mapping units and Mantel's test resulted in 10 clusters as the optimal number, with a correlation value of 0.6152. The cluster analysis allowed reducing 33 mapping units to 10 ecological sites with their respective description of soil and vegetation characteristics. The floristic composition within the studied sites suggests that they support markedly different plant communities.

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Multi-year occupancy of sagebrush associated songbirds across a gradient of juniper encroachment in the Steens Mountain area

Cara Christensen[1], Vanessa Schroeder[2], Sam Wolfe[3], Holly Higgins[4], Dustin Johnson[2], Jonathan Dinkins[1]

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Contributed Oral Presentation

Abstract

The populations of many songbird species in the Great Basin have declined over the past several decades due to habitat loss and degradation related to juniper (*Juniperus occidentalis*) encroachment. In response, land managers have removed juniper from areas outside its historic range which has had mixed effects on songbird populations. Within the sagebrush (*Artemisia spp.)* steppe ecosystem, populations of sagebrush-obligate or associated species generally increase after juniper removal, while woodland-associated species decline. Songbird occupancy post-removal is relatively unstudied for many species. Broadly, we are studying the short and long-term impacts of juniper removal on songbird occupancy across time in sagebrush, aspen (*Populus tremuloides)*, and riparian areas in the Steens Mountain area, Oregon. Much of this area is a designated wilderness are consisting of public and private land used primarily for grazing and hunting. Aspen stands and riparian areas support a high diversity of songbird species despite being relatively small in size. Juniper is encroaching in these areas and the impact of removal on songbird occupancy within these areas is not well understood. From May to July 2019 and 2020, we conducted point counts to establish pre-treatment species occupancy in these areas. From May to July 2021, we conducted our first post-treatment point count surveys. We will present the results of multi-year occupancy analyses stratified by sagebrush, aspen, and riparian areas across a gradient of juniper encroachment and removal. These preliminary evaluations will provide insights into the short-term effects of juniper removal on local colonization and extinction over time and inform management agencies about the influence of juniper encroachment on songbird occupancy in aspen and riparian areas.

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Forecasting landscape change using state and transition simulation models in southern New Mexico

Erica Christensen[1], Leonardo Frid[2], Joel Brown[3], Matt Reeves[4], Brandon Bestelmeyer[1]

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

The most important part of an Ecological Site Description is the state and transition model (STM): a model which describes the common potential ecological states an ecological site may exhibit, as well as the drivers that cause changes among states. Conducting using STMs can be a powerful tool for predicting the future states and function of a landscape, including comparing the effects of changes in climate and management. However, constructing a simulation requires detailed knowledge of the mechanisms driving transitions between states, including accurate estimates of the probability a state change will occur in response to a transition driver. These probabilities are difficult to estimate for natural systems, as multiple drivers are often present simultaneously, and probabilities may differ by spatial properties such as elevation and soil type. Here we use a time series of remotely-sensed vegetation data (1985-2020) to estimate rates of transition between ecological states on a single Ecological Site. We demonstrate the approach in an arid grassland system where the main drivers of state transitions include woody shrub encroachment and drought causing perennial grass mortality. We found that using remote sensing tools provided data-based estimates of transition parameters, though the nature of the tools restricted the types of transitions that were detectable.

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USDA NIFA Programs Supporting Precision Grazing Research and Extension: A Brief Overview

Andres Cibils

USDA NIFA, Kansas City, USA

McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

The National Institute of Food and Agriculture (NIFA) is the extramural funding agency within USDA's Research, Education, and Economics mission area. NIFA provides leadership and funding for programs that advance agricultural research, education, and extension to help solve national challenges in agriculture and food. To ensure science is put into use, NIFA’s integrated approach includes the three components of the agricultural knowledge system: a) research to provide answers to the complex issues facing the nation and world; b) education to strengthen schools and universities to train the next generation of scientists, educators, producers, and citizens; and c) extension to provide the knowledge gained through research and education to the agricultural workforce. This presentation will highlight NIFA’s Agricultural and Food Research Initiative (AFRI) Foundational and Applied Science Program priorities that fund proposals addressing precision grazing. Examples of recently funded projects will be discussed.

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USDA NIFA programs supporting undergraduate and graduate students, postdocs, and new faculty

Andres Cibils, James Dobrowolski, Erin Ryley, Ray Ali

USDA NIFA, Kansas City, USA

Contributed Oral Presentation

Abstract

The National Institute of Food and Agriculture (NIFA) is the extramural funding agency within USDA's Research, Education, and Economics mission area. NIFA provides leadership and funding for competitive and capacity programs that advance agricultural research, education, and extension to help solve local, regional, and national challenges in agriculture, natural resources, and food. To ensure that the science, education, and outreach is put to good use, NIFA’s integrated approach may include up to three components of the agricultural knowledge system: a) research provides answers to the complex issues facing the nation and world; b) education strengthens schools and universities to train the next generation of scientists, educators, producers, and citizens; and c) extension translates the knowledge gained through research and education to the agricultural workforce. This half-day workshop will be directed to beginning researchers, educators, and extension faculty. Our goal will be to describe current programs at the USDA-NIFA that support undergraduate, graduate, postdoctoral, and new investigator research, extension, and education projects, including those aimed at supporting students and faculty at Tribal Colleges. This interactive session will seek to help the next generation of rangeland scientists navigate the USDA-NIFA grant application process. Topics covered will include: 1) the anatomy of a Request for Applications (RFA); 2) what it takes to write a successful grant proposal; 3) an overview of USDA-NIFA’s grant types--emphasizing those pertinent to SRM’s beginning researchers; and 4) the resources available to support new investigator success. Our workshop will include a listening session to elicit feedback from participants regarding NIFA’s ability to support their needs.

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Perceptions of Prescribed Fire Across Stakeholder Groups in the Northern Plains

Autumn Clark[1], Devan McGranahan[2], Benjamin Geaumont[1], Carissa Wonkka[3], Jacqueline Ott[4]

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Contributed Oral Presentation

Abstract

Although fire provides ecosystem benefits to the working landscapes of the Northern Great Plains, the use of prescribed fire in the communities within this region has been slow to take hold. A better understanding of the perceptions and attitudes towards prescribed fire among a wide-range of practitioner groups is imperative to considering safe and effective prescribed fire use. In the spring and summer of 2021, we conducted semi structured telephone interviews with private land managers, state and federal land management professionals, and fire management professionals across North Dakota and northwestern South Dakota. The interviews focused on assessing: individual familiarity with prescribed fire, use of prescribed fire by land managers, knowledge land management professionals' have of the landowners in their community, and the training of fire management professionals. Landowners interested in burning reported burn bans and insufficient help as barriers to application. Landowners who did not burn emphasized prior prescribed fire escapes, liability concerns, and lack of fire use in the area as barriers to application. The results suggested that increased prescribed fire knowledge for land management professionals and local demonstrations of fire use could provide landowners with more decision-making information. These interviews lay the groundwork for a quantitative analysis about prescribed fire in stakeholder communities. This increased understanding will help inform managers on their decisions to use fire to restore and maintain fire-dependent landscapes on which these Northern Great Plains communities rely.

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Public Grazing Lands: A conservation space or a resource for local producers?

Autumn Clark[1], Devan McGranahan[2]

[1]North Dakota State University, Fargo, USA. [2]USDA-ARS, Miles City, USA

Poster

Abstract

Ranchers and farmers in the Northern Plains have a unique resource in the form of public grasslands available to lease for grazing and other agricultural purposes. Many producers rely on these lands as a considerable portion of their operation and their resulting income. These lands are owned and managed by various State and Federal agencies: The Bureau of Land Management, U.S Forest Service, U.S. Fish and Wildlife Service, and State Trust Lands. In the Spring and Summer of 2021, we conducted interviews with these agency personnel in North and South Dakota. These interviews produced information on the way agencies manage their public lands, the way they interact with lessees, and the overall view of the purpose of disturbance on the public lands. The results also illustrated that the different agencies' view of these lands lies along a gradient with a conservation space at one end and as a resource for local producers at the other; some agencies lie in the middle, with having identified priorities to serve both. Understanding how these public lands are viewed and managed by agencies provides researchers with a starting point for conversation about working lands also being conservation spaces with local producers, and might provide opportunities for demonstrating novel management practices.

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Breeding Bird Nesting Abundance and Success in a Modified Twice-over Rest-rotation Grazing System

Justin Clarke[1], Torre Hovick[1], Kevin Sedivec[1,2], Ryan Limb[1], Ben Geaumont[3], Jason Harmon[1]

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Poster

Abstract

Grassland birds are one of the most threatened avian guilds, largely due to loss and mismanagement of grasslands. Current management negatively influences avian biodiversity by creating homogenous pastures through uniform grazing practices and altered or suppressed fire regimes. Restoring disturbance regimes including fire can be an effective way to create heterogeneity but, in many regions, cultural aversion to fire requires creative management practices to restore heterogeneity. We implemented a modified twice-over rest-rotation grazing system with varying stock rate intensities of cattle in 2018 to create heterogeneity in vegetation structure in the absence of fire. We assessed breeding bird nesting abundances and success starting in 2021. We used nest dragging to locate nests on four replicates of four different grazing intensities based on percent utilization: heavy (60+ %), full (40-60 %), light (20-40 %), and rested (0 %). We monitored nests every 2-4 days until the nest fledged or failed. Vegetation surveys were conducted at the nest within 2-3 days of the actual or expected fledge date. We found 437 nests belonging to 18 facultative and 6 obligate grassland birds. Nesting species richness was highest in the full and light treatments (18 and 19 respectively), and lowest in the heavy and rested treatments (10 and 12, respectively). Additionally, the light and full treatments each had approximately double the number of nests as the heavy and rested treatments. Overall apparent nest survival was 29% for all species combined. In the future, we will explore the drivers of nest success using a mixed-effects logistic exposure method and hierarchical modeling steps. Our preliminary results show that variation in grazing intensity influences diversity in breeding bird nesting abundances and provides additional insights into the importance of heterogeneity in rangeland systems to manage for biodiversity.

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Potential Benefits of Tanniferous Forages in Integrative Crop-Livestock Agroecosystems

Andrea Clemensen, Jonathan Halvorson, Rachael Christensen, Scott Kronberg

USDA-ARS, Mandan, USA

Poster

Abstract

Integrating livestock into cropping systems may enhance ecosystem services while still providing efficient food production. Including tanniferous forages in crop-livestock systems could further enhance ecosystem services. Interest in phytochemicals, such as tannins, has increased over the past several decades, and research continues to reveal the potential benefits of tannins in agricultural systems. However, research evaluating the influence of tanniferous forages in integrative crop-livestock systems is limited. We discuss how tannins influence soil microbial dynamics and nutrient cycling, the function of tannins in forages, and the role tannins have in improving the health of foraging animals. We consider the potential advantages for human health from consumption of animal-based foods from animals that consumed tanniferous forages or supplemental plant materials. Expanding our knowledge of phytochemicals and their influence in agriculture system dynamics may be an effective tool to enhance agroecological sustainability.

89

Establishing Perennial Grasses Reduces Cheatgrass and Associated Fuels

Charlie Clements, Dan Harmon

USDA_ARS, RENO, USA

Poster

Abstract

The introduction and subsequent invasion of cheatgrass (*Bromus tectorum*)onto millions of acres of Great Basin rangelands has truncated succession by providing a fine-textured early maturing fuel that has increased the chance, rate, spread and season of wildfires. With each passing wildfire season more critical wildlife and grazing resources are being converted to cheatgrass dominance, therefore resource managers and land owners are facing the daunting task of reducing wildfire risks caused by associated cheatgrass fuels. Chemical weed control practices, in combination with rangeland seeding efforts, have the ability to be successful in actively suppressing and reducing cheatgrass associated fuels. 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 and associated fuels. We tested the application of the pre-emergent herbicide, Sulfometuron Methyl @ 1.75oz/ac rates in a completely randomized block design in northern Nevada. The treated plots were fallowed for one year and then seeded to a perennial grass mix of Siberian wheatgrass (*Agropyron fragilla* ssp. *sibiricum*) at 4 lbs/ac rate, 'Anatone' bluebunch wheatgrass @ 4 lb/acre rate, Sherman big bluegrass @ 1 lb/acre rate and Sandberg's bluegrass @ 1 lb/acre rate in the fall 2015 and 2016. Sulfometuron Methyl significantly reduced cheatgrass above-ground densities by 98.7%. This reduction in cheatgrass densities significantly improved the emergence and establishment of seedlings of seeded species which averaged 0.8 and 0.9/ft^2. Cheatgrass was significantly reduced with the establishment of perennial grasses as the control plots averaged 1,206 lbs/acre of dry weight cheatgrass fuel compared to 135 lbs/acre of dry weight cheatgrass fuel, an 89% reduction in cheatgrass fuel loads. The ability of resource managers to successfully seed perennial grasses will. significantly reduce catastrophic wildfires on arid Great Basin rangelands.

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Improving Great Basin Wildrye Communities: The advantage of using the Lawson Aerator

Charlie Clements, Dan Harmon

USDA-ARS, RENO, USA

Poster

Abstract

Heavy duty implements designed and built for manipulating rangeland vegetation and soils have been used for decades. In the 1950's, early developments of Rangeland drills resulted in the effective seeding of hundreds of thousands of acres of deteriorated rangelands to perennial grasses in an effort to curb erosion and increase the forage base for livestock and reduce the spread of the noxious weeds. The Lawson Aerator is one of the newer implements to enter the scene for rangeland improvements. The Lawson Aerator, designed as a pasture renovator in southern states that were being invaded by woody species, has earned a solid reputation and since found its way West. The aerator has significant weight distributed over 2 tandem drums that are typically 12' x 3' diameter. The drums display angled, protruding and spaced 8" x 4" x 1" steel plates with sharpened ends for effective chopping of woody material and penetration into soils for aeration. The variable pitch between the bladed drums can be adjusted to reduce or increase the impact to vegetation. Here we report on the use of the Lawson Aerator in a degraded Great Basin Wildrye community that had significantly reduced in grazing capacity as decadent big sagebrush and greasewood shrubs dominated the community. In the fall and early winter of 2020/2021, we initiated the mechanical treatment of 900 acres using the Lawson Aerator to improve herbaceous density and forage. Plots were set up to measure in a cardinal direction the impact/benefit of manipulating this degraded habitat to re-invigorate the Great Basin Wildrye community. Using the Lawson Aerator to vegetatively manipulate this habit resulted in an increase of 690% in density and 1,180% in forage. Managers should take a closer look at using this implement to improve degraded shrub habitats and improve herbaceous species composition.

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Sage-grouse population response to wildfire: how underlying ecosystem and demographic processes illustrate patterns of abundance across the distributional range

Peter Coates[1], Ian Dwight[1], Cali Roth[1], Brian Prochazka[1], Michael Chenaille[1], Mark Ricca[1], Cameron Aldridge[2], Adrian Monroe[2], David Pilliod[3], Mathew Rigge[4]

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Contributed Oral Presentation

Abstract

Adverse effects of wildfire on greater sage-grouse (*Centrocercus urophasianus*) within the Great Basin are accelerated by an invasive grass-fire cycle. Conversion of sagebrush (*Artemisia spp*.) to exotic grassland following wildfire reduces functional habitat for sage-grouse and jeopardizes population persistence. However, chronic effects of wildfire may vary across sage-grouse distributional range based on regional differences in climate and ecological properties related to ecosystem resilience and resistance to invasive annual grasses. To understand how wildfire impacts sage-grouse across the distributional range, we employed a Bayesian state-space model framework, which relates sage-grouse population rate of change (λ) across a range-wide study extent to changes in net sagebrush loss and recovery over the past 35 years around leks while accounting for environmental covariates. We found support for an interaction between cumulative burned area and a one-year lag effect on summer precipitation. Although the strength of the effect varied among regions across sage-grouse range, which we delineated by broad-scale clusters of leks grouped by shared climatic conditions, the positive influence of precipitation was typically reduced as the proportion of burned area around leks increased. Additionally, we carried out a before-after-control-impact-paired-series study design using 10 years of sage-grouse telemetry to estimate nest and adult survival. We then developed a stage-based, stochastic population growth model that integrated our estimated parameters from wildfire impacts to understand cumulative impacts to overall rate of change in population abundance. Our results suggest wildfire has both an immediate and strong impact to key life stages. Lastly, we used models to project λ over the course of 35 years under different management action scenarios to inform specific actions that reduce net sagebrush loss and neutralize negative impacts of habitat loss. Findings are preliminary and provided for timely science.

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Land use history influences plant community composition in the Prairie Pothole Region

Carlee Coleman[1], Cami Dixon[2], Shawn DeKeyser[1]

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Contributed Oral Presentation

Abstract

The Prairie Pothole Region (PPR) is a highly modified landscape where remnant tracts of unplowed prairie are repositories of native plant biodiversity. However, idle land use practices on these lands have facilitated introduced species invasion and subsequent declines in native species abundance and community diversity. A previous study comparing historically idle landscapes to those with a long-term history of annual grazing found differences in invasive grass frequency; notably that smooth brome (Bromus inermis Leyss) was significantly less prevalent on annually grazed lands. This previous study occurred on two US Fish and Wildlife Service (USFWS) management districts and nearby private grazing land in North Dakota, but a broader assessment is warranted to understand this relationship across the PPR. We selected 26 USFWS units and adjacent or nearby native prairie with a history of livestock grazing in the PPR of North Dakota and South Dakota. We estimated absolute cover of all species present in five 10m2 plots at each paired site in June and July of 2021. Non-metric multidimensional scaling indicates landscape-level patterns in plant community characteristics, and permutational analysis of variance reveals significant differences in species composition between paired sites ($p < 0.021$, $F = 1.935$). Paired t-tests reveal that lands with a long-term history of grazing have significantly higher total species richness ($p <0.005$) and floristic quality index values ($p <0.0415$) than USFWS units. Additionally, smooth brome was significantly ($p < 0.0186$) less prevalent at sites with a long-term history of grazing (13.4% mean relative cover) than USFWS units (23.3% mean relative cover). Given these differences, remnant native prairie with a long-term history of annual grazing may provide unique opportunities for conserving native plant diversity in the PPR and impeding smooth brome establishment.

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Targeted management effects on native species composition in the Prairie Pothole Region

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Contributed Oral Presentation

Abstract

Remnant native prairie managed by the US Fish and Wildlife Service (USFWS) in the Prairie Pothole Region (PPR) should serve as a repository of native plant biodiversity, yet this resource is threatened by introduced plant invasion. Efforts to increase native species diversity and abundance have resulted in inconsistent outcomes as managers face biological and environmental uncertainty in selecting management tools. The Native Prairie Adaptive Management program (NPAM) was developed to increase native plant cover using practical, cost-effective management practices to target site-specific conditions. Though the program has demonstrated effectiveness in increasing the overall cover of native plants, the species-level composition of those changes remains unclear. Our objective was to explore how native species composition has changed between 2012 and 2020 in response to differing levels of spring prescribed burning. In 2012, we established permanent modified-Whittaker plots to assess plant community composition on 30 sites enrolled in the NPAM program in North Dakota and South Dakota. We remeasured the sites in June and July of 2020 to explore changes in species composition over a longer period. Permutational analysis of variance indicates significant ($P < 0.025$, $F = 1.874$) compositional differences between sites burned 0, 1 or 2 times and sites burned 3, 4 or 5 times. T-tests reveal that frequent burning increases the abundance of some species and decreases others, and across all sites, floristic quality was higher in 2020 than 2012. An unintended consequence of using prescribed burning to increase native species richness and abundance is the significant ($p = 0.036$) increase of sweet clover (Melilotus officinalis (L.) Lam.) on sites burned at higher frequencies. Management to benefit the native plant communities of the PPR will prove challenging in a landscape invaded by introduced species.

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A Pilot Study to Estimate Crude Protein in tanglehead (*Heteropogon contortus*) Using Unmanned Aerial Vehicles in Semi-Arid Rangelands

Rider Combs[1], J. Alfonso Ortega-S[1], Humberto Perotto-Baldivieso[1], David Wester[1], Sandra Rideout-Hanzak[1], Doug Tolleson[2], Michael Page[1], Annalysa Camacho[1]

[1]Texas A&M University-Kingsville, Kingsville, USA. [2]Texas A&M University, Sonora, USA

Poster

Abstract

Monitoring rangeland plant communities is a critical component of successful livestock operations. The use of unmanned aerial vehicles (UAVs) has greatly improved opportunities to assess and monitor rangelands. The goal of this pilot study was to estimate percent crude protein in tanglehead using spectral signatures. This was achieved by testing five spectral bands and four vegetation indices derived from UAV multispectral imagery. The imagery was collected with the DJI Phantom IV Pro at an altitude of 50 m above ground level (AGL) in Jim Hogg County, Texas. The UAV was equipped with a multispectral sensor (Micasense RedEdge MX) to record the spectral signatures of the tanglehead plants. Following the flight missions vegetation samples were clipped, dried, ground and sent to the Texas A&M AgriLife Extension Service Soil, Water and Forage Testing Laboratory for combustion and near infrared spectroscopy foage analysis. UAV imagery was processed in Pix4D and reflectance value orthomosaics were generated for each reflectance band. We obtained spectral signatures and vegetation indices for each forage sample. Percent crude protein samples were regressed against the spectral signatures and vegetation indices. Results in out study showed the Normalized Green-Red-Difference Index (NGRDI), and the near infrared (NIR) reflectance band to have significant relationships with r^2values of 0.60 and 0.58 respectively. The combination of the red, blue, and NIR reflectance bands in a multiple regression model produced the best explanatory performance (R^2_{adj} = 0.73) with combustion-estimated percent crude protein. This indicates the ablity of spectral refelectance values to estimate the percent crude protein in tanglehead grass. This has the potential to improve time sensitive management decisions on semi-arid rangelands.

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Response of Tanglehead (*Heteropogon contortus*) Expansion to Prescribed Fire and Cattle Grazing

Rider Combs, J. Alfonso Ortega-S, Humberto Perotto-Baldivieso, David Wester, Sandra Rideout-Hanzak

Texas A&M University-Kingsville, Kingsville, USA

Contributed Oral Presentation

Abstract

Tanglehead (*Heteropogon contortus*) is a native invasive grass that dominating plant communities throughout the sandy soil sites on the South Texas Sand Sheet. The earlies report of expansion occurred from a rancher in the late 1990's in Jim Hogg County, Texas. Since then mature tanglehead dominated plant communities become coarse, unpalatable and low in percent crude protein. Prescribed fire is a common management strategy used to increase the palatability and utilization of tanglehead by cattle (*Bos taurus*). The goal of this study was to evaluate the effects of four different treatment combinations of prescribed fire and grazing on the expanse of tanglehead. The objective of this study was to determine the rate of individual tanglehead plants' expansion under four treatment combinations. On a 95 ha tanglehead dominated pasture in Jim Hogg County, Texas, three ~ 4 ha prescribed patch burns were implemented in February of 2019. Over the course of two years, cattle were stocked at rate of 0.1 au/ha/yr. Every 30-40 days following the prescribed fire, changes in thirty plants inside permanent grazing exclosures and thirty plants paired outside of the exclosures will be documented. The treatment effects of tanglehead basal circumference, inflorescence counts, seedling density, tanglehead foliar cover, percent bare ground and other plant species foliar cover inside a 0.25 m^2 frame surrounding each plant were recorded. In the burning and grazing treatment the basal circumference, percent bare ground, and tanglehead foliar cover for 2 years following the prescribed fire did not increase. The burning and grazing treatment was successful in controlling the spread of tanglehead. This can help with critical management decisions to maintain cattle body condition scores and achieve optimum cattle productivity.

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Could Carbon Sequestration in Global Rangelands Mitigate Climate Change?--A Modeling Perspective

Richard Conant

Colorado State University, Fort Collins, USA

Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Grassland ecosystems cover a large portion of Earths' surface and contain substantial amounts of soil organic carbon. Previous work has established that these soil carbon stocks are sensitive to management and land use changes: grazing, species composition, and mineral nutrient availability can lead to losses or gains of soil carbon. Because of the large annual carbon fluxes into and out of grassland systems, there has been growing interest in how changes in management might shift the net balance of these flows, stemming losses from degrading grasslands or managing systems to increase soil carbon stocks (i.e., carbon sequestration). This talk focuses on how well we can model these systems, their management, and soil C responses and includes thoughts on best practices for modeling and model validation and an assessment of requirements for systems to recognize and value grazingland C offsets.

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Season of Grazing Interacts with Soil Texture, Selecting for Cover of Biocrust Morphogroups

Lea Condon[1], Roger Rosentreter[2], David Eldridge[3], Kari Veblen[4], Peter Coates[5]

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Contributed Oral Presentation

Abstract

Livestock grazing is often placed in opposition to the perpetuation of biological soil crusts (biocrusts). We explore hypothesized interactions between season of grazing and soil texture to determine if some morphogroups of biocrust can be maintained with grazing. We hypothesize that soil surface firmness will influence the ability of biocrusts to withstand trampling, reasoning that finer soil textures are firmer when dry and that coarser soil textures are firmer when wet. We test these relationships at the scale of the state of Nevada (USA) on lichen and moss cover with pre-existing datasets and at the scale of Birds of Prey, National Conservation Area (Boise, Idaho, USA) on morphogroups of biocrusts with field collected data. Preliminary results demonstrate two associations of biocrusts: one dominated by light algal crusts and lichens that more frequently occur with wet season grazing, and a second association dominated by tall mosses and cup lichens that more frequently occur with dry season grazing on finer textured soils. We observed the highest cover of *Bromus tectorum*, on sandy sites that are grazed at relatively high intensities and when soils are dry, creating unstable soil surfaces that are likely putting biocrusts at greater susceptibility to trampling. Our findings suggest that accounting for soil texture and moisture can be used to maintain cover of biocrusts which is associated with reduced invasion by *B. tectorum*. Further, we report that biocrusts most frequently occur in areas with relatively low resistance to invasion by *B. tectorum* and low resilience (i.e., ability to restore to native plant communities), which largely comprises sagebrush ecosystems of the Great Basin, USA. Findings are preliminary and provided for the best timely science.

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Winterfat Seeding Depth, Seed Coatings, and Seed-Soil Contact

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Poster

Abstract

Winterfat (*Krascheninnikovia lanata*) is a half-shrub native to Western North America and is valuable to wildlife and livestock due to its high protein content. Until recently, this species has been under-utilized in rangeland improvement projects due to the seed being contained within a fruit that is covered with silky bracts, which impair flow through mechanized seeders. Recent discoveries have shown that this limitation can be overcome by flash-flaming the appendages from winterfat fruits and applying a polymer coating. Now that winterfat can be seeded, research is needed to determine cultural practices for using coated fruits, including determining the optimal depth the fruits should be planted. We planted untreated and coated winterfat fruits within a walk-in growth chamber in 25.4 X 53.3 cm flats that contained either loam or sandy-loam soils. Fruits were sown on the soil surface and at 3.2, 6.3, and 12.7 mm below the soil surface. On the soil surface, there were 3-fold more coated seeds emerged than uncoated seeds. We observed that the hairs of uncoated fruits kept the fruit suspended slightly above the soil while coated seeds laid in direct contact with the soil. We hypothesized that improved soil contact associated with the coated seeds provided them with more moisture for germination. Seedling emergence declined when winterfat fruits were sown below 6.3 mm. Thus, this studies indicates that seed coating can improve seedling emergence when fruits are sown on the soil surface. Results also indicate that coated winterfat fruits can be sown to a maxiume depth of 6.3 mm, and not have a significant impact on seedling emergence. Studies are now ongoing to repeat this research in the field at multiple field sites.

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Seed Spec - A Geospatial Web Application that Allows Users to Develop a Site Specific Native Seed Blend

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Contributed Oral Presentation

Abstract

Establishing native vegetation in any reclamation project can be a challenging task. The species and varieties that match the site must be identified and used to help ensure adequate establishment and persistence. Data exists to help producers or project managers identify what species are native to a given area and commercially available, but can be cumbersome, not user friendly, and time consuming.

Bamert Seed Company has worked with Colorado State University to develop a web application to easily identify a project area of interest (AOI) and provide information on native species composition for the AOI. The tool will provide a list of commercially available species that correspond to the plants that grow natively in the AOI and intuitively walk the user through developing a site-specific native seed blend. The recommended seeding rate from NRCS will be used to calculate the pounds of pure live seed (PLS) that will be needed for the project. Users will have the ability to adjust the seeding rate based on their establishment objectives and seeding method they will be using. Having this tool will allow the producers/reclamation specialist a timely way to determine the best blend for their AOI and get the seed blend to a vendor/seed dealer with knowledge that the species selected will work for their specific site. George and Rob will discuss the importance of native plants and the benefits they bring in diversifying operations, adding biodiversity, and improving soil health. They will discuss and present version 1 of the tool and ask attends to provide input on what other functionality/data would be useful on their operations for version 2.

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Improving restoration success through a precision restoration framework

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Contributed Oral Presentation

Abstract

Dryland ecosystems represent a significant portion of global land area, support billions of people, and suffer high rates of land degradation. Successfully restoring native vegetation to degraded drylands is a global priority and major challenge – highlighting the need for more efficient and successful restoration strategies. We introduce the concept of “precision restoration”, which targets critical biotic and abiotic barriers to restoration success and applies specific tools or methods based on barrier distribution in space and time. With an example from the sagebrush steppe biome, a North American cold desert, we present a framework for precision restoration in drylands that involves: 1) identifying site-specific critical barriers to restoration success, 2) understanding the spatial and temporal variability of each barrier, and 3) applying the best available restoration strategies given the specific barrier and its variability, described in the first two steps. This framework aims to enhance restoration success by focusing restoration practices on ameliorating the influential barriers when and where they occur and away from applying singular landscape-wide approaches/

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Introduction to the IYRP 2026 Symposium

D. Layne Coppock[1], Jim O'Rourke[2]

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

The purpose of this symposium is to help chart a path forward for a proposal concerning the International Year for Rangelands and Pastoralists (IYRP) for 2026. The symposium has two segments: (1) This seminar in an in-person/virtual format; and (2) stakeholder workshops in a virtual format. In sum, the IYRP aspires to move concerns about rangelands and rangeland inhabitants to the forefront of global awareness and action. It is planned that the IYRP will spawn worldwide efforts—beginning now—to better recognize the multiple values of rangelands and invest more in outreach, rural development, wise policy formulation, and filling knowledge gaps via research. In a process initiated at the 2008 International Rangelands Congress in China by the Government of Mongolia, the IYRP proposal has been endorsed by hundreds of global stakeholders. Approval of the IYRP proposal is a stepwise process involving various multilateral agencies. Ultimately, the proposal needs to be endorsed by the United Nations General Assembly, and this is expected to occur in late 2021 or early 2022. In this opening presentation, we will highlight IYRP goals and focus on justifying the slate of speakers. Given that climate change is a pervasive threat to the planet, a major thread connecting the talks is how can global rangelands become part of solutions concerning climate-change mitigation and adaptation, while at the same time improving natural resource management and boosting livelihoods among various stakeholder groups. Can the global narrative be altered from one of “the marginalization of rangelands” to one of “the global value of rangelands?” Given rangelands are vast, their contributions to ecosystem services worldwide are immense. How can we better capture these benefits? Finally, we will illustrate how stakeholders must now come together to tackle global challenges facing rangelands. This is an opportunity for poor and wealthy nations alike.

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MORPHOLOGICAL DIVERSITY AND CHEMICAL NUTRITIONAL ANALYSIS OF A NEW AFRICAN GRASS (*Eragrostis echinochloidea*) IN CHIHUAHUA

Raul Corrales-Lerma[1], Nathalie Socorro Hernández-Quiroz[1], José Humberto Vega-Mares[1], Martín Martínez-Salvador[1], Federico Villarreal-Guerrero[1], Carlos Raúl Morales-Nieto[1], Alan Álvarez-Holguín[2]

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Contributed Oral Presentation

Abstract

Exotic grasses are gaining ground and weakening the diversity of grasslands in northern Mexico. In recent decades, natural grasslands face a strong invasion of exotic species and the native diversity of the pastoral ecosystems of Northern Mexico has been severely affected. The objective was to characterize the morphology and nutritional quality of a new introduced grass from Africa to Chihuahua, which were named hard grass (*Eragrostis echinochloidea*). The study was carried out in three municipalities in the State of Chihuahua. Twelve morphological variables were evaluated, as well as the production of dry matter and the nutritional value in four phenological stages. Data were analyzed with the SAS statistical package through Ward's multivariate analysis by grouping and analysis of variance with Tukey's grouping. The hard grass did not present enough morphological variability to differentiate and separate the populations by categorical groups. Forage production was between 2,300 and 3,000 kg DM ha^{-1}. The contribution of Crude Protein was between 12.8 and 4.5% in regrowth and dormancy stages, respectively. In lignin, the contributions were from 2.9 to 7.9%. Protein is the most valued nutrient in grasslands and lignin the least desirable, so a poor nutritional value in a grass makes it less preferred by livestock and wildlife. Consequently, the native species with the highest taste are at risk due to consumer selectivity. Hard grass is an African grass of recent introduction to Chihuahua, its lack of morphological variability indicates that it is the same genotype. Its productive and nutritional characteristics indicate that it is an invasive species. It is recommended to take control measures, otherwise, in a short time, this species may be one more grass on the list of invasive African grasses in rangelands of Chihuahua.

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Long-term *Halogeton glomeratus* control with indaziflam in Moffat County, CO US.

Jacob Courkamp[1], Paul Meiman[2]

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Poster

Abstract

Particularly problematic in disturbed areas with saline soils, the invasive annual forb *Halogeton glomeratus* (M. Bieb) C.A. Meyer is widespread in rangeland ecosystems in the intermountain region of western North America. High levels of oxalates in the leaves of actively growing plants make this invader toxic to livestock. While several strategies for mitigating its toxicity have been developed, heavy losses of sheep have occurred in the past and there is little doubt that usable forage is greatly reduced in areas where halogeton is dominant. Further, because halogeton can produce high numbers of persistent seeds and decaying plants often increase the salinity of soils favoring its continued dominance, restoring invaded rangelands can be extremely difficult. Indaziflam (Rejuvra®, Bayer) is a pre-emergent herbicide recently labeled for use in rangelands grazed by livestock, and while it has shown promise as a tool for managing invasive annual grasses, its potential for managing other problematic rangeland weeds remains to be investigated. We applied indaziflam at two different rates (73 and 102 g ai ha^{-1}) to halogeton-invaded rangeland in Moffat County in northwest Colorado. Treatments also included other herbicides commonly used to control halogeton, both alone and in combination with indaziflam. Follow-up evaluations 11 and 22 months after treatment showed near complete control of halogeton in all plots treated with indaziflam at either rate, regardless of tank-mix partner. Our results suggest that indaziflam may represent a promising new tool to manage halogeton, reduce its impacts, and help managers restore invaded rangelands. Additional research is necessary to replicate our findings, determine the optimal timing of application, and assess the need for follow-up treatments.

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Examining the Relationships Between Behavior Traits, Grazing Patterns, and Production Characteristics in a Herd of Rangeland Cattle

Maggie Creamer, Leslie Roche, Tina Saitone, Kenneth Tate, Kristina Horback

UC Davis, Davis, USA

Poster

Abstract

Consistent behavioral differences among cattle have been reported to impact animal weight gain, ease of handling, and reproduction. The current research seeks to refine traditional temperament tests (i.e., chute score and exit velocity), and create novel cognitive tests (a social-feed tradeoff task) to evaluate if these behavioral differences are related to grazing patterns (via Knight GPS collars) during summer season on range. The goal is to ultimately provide knowledge for management decisions regarding achievement of optimal grazing distribution on heterogenous rangelands. Behavior and GPS data will be collected over two summers (2021 and 2022) to examine repeatability of behavior traits and grazing patterns. Principal component analysis will be used to aggregate observed behaviors into distinct traits, and the animaltracker R package will be used to analyze GPS data. Mixed modeling will be used to examine the relationship among the behavior traits, grazing components (i.e., home range, elevation, distance traveled, and average travel speed) and production traits (i.e., calf weaning weight, and body condition score). Hierarchical cluster analysis will be used to cluster cattle with similar behavior traits and similar grazing patterns to identify broad patterns across the herd of cattle and further categorize cattle by type. If it can be realized through this study that specific observable behavior traits relate to grazing on rangeland, there could be a shift to breeding and selection paradigms geared toward conservation of rangeland habitats, vegetation, and overall quality of land. Additionally, if traits are synergistically associated with better production characteristics, there could be overarching economic incentives to selecting cattle that will graze both sustainably and profitably without compromising productivity.

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Using remote sensing in rangeland management: turning an abundance of spatial data into actionable information

Megan Creutzburg

Institute for Natural Resources, Oregon State University, Portland, USA

Contributed Oral Presentation

Abstract

The number of maps and spatial decision support tools for rangelands in the western US has exploded in recent years as interest in rangeland management has climbed and technological advances have opened new doors. These new maps offer great opportunities to incorporate data crossing broad spatial scales and long time frames into decision-making, but also present an overwhelming amount of new and ever-changing information for users. This presentation will start with some guiding principles for how users of rangeland maps can approach the use of remotely sensed maps in rangeland management applications, from a paper recently published in Rangelands: "Guiding principles for using satellite-derived maps in rangeland management" (Allred et al. 2021). It will also highlight how the Oregon SageCon Partnership (https://sageconpartnership.com/) has leveraged new spatial data into synthesis maps targeted toward specific applications, with examples of how maps can improve the efficiency and effectiveness of decision-making. These synthesis maps include a set of Ecostate Time Series maps to depict change over time in the distribution and severity of primary threats to rangeland health (invasive annual grass and juniper encroachment), and Geographic Strategy maps to guide opportunities for proactive, landscape-scale management of invasive annual grasses in the state. I will conclude with some considerations for map producers about how to increase the usefulness and adoption of map products by end users.

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Rain Gauges for Range Monitoring: Co-developing tools and best practices for ranch-scale drought detection

Michael Crimmins

University of Arizona, Tucson, USA

Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

What should be my decision-making dates and triggers? Precipitation monitoring on rangelands can be a critical piece of information to track and predict how forage conditions and water availability may change through a growing season. Ranchers need data that is near their grazing areas to be able to make decisions about when and what to trigger in established drought plans. To improve precipitation and drought monitoring at finer scales, an AZ working group has proposed tools such as a rugged cumulative rainfall gauge designed for quick and easy readings at remote sites, and online tools (e.g., https://myraingelog.arizona.edu/) to support the use and interpretation of rain gauge data. This presentation will highlight the activities of the working group, the tools and best practices developed and current progress in supporting this network.

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Balancing livestock grazing, plant diversity, and Greater sage-grouse habitat on semi-arid rangelands of northeastern UT

Jessie Danninger[1], Kristin Hulvey[1], Megan Nasto[1], Taylor Payne[2]

[1]Working Lands Conservation, Logan, USA. [2]Utah Department of Agriculture and Food, Randolph, USA

Poster

Abstract

Managers of publicly-owned rangelands have to balance the many interests of different groups that utilize the land, whether human, livestock, or wildlife. They are often faced with the tough decision to prioritize interests at the expense of others when management goals conflict. Three potentially conflicting management goals on semi-arid rangelands include raising livestock, maintaining plant diversity, and providing good habitat for the Greater sage-grouse. It is possible that livestock grazing reduces plant diversity and/or sage-grouse habitat quality. Such tradeoffs may lead managers to remove livestock from rangelands to improve overall ecosystem functioning. To test whether there are tradeoffs among these management goals, we examined how the presence, duration, and timing of livestock grazing affects overall riparian plant diversity, plus two metrics contributing to habitat quality for sage-grouse: perennial forb and grass cover. Our study took place in Rich County UT, on sage-steppe rangelands that were historically grazed using different grazing durations and timings. These included short- (2-4 weeks), medium- (1.5-2 months), and long-duration (4 months) pastures, and exclosures where no grazing occurred. Additionally, the medium-duration pastures were grazed either early or late in the season. We found that cattle presence and grazing duration affected both plant diversity and perennial forb cover, while grazing timing had no effect. We found no effect of presence, duration, or timing on perennial grass cover. Plant richness was highest in short- and medium-duration pastures, and lowest in long-duration pastures and exclosures. Additionally, total perennial forb cover was highest in the exclosures and short-duration pastures, and lowest in the medium-duration and season-long pastures. These results indicate that at our sites livestock do not need to be removed. Rather, employing short-durations balanced all three goals. This highlights how managing duration can be an effective tool to balance multiple ecosystem goals on western rangelands.

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Vegetative Response To Mechanical Practices In The Rio Grande Chaparral Plains

Jose de la Luz Martinez[1], Servando Leal[2]

[1]USDA/NRCS, KIngsville, USA. [2]South Texas Grazing Land Coalition, Bruni, USA

Poster

Abstract

South Texas range managers must be in constant fight with brush encroachment. Plant species like mesquite, huisache, blackbrush and prickly pear can invade, change the species composition, and decrease forage production in any agricultural operation of South Texas. With the idea of improving efficiency and decrease costs, South Texas producers have been adjusting the way they mechanically control brush by skipping “passes” with implements in the tractor that they say would give the same results at the end. To further examine this, we prepared 12 different plots of land where different implements or combination of implements were used to mechanically control brush and collect data for 4 years on forage production and brush encroachment on these plots. The results of this research concluded that brush is less present after 4 years when more implements are used, and forage production is higher on those plots that were seeded compared to the plots that were not seeded. We then can recommend at least 3 different implements with seeding when the objective is to produce forage.

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The use of technology to improve beef cattle research in extensive rangeland environments

Timothy DelCurto, Samuel Wyffels

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Wilcox-Strengthening Collaborations Between Researchers and Stakeholders: Linking Data and Management in Rangelands

Abstract

Research related to beef cattle production in extensive rangeland environments has been challenging for researchers in respect to experimental design and statistical inference. Specifically, creating study designs that mirror actual production environments yet have enough observations for statistical inference is a challenge that often hinders researchers' efforts to publish. In contrast, past efforts to create experimental numbers such as replicated pens, pastures, or individual feeding create a study environment that often may not simulate actual extensive production environments. Simply put, finding a balance between statistical needs and application to the western rangeland production environments has been problematic. However, approaches are available to gain statistical inference by creating multiple observations within a common group of animals and/or an extensive rangeland environment. The application of new technology has made it possible to apply treatments (e.g., supplementation studies) to individual animals in extensive environments where large, diverse herds/flocks of cattle/sheep are managed as a single group. Specifically, using individual animal identification (EID) and feed intake technology has opened a wide range of research possibilities for beef cattle production systems in rangeland environments. Embracing new technologies such as EID tags, weather stations, and feed intake monitors combined with multiple regression modeling tools will aid in designing and publishing beef cattle production research, as well as the application of research to management of extensive rangelands.

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Mongolia's Leadership in Creating a Vision for the IYRP

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Mongolia's Leadership in Creating a Vision for the IYRP

Mongolia is among the few nations that have preserved nomadic pastoralism and maintained cultural identities carried out on natural rangeland. Mongolia has almost 300,000 semi-nomadic herders (181,000 households), approximately 10% of the country’s population, whose livelihood is directly dependent on the rangelands that provide forage to 67 million head of livestock (NSO, 2020) across the various ecoregions. Herders are de-facto managers of the rangelands that account for 70% of Mongolia’s land area, and the sector contributes 9.6% of the national GDP. Contemporary Mongolian herders carry over the traditional rangeland management practices that have resulted from the millennia-long nomadic adaptation process to the Mongolian plateau's harsh continental climate and geography. The climate change--including prolonged dry and hot weather--more frequent and intense climatic hazards, and reduced precipitation in warm seasons for the last decades increase herders’ vulnerability to climate change by adding to the complex systemic weaknesses undermining government targets for increased livestock productivity. Rangeland is important for everyone in Mongolia, and herders today are very much aware about poor management that is causing environmental degradation. Herders, agriculture officers, the private sector, and consumers collaborate in the implementation of resilience-based rangeland management that produces environmentally responsible products. With assistance from an International Support Group, the Government of Mongolia took the initiative to designate the IYRP for 2026 to bring global attention to challenges that pastoralism and rangelands face globally. Since 2018, The Mongolian Government has taken several key measures that have contributed to international partnerships supporting the approval of the IYRP. These include the creation of a national support group, preparation of the formal proposal, providing liaison with respective UN bodies and other governments, and IYRP promotion at international events.

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Drought Timing Matters in the Sagebrush Steppe, but Not by the End of the Season

Elsie Denton[1], Emily Bishop[2], Dustin Golembiewski[2], Katherine Collins[1]

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

While dryland ecosystems like the sagebrush steppe evolved alongside periodic drought, the timing of when drought occurs may shift as our climate changes. Understanding how the sagebrush steppe responds to within year variation in timing of drought will allow us to make better land management decisions to sustain ecosystem function even in the presence of prolonged dry periods. To test ecosystem response to drought timing we imposed a 50% reduction in long-term average growing season rainfall either Early (Mar-mid Apr), Mid (April-mid May) or Late (May through Jun), these plots were compared to control plots (replication 15, N 60). A large number of plant responses were accessed including within season and end of season biomass production above and belowground, NDVI, soil moisture, species composition, and plant water potential and reproductive output for key species. Soil moisture in drought plots dropped as compared to control during all treatment periods. Some species experienced increased water stress in both the Early and Mid-season droughts, though no change in plant water potential was observed in any of the species still green by the Late-season drought. Belowground biomass production in the middle drought was half than in control plots for the same time period, with the loss of production mostly resulting from reduction in root growth in the top 10 cm of the soil. However, by end of season, any difference in total belowground biomass between treatments had disappeared, indicating the capacity for within season recovery. No differences in reproductive output by timing were detected though slight reductions in seed head number and seed production as compared to the control were observed in all drought treatments.

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Increased abundance of the common raven within the ranges of greater and Gunnison sage-grouse: influence of anthropogenic subsidies and fire

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Contributed Oral Presentation

Abstract

The common raven (*Corvus corax*; raven) is native to North America and has increased in abundance, especially throughout western North America, during the last century. Human subsidies have facilitated raven dispersal into less suitable habitats and enabled these populations to maintain higher annual survival and reproduction. Concomitantly, overabundant raven populations are impacting other native at-risk species such as the greater sage-grouse (*Centrocercus urophasianus*) and potentially the Gunnison sage-grouse (*C. minimus*). Using Breeding Bird Survey data from 1995–2014, we evaluated raven count data to quantitatively describe changes in abundance and expansion into sagebrush (*Artemisia* spp.) ecosystems, specifically sage-grouse habitat. We focused our analyses on the seven sage-grouse Management Zones (MZs) delineated across 11 western U.S. states and 2 Canadian provinces. We assessed the effects of land cover and anthropogenic disturbance on instantaneous growth rate (r) or carrying capacity (K) of ravens. Abundance of ravens in western and southeastern MZs was greater than northeastern MZs within the greater sage-grouse range. While raven abundance was lower in MZ I and II (Alberta, Dakotas, Montana, northwestern Colorado, Saskatchewan, and Wyoming), raven expansion and percent increase were equivalent or greater than all other MZs. High abundance in MZ VII indicated Gunnison sage-grouse have been exposed to increased raven populations for several decades. Areas with greater transmission line density had higher r; higher K was positively related to proportion of urban land cover within 25 km and burned area within 3 km and negatively related to greater distance from landfills and proportion of forest land cover within 15 km. Ravens have capitalized on human subsidies to increase abundance and expand into sagebrush ecosystems that did not historically support high raven populations. As such, managers are now faced with a new dilemma of reducing populations of one native species to benefit other native sagebrush obligate species.

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Differences in herbage mass but equal stocking rate can be achieved through herbage allowance management in native subtropical grasslands

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[3]Universidad de la República, Paysandu, Uruguay

Poster

Abstract

The objective of this work was to evaluate the effect of mean herbage allowance High and Low (HA, 4 and 7 kg DM/kg BW respectively) but equal winter HA (3-4.5 kg DM/kg BW) on the seasonal stocking rate (SR, kg BW/ha) and herbage mass (HM, kg DM/ha) from December 2015 to March 2020. Herbage mass, SR and actual HA were measured and adjusted monthly in eight plots, four in High and four in Low HA, in two blocks. Season was divided into growing (from October to April) and dormant (from May to September) seasons. Monthly data was analyzed using MIXED procedure of SAS, with HA and season as fixed effects and block as random effect and Tukey test for mean separation and regression analysis using HM and actual HA as independent variables and SR as the dependent variable. The mean HM and HA were greater ($P<0.01$) in High than in Low (2970 vs 1751 ± 174 kg DM/ha and 7.1 vs 4.3 ± 0.3 kg DM/kg BW respectively). However, mean stocking rate was equal ($P>0.10$) in High and Low HA (463 vs 428 ± 23 kg BW/ha respectively). During dormant season SR was greater ($P<0.01$) 564 vs 392±30 in High than Low explained by HM and actual HA as follow, SR = 398.8(17.3) + 0.2 (0.007) HM – 75.3(3.4) actual HA while during growing season it was as follow, SR = 425(17.4) + 0.14(0.006) HM – 54(2.4) actual HA. HM and SR were positively correlated ($P<0.001$) r=0.59 and r=0.44 for dormant and growing seasons respectively. This kind of management of stocking rate contrast the results of traditional negative correlation of HM-SR and could be a model to other cow-calf systems in many grasslands around the world.

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Does indaziflam control annual bromegrass in Canada's mixed prairie?

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Contributed Oral Presentation

Abstract

Compared to the western US, rangelands in Alberta and western Canada have experienced relatively little annual brome invasion to date. However, introduced annual bromes have been increasingly observed along the US-Canada border leading to concerns about grassland conservation. Early control of brome may be a valuable strategy to provide containment of the invasion. The herbicide indaziflam has recently shown promise in controlling annual grasses on western US rangeland, though how these results apply to northern temperate grasslands of western Canada remains uncertain. Field trials at two locations in the dry mixedgrass prairie of southeast Alberta compared the effects of four rates of indaziflam (0, 40, 80 or 160 g ai ha^{-1}) applied at two times (fall or spring) on annual-brome invaded native grassland. Biomass responses of brome and other vegetation were assessed over 2 years. One year after treatment there were no significant effects of indaziflam rate or timing on annual-brome biomass. However, two years after treatment brome biomass decreased at all herbicide rates, with larger declines from fall rather than spring application. Notably, perennial grass biomass increased under the highest rate (160 g ai ha^{-1}) of indaziflam. These results indicate indaziflam may be a potential tool for managing annual brome invasion and conserving native mixed prairie in western Canada.

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Impacts of mature female eastern red cedar (*Juniperus virginiana* L.) trees on bud bank production and composition in the mixed-grass prairie of the Northern Great Plains

Austin Domeier, Alexander Smart, Lan Xu

South Dakota State University, Brookings, USA

Poster

Abstract

Eastern red cedar (ERC) (*Juniperus virginiana* L.) trees are invading prairies throughout the Great Plains due to fire suppression and from planting ERC trees in shelterbelts. This encroachment poses a threat to native plant communities in terms of their reproduction, regeneration, and diversity. It is unknown how ERC trees impact belowground propagules, such as rhizome and crown bud production, in the mixed-grass prairie. The objective of this study was to evaluate how mature female ERC trees impact the vegetative bud bank at varying distances from an ERC trunk. In October 2020 in south-central South Dakota, ten female ERC trees with canopy diameter 5-10m, similar environmental characteristics (ie. soil type, slope), and isolated from other large ERC trees were selected for soil sampling at four treatment distances: under canopy (UC), canopy edge (CE), two meters from canopy edge (2M), and grassland control (GL). Four transects extended from each tree stem where a soil core (10cm dia. x 10cm depth) was sampled at the four treatment distances, totaling 16 cores per tree and 160 cores overall. Soil cores were washed with high-pressure water to remove debris and soil to expose vegetative propagules. Roots were removed from individual plants and their propagules were separated into crowns and rhizomes. A dissecting microscope (10x magnification) was used to determine crown and rhizome bud densities per soil core by the functional group. Bud community densities were analyzed with nonmetric multidimensional scaling and perMANOVA for comparisons. A total of 745, 6848, 9149, and 9164 buds (#/160 cores) were counted in treatments UC, CE, 2M, and GL, respectively. Bud production composition significantly differed among treatments (P=0.0002) and between all treatments except for between 2M and GL (P=0.3622). Our results suggest that mature female ERC are drastically impacting bud production and composition up to two meters from the canopy edge.

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Adaptive Capacity to Drought on the Coloradan Shortgrass Steppe

Emily Donaldson

University of Wyoming, Laramie, USA

Poster

Abstract

Climate change is increasing the regularity and severity of drought in the intermountain West, requiring ranching operations, communities, and groups to more frequently respond to highly unpredictable conditions to avoid substantial ecologic, economic, and social impacts. Accounting for drought's complex, context-specific nature, this research study examines interacting factors that influence rancher and rangeland organizations' knowledge, decision-making processes, management strategies, and adaptive capacity to drought on Colorado's northeastern semi-arid shortgrass steppe. We plan to use a mixed-methods approach including rancher surveys and rangeland organization focus groups to compare differences in drought decision-making and adaptive management. We predict that exploring perceived drought thresholds, decision-making triggers, and existing adaptive strategies will help inform future drought management tools and strategies by identifying key communication gaps and resource needs to enhance outreach and collaboration for ranchers and rangeland organizations.

Keywords: Drought; Decision-making; Adaptive Capacity; Cattle; Ranching; Organizations

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In The Weeds: A Review and Synthesis Invasive Species Governance

Elena Dosamantes, Aaron Lien

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Poster

Abstract

Invasive species are a prevalent and intensifying 21st century environmental challenge. As distant places become ever more connected through movement of goods and people around the globe, non-native plant and animal species are provided new avenues to spread. An unknown number of these species will transition from relatively innocuous non-native species to harmful invasive species that can alter both human and natural systems. While international institutions are in place to prevent the importation of non-native species, at the sub-national level there are few similar institutions, especially for invasive plant species. Effective management local and regional management of invasive plants requires not only knowledge of methods for control and irradiation, but also knowledge of the factors that enable and inhibit coordination and cooperative—collective action—between disparate actors. In this study, we undertake a systematic review of the invasive plant literature and show that there is relatively little research to understand the social and governance factors related to effective management of invasive plants at a national level.

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'Damns given' and other error types in rangeland monitoring

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

In any field research or monitoring program, errors are going to be made. At the broadest level, errors can be classified as sampling (due to not having a sample perfectly representative of the population) or non-sampling (any other reason). Sampling errors are often discussed because they are easy to estimate and reduce. However, discussions of non-sampling errors frequently amount to, "try to minimize them" because they can be hard to identify and often impossible to estimate. Despite this, non-sampling errors can have a major impact on indicator estimates and should be considered. The Bureau of Land Management's Assessment, Inventory, and Monitoring (AIM) program provides a good platform to classify the types of errors made and draw more attention to the types of non-sampling errors that may occur. This classification incorporates errors made during plot selection, errors made during the site visit including behavior effects (misinformation, "damns given," drift, and honest mistakes) and the methodology used (inherent bias and ambiguity), and errors made after data collection including data management errors and comparability effects. We use existing terrestrial AIM data to illustrate the magnitude and effect of several different types of non-sampling errors discussed in the framework. The proposed classification of non-sampling error types establishes a framework for identifying the various opportunities for errors to occur. With this framework it is possible to derive techniques for measuring potential and realized effects of non-sampling errors and evaluate strategies for reducing non-sampling errors. Ultimately, a better understanding of the magnitude of non-sampling error relative to sampling error will lead to better data to support rangeland management decisions.

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Interacting effects of disease and weather variability on rangeland biodiversity associated with black-tailed prairie dog (Cynomys ludovicianus) colonies

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Contributed Oral Presentation

Abstract

Rangeland ecosystems worldwide are experiencing novel pressures during the Anthropocene, including land conversion, disease dynamics, non-native species, and climate change. These issues can be compounded in rangelands occupied by burrowing rodents, like prairie dogs (*Cynomys* spp.). In the North American Great Plains, black-tailed prairie dogs (*C. ludovicianus*) are a keystone species that structure habitat for associated taxa, but lethal control driven by agricultural conflict has severely reduced their abundance. Novel disease dynamics caused by epizootic plague (*Yersinia pestis*) within prairie dog colonies have further destabilized associated wildlife communities. Following an outbreak of plague in a large colony complex in northeastern Wyoming, we capitalized on a natural experiment (2015 – 2019) to investigate responses of vegetation, birds, ungulates, and mesocarnivores to removal of prairie dogs by disease. Plague decimated black-tailed prairie dog populations in what was then the largest extant colony complex in the world, reducing colony area from over 16,000 ha to less than 100 ha. We documented dramatic declines in mesocarnivore occupancy and raptor abundance post-plague, with probability of occupancy or abundance approaching zero in species that rely on prairie dogs for a high proportion of their diet (e.g., ferruginous hawk [*Buteo regalis*], American badger [*Taxidea taxus*], and swift fox [*Vulpes velox*]). Following the plague outbreak, abnormally high precipitation in 2018 hastened vegetation recovery on colonies where constant herbivory had formerly maintained shortgrass structure necessary for certain colony-associates. As a result, we observed large shifts in avian communities on former prairie dog colonies, including near-disappearance of mountain plover (*Charadrius montanus*) and increases in mid-grass associated songbirds (e.g., lark bunting [*Calamospiza melanocorys*]). Our research highlights how climate can interact with disease-induced loss of a keystone species to induce drastic and rapid shifts in wildlife communities.

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Need for a Paradigm Shift in the Genetic Management of Fragmented Populations

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Contributed Oral Presentation

Abstract

Thousands of small, isolated populations or species are threatened from a lack of gene flow that has resulted in inbreeding depression, lower genetic diversity and hence reduced ability to adapt to changing environments, and ultimately an increased risk of extinction. We offer a new management strategy with clear guidelines that incorporates genetics and evolutionary biology and advocate for this approach rather than inaction. Augmentation of gene flow as a management strategy has been underutilized owing to concerns surrounding outbreeding depression. Our collective body of work demonstrates that the risks of outbreeding depression can be predicted, inbreeding depression is ubiquitous, and taxa (populations or species) with lower genetic diversity will experience even greater challenges with ongoing global climate shifts. We review the essential steps of a science-based genetic management plan for diploid animal and plant populations in the context of current practices and share examples where this management plan has been successfully deployed to encourage others to adopt this approach.

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Modeling the Drivers of Thresholds in Vegetation Cover Change in an Arid Grassland

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Poster

Abstract

In an era of unprecedented ecological change, the ability to identify the effects of climate and land use on vegetation dynamics is paramount. However, this has long proved difficult for many reasons, including a lack of long-term data, time lags, and complex interactions between seasonal and annual trends. The development of algorithms to identify thresholds in vegetation time series greatly aided our ability to look at deviations from long term trends. However, thresholds were delineated as binary entities, and depended on the user's choice of algorithm, of which there are many. The development of Bayesian ensemble models allowed users to borrow strength from multiple algorithms and display thresholds in vegetation dynamics in terms of probabilities and uncertainties. Here, we extend this framework to relate estimated vegetation thresholds to possible drivers of vegetation change. Using Bayesian hierarchical models, we relate remotely-sensed vegetation change to climate variability, threshold vegetation cover, and patch arrangement. Arid southwestern grasslands have been rapidly transitioning to shrublands over the past 150 years due to interactions between climate and land use decisions. Modeling vegetation change thresholds will allow managers and scientists to understand thresholds in vegetation cover and connectivity that lead to grassland collapse, as well as the interplay of management and climate. Additionally, this modeling framework has broad applicability for evaluating ecological change and its potential causes over time.

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Comparison of evapotranspiration models for a juniper-dominated watershed and a sagebrush-dominated watershed in central OR, USA

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Poster

Abstract

Evapotranspiration (ET) is a large component of the water balance in many semiarid rangeland ecosystems and more information is needed to understand how western juniper encroachment impacts ET. However, direct measurements of ET are often difficult and cost-prohibitive at remote, data-scarce sites. The objective of this study is to compare methods of modeling ET for two small watersheds, one dominated by western juniper and one dominated by sagebrush, in central Oregon, USA. A secondary aim of this project is to characterize the relationship between Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), canopy cover, soil moisture, and ET. A small unmanned aerial vehicle (UAV) was used to collect thermal infrared and multispectral imagery throughout all seasons excluding winter for one year. Soil moisture, canopy cover, and meteorological information were collected at the same time as the UAV flights. QWaterModel was used to estimate ET from the UAV-based thermal imagery. Landsat 8 imagery for seven years was used to calculate ET using the Mapping Evapotranspiration at High Resolution with Internalized Calibration (METRIC) model, and to calculate NDVI and NDWI. Daily ET for the same time period was modeled using the Soil and Water Assessment Tool (SWAT). Calibration and validation of the SWAT model were conducted with SWAT-CUP (SWAT Calibration and Uncertainty Program) using on-site soil moisture, springflow, and streamflow measurements. Regional ET was calculated using Moderate Resolution Imaging Spectroradiometer (MODIS) ET data. Preliminary estimates of average annual ET range from 213 mm yr^{-1} (SWAT) to 278 mm yr^{-1} (MODIS). Annual average NDVI and NDWI, respectively, are 0.25 and 0.12 at the juniper-dominated watershed and 0.23 and 0.06 at the sagebrush-dominated watershed. While data analysis is ongoing, the results of this study provide insight into the ET dynamics of semiarid sagebrush ecosystems experiencing juniper encroachment.

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Evaluating trade-offs between restoration of burned landscapes and targeted suppression of wildfires in sagebrush ecosystems

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Contributed Oral Presentation

Abstract

In sagebrush ecosystems, wildfire is increasing in frequency and extent with the expansion of invasive grasses and adversely affecting greater sage-grouse (*Centrocercus urophasianus*) populations. Although post-wildfire restoration of sagebrush communities is important and often necessary to improve habitat for sage-grouse and other sagebrush obligate species, it can be challenging and relatively expensive with variable levels of success. Hence, quantitative evaluation of trade-offs between retroactive (restoration) versus proactive (prevention and suppression) management strategies can be highly informative for both sage-grouse conservation and for allocation of sagebrush restoration efforts. We simulated management scenarios of post-fire sagebrush recovery by active seeding and outplanting and compared spatially explicit outputs with scenarios of simulated wildfire reduction using wildfire history data from 1984 to 2015. The simulated scenarios included 1) passive recovery; 2) 25, 50, and 75% seeding and seedling transplants in post-burn landscapes; and 3) 25, 50, 75% wildfire reduction through suppression and prevention. We found that 75% suppression of randomly selected wildfires resulted in the lowest net loss of sagebrush and negated adverse impacts to sage-grouse populations. Furthermore, targeted suppression near leks and sage-grouse conservation areas effectively reduced the number of wildfires requiring operational intervention by an average of 65.4% and 78.8%, respectively. Recovery of sagebrush following wildfire was outpaced by continuing wildfire reoccurrence in both seeding and outplanting simulation scenarios. Therefore, actively reducing wildfire size and frequency through prevention and suppression management actions within sagebrush ecosystems was far more effective per unit effort than relying on post-wildfire restoration activities alone. These findings are preliminary and provided for timely science communication.

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Competing Conservation-Mitigation Paradigms on California Grazinglands

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Poster

Abstract

Human population growth and the development of supporting infrastructure are only expected to increase over the next mid-century. In California, the interface between urban-agriculture-wild landscapes will likely see most of this development activity with some estimates of the impact of conversion of pasturelands forecasted as high as 10,000 km^2 by mid-century. The eventual conversion of these landscapes and loss of critical and protected habitats and ecosystem services must be mitigated. In this study we explore two competing conservation-mitigation paradigms. The agricultural-conservation tradeoff paradigm is underpinned by the assumption that in order to conserve-enhance desired ecological traits of a site; goal setting, land use decision-making, and management implementation must shift to the authority of new "expert" conservation professionals and agricultural production becomes secondary and/or eliminated. The agriculture-conservation synergy paradigm recognizes that desired ecological traits already exist on the site and current goal setting, agricultural based land use decision making, and management implementation are at least compatible with conservation and potentially required for the existence of desired ecological traits. The goal of this study is to use the Little Lake Valley (LLV) Mitigation Management Plan (MMP) as a case study and lens to assess the social-economic-ecological ramifications of following the tradeoff versus the synergy paradigms. This tradeoff based MMP has been unfolding over the past 10 years. We used this opportunity to examine the extent to which these paradigms lead to different goal sets, decision-making processes, management practices and strategies, and the social and economic costs associated with transitioning to a tradeoff conservation management strategy versus maintaining an in-place synergy-based strategy. Furthermore, we use these findings to discuss the LLV MMP in the context of the existing scientific literature and alternative conservation strategies.

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Utah's Watershed Restoration Initiative – By the Numbers

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Poster

Abstract

The Utah Watershed Restoration Initiative (UWRI) is a partnership-based program, administered by the Utah Department of Natural Resources, which seeks to improve the functional capacity of high priority watersheds throughout the state. Since its inception in 2006, the UWRI partnership has completed 2,450 projects to restore or rehabilitate 2,250,000 acres and 2,150 stream miles in Utah watersheds. The UWRI program is unique to the west, in that it transcends jurisdictional boundaries, and local, state, and federal management authority to focus finite resources on completing high priority conservation projects. For additional information, please visit the website at https://watershed.utah.gov/

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Wind erosion modeling using big data to support rangeland management

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Contributed Oral Presentation

Abstract

Aeolian processes are fundamental to arid and semi-arid ecosystems, but existing wind erosion and dust emission models are not well suited to address rangeland science and management concerns. Models that leverage standardized vegetation and soil monitoring data and produce erosion estimates that capture intra- and inter-annual variability are needed to inform land health and air quality assessments. In response, USDA-ARS recently developed the Aeolian EROosion model (AERO) in collaboration with NRCS stakeholders. AERO combines a spectral dust emission scheme with horizontal sediment transport estimates that are sensitive to the height, cover, and spatial configuration of vegetation to predict horizontal sediment transport and vertical dust emission across rangeland landscapes. The model was calibrated for rangelands using an approach that accounts for unknown sources of error, quantifies model uncertainty, and produces probability distributions of predicted sediment fluxes. By integrating AERO with a newly developed Landscape Data Commons (LDC), we are able to leverage large datasets such as NRCS's National Resources Inventory (NRI) and Bureau of Land Management's Assessment, Inventory and Monitoring (AIM) to assess wind erosion risk across U.S rangelands (~60,000 plots). Further, the LDC provides a robust platform and flexible infrastructure for tool development and advanced data analyses using AERO estimates that will facilitate the development and integration of wind erosion indicators into existing management frameworks, such as ecological site concepts and state and transition models. This will improve the efficacy of management and conservation actions by allowing land managers to consider wind erosion in land use and management planning alongside other indicators of ecosystem structure, function and ecosystem services and is critical to establishing effective benchmarks to reduce and/or avoid soil erosion and land degradation on rangelands. Here, we present the AERO model, calibration for rangelands, and provide example applications of AERO to large monitoring data sets.

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Indicators of observed and projected climate vulnerability and transformation in New Mexico

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

Observed metrics such as changes in mean and extreme temperature and reduced snowpack indicate climate change is already occurring in New Mexico. In many parts of the world, these measured biophysical changes are leading to ecosystem, individual and community transformation. In New Mexico, agricultural producers are already adapting and in some cases may be transforming systems to cope with the impacts of climate change. Biophysical and agroecosystem variability indicates that adaptation may be sufficient in some locations, time windows and agroecosystems whereas transformation may be necessary in other systems and locations in the future. Here we present historic and projected available soil water across New Mexico to highlight temporal and spatial variability in one metric of climate exposure. We overlay changes in soil water with observed rangeland forage (net primary production), insurance indemnity payments, conservation practice implementation, surface water/ground water use, depth to water and risk-based metrics to quantify observed agroecosystem adaptation (insurance, irrigation, conservation practices) and potential agroecosystem transformation (changes in acres planted, livestock numbers, irrigators, depth-to-water). We discuss when a trend becomes a transformation and potential conditions for appropriate, community-led, respectful agroecosystem transformation.

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Non-Forage Rangeland Resources: important yet often ignored components of rangeland management

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Contributed Oral Presentation

Abstract

Rangelands cover over 50% of the earth's terrestrial surface and are home to more than two billion people. While livestock production is the most common land use activity throughout global rangelands, millions of people rely on rangeland plants for more than just forage; wild plants are used for food, medicine, fiber, and other subsistence, commercial, and spiritual purposes. These culturally, ecologically, and economically important resources, for which we propose the term Non-Forage Rangeland Resources (NFRR), have received little attention from academic researchers, land managers and policy makers. As a result, they are rarely considered in rangeland conservation, management, or restoration efforts, despite their importance to food production and security, economies, and the culture, identity, and livelihoods of millions worldwide. The objectives of this research were to 1) quantify the number of articles that address use, ecology, conservation, or management of NFRR in peer-reviewed journals dedicated to rangeland and dryland ecosystems, 2) describe, characterize and synthesize published knowledge, and 3) identify information and knowledge gaps to guide future research. We reviewed papers published during the past 10 years (2011-2021) in the five preeminent journals focused on rangeland science and management: *Rangeland Ecology and Management, Rangelands, Journal of Arid Environments, The Rangeland Journal,* and the *Journal of Rangeland Science*. Articles addressing NFRR were identified and coded by theme, ecosystem, country, plant functional group (grass, shrub, forb, etc.), and use. We calculated the percentage of articles published that addressed some aspect of NFRR harvest, use and management, and describe predominant themes and emphases of the articles. Finally, we identify gaps in the literature and provide recommendations to more fully address NFRR management issues impacting communities dependent upon rangeland systems.

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Restoration of native grassland in the South Texas sandsheet a case study

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Contributed Oral Presentation

Abstract

Restoring native grasslands within the South Texas sandsheet has historically been difficult. Along with the sandy substrate, the region is host to many non-native plant species that can outcompete native species. Further, many past commercially available seed sources were not adapted to the region, and recent releases of native plant ecotypes have not yet been thoroughly evaluated. Restoration in this region is often made even more difficult when restoration areas are small (1-2 ha) relative to the management area that is managed for cattle and wildlife. In an effort to study the ability of newly developed native seed releases to restore native grassland, the *South Texas Natives* project partnered with a private ranch in Brooks County, Texas to restore 2 defunct oil production pads. In 2016, the 2, 1 ha pads were covered with stockpiled topsoil and seeded with a mix containing 29 locally adapted native species developed by the *South Texas Natives* program and the E. “Kika” De La Garza Plant Materials Center. Along with evaluating the establishment of each species, we also chose to evaluate the effects of cattle grazing on the restoration. To evaluate the effects of cattle grazing, 3 grazing exclosures (each 40 m^2) were constructed within each restoration area. Plant density data was collected each fall utilizing 20, 0.25m^2 frames located randomly throughout each restoration area, in addition to 3, 0.25m^2 frames randomly located within each grazing exclosure. The restoration of these areas was successful with an average of 2.1 seeded species/0.25m^2; the species included late successional plants such as Indiangrass and big bluestem. We recorded 27 of the 29 seeded species throughout the restoration process. While seeded cover density remained high non-native density remained low at 0.57 plants/m^2. Results from this project are promising for other restoration projects proposed within the region.

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Community Security in Beef Production: An Approach to Social and Economic Sustainability of Rangeland Dependent Livestock Enterprises

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Contributed Oral Presentation

Abstract

Livestock producers depend on precipitation, grasses, and soil health. They depend on supply chains, consumer demand, and scientific advancements for animal health. They also depend on well-being in the local community, social cohesion in operations, and human motivations that do not all fit squarely into ecology or economics. Social community elements of the beef industry constitute a key ingredient in sustainability yet remain less attended to in scientific investments to establish a full lifecycle assessment. Similar to large-scale crises across the broader picture of rural America – such as outmigration of long-term residents, health epidemics, demographic aging, and landowner consolidation – beef production communities face unprecedented social vulnerabilities. External changes, such as threats to public lands grazing, animal welfare politics, endangered species regulations, and public dietary trends, accumulate to expand community vulnerability for producers through litigation, anxiety, and stress.

We propose to present initial results of a study contributing to analyses of the economic and social sustainability of the U.S. beef industry. This analysis synthesizes results from a secondary data analysis of regional herd inventory dynamics with initial results of semi-structured producer interviews. Using U.S. Agricultural Census Data, we analyze regional herd inventory numbers based on animal production type and identify three topics of interest: a) regional patterns and shifts in animal production type; b) determination of state-level drivers of regional trends; and c) observation of regional patterns that deviate from the national cattle cycle. We couple the herd analysis with output from semi-structured producer interviews to begin to build a framework for community security toward this relatively understudied dimension of beef production and social sustainability.

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Greenhouse Gas Flux from Prairie Dog Mounds

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Poster

Abstract

Prairie dogs (*Cynomys* spp.) can induce considerable soil heterogeneity in grazing lands, with mound areas frequently acting as nutrient 'hot spots' compared to non-mound areas. Elevated levels of available nutrients in mound areas can alter greenhouse gas flux dynamics, yet investigations documenting such impacts are lacking. This study sought to quantify soil-atmosphere dynamics of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) fluxes on grassland with and without prairie dogs. The study was conducted near Mandan, ND USA on a cool-season grass pasture affected by prairie dog activity since 2012. Evaluated treatments included two biomes (prairie dog mounds and undisturbed grassland) with and without incorporated wood shavings. Gas fluxes were measured *in-situ* 31 times over a 12-month period using a portable gas analyzer. Carbon dioxide efflux was significantly greater from undisturbed grassland compared to prairie dog mounds (56 vs. 38 mg C/m^2/hr; P=0.03), an outcome attributed to an absence of vegetation in the latter. Compared to undisturbed grassland, prairie dog mounds exhibited significantly lower CH_4 uptake (-32 vs. -12 µg C/m^2/hr; P<0.01), but significantly greater N_2O flux (-0.3 vs. 6.0 µg N/m^2/hr; P=0.02). Prairie dog mounds contained 3- and 42-fold greater soil NH_4-N and NO_3-N, respectively, in the surface 0.1 m compared to undisturbed grassland. Incorporated wood shavings did not impact fluxes of CO_2, CH_4, or N_2O (P=0.89, 0.66, and 0.53, respectively). Carbon dioxide efflux and N_2O flux were positively associated with near-surface soil water content and soil temperature. Findings from this study suggest prairie dogs can have significant impacts on carbon and nitrogen dynamics in grasslands through alterations in soil-atmosphere fluxes of CO_2, CH_4, and N_2O.

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Ilemchane Transhumant Pastoralists' Traditional Ecological Knowledge and Adaptive Strategies: Continuity and Change in Morocco's High Atlas Mountains

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Poster

Abstract

Mountain rangelands are critical resources for mobile pastoralists, and provide benefits to humankind broadly. Yet mountain pastoral social-ecological systems (SES) face challenges that affect both mountains and rangelands. Herders' traditional ecological knowledge (TEK) underpins their adaptive strategies, and serves as a resource for future adaptation. This holistic case study of Ilemchane transhumant herders in Morocco's High Atlas Mountains applies a simple framework to explore how herders' biophysical TEK, practices and institutions interrelate, and how climate and social changes affect the SES. Using participant observation, interviews, and surveys, we find Ilemchane climate, plant and ecological knowledge shapes their practices and institutions, which in turn reinforce or alter TEK. Building on a recent synthesis of mountain SES, we identify a paradox of remoteness, wherein Ilemchane remoteness both maintains traditional transhumant culture and TEK and threatens end it. Overcoming this paradox may require both internal organization and collective action, and external support.

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The invisible thread: Women as tradition-keepers and change-agents in Spanish pastoral social-ecological systems

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Contributed Oral Presentation

Abstract

Pastoral social-ecological systems (SESs) provide myriad benefits to humanity and face multiple challenges in the 21st century, including interacting climate and land-use change, political marginalization and demographic shifts, leading to loss of traditional knowledge and practices associated with sustainable use. Research and policy increasingly recognize women's roles in sustaining pastoral SESs in the Global South, yet women pastoralists in the Global North have received scant attention. In Spain, like other countries in the Global North, the rise of intensive industrialized agriculture contributed to rural depopulation, land abandonment, and the masculinization of rural spaces. In this qualitative study, we address the empirical gap in studies of women pastoralists in the Global North by investigating Spanish women pastoralists' roles in pastoral SES conservation, adaptive transformation, and abandonment (regime shift). Drawing on in-depth life-history interviews with 31 women from four regions of Spain, and participatory workshops with women in each region, we explore women pastoralists' diverse identities and roles in conserving, transforming and abandoning pastoral SESs, focusing on three levels of social organization: the household/enterprise and local community, the extensive livestock sector, and society broadly. We find that women contribute to all three processes and highlight synergies between women's roles as tradition-keepers and change agents that could serve as a leverage point for adaptive transformation. Our analysis also reveals key contradictions in women's material and discursive practices; how these are shaped by intersecting axes of social difference such as age, class, origins and family status; and their implications for policy and practice to foster adaptive transformation of extensive livestock systems.

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Saltcedar Control Using Herbicides in Southwest Kansas

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Contributed Oral Presentation

Abstract

Saltcedar (*Tamarix ramosissima*) is a deciduous shrub or tree with a height up to 7 m. Saltcedar occurs throughout the Great Plains, southwestern and southeastern U.S. In Kansas, it grows best on sandy soils along rivers and streams. Saltcedar has replaced cottonwood (*Populus* spp.), willow (*Salix* spp.), and other riparian species. The objective of this study is to compare the efficacy of five herbicides for saltcedar control. The study was conducted on the Cimarron National Grasslands in southwest Kansas. Four foliar treatments, 1% imazapyr, 1% imazapic, 0.5% imazapyr + 0.5% glyphosate, and 7 fl oz aminopyralid + 6 pint/acre triclopyr, were applied in September of 2017-2020 along with a basal bark treatment of 10% triclopyr in diesel. The herbicides were applied with a backpack sprayer in 50 gal/acre spray volumes. Ten to 18 trees were treated each year and evaluated for mortality 1 year after treatment. Data were analyzed using Chi Square at p = 0.05 level. In 2017, all treatments except aminopyralid + triclopyr provided 100% control of saltcedar. In 2018, mortality was reduced, probably because of warmer air temperatures and wind speeds greater than 10 mph during herbicide application. In 2019, imazapyr, imazapyr + glyphosate, and the basal bark application of triclopyr in diesel all provided greater than 80% control of saltcedar. All foliar treatments provided 100% control in 2020 and were superior to the basal bark treatment. Overall, the 0.5% imazapyr + 0.5% glyphosate treatment was superior to the aminopyralid + triclopyr treatment. Imazapic provided control equivalent to the other foliar treatments. Basal bark treatment of saltcedar with 10% triclopyr in diesel can also be effective if all stems are treated properly. Control of saltcedar can vary from year to year depending on environmental conditions and the herbicide used.

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A new method of close range remote sensing to quantify changes in litter and grass growth

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Schladweiler-Reclamation and Restoration Issues in Arid Environments of the Southwestern United States

Abstract

Throughout the last century, changes in land cover have been recorded globally in dryland environments, which make up approximately 40% of the Earth's surface. Connectivity provides the means to understand environments that are shaped by aeolian processes and are driven across a range of spatial scales. In particular, the transition from continuous grass cover to patchy shrub dominated environments has been of particular interest as this results in increasing connectivity. Previous research has indicated that precipitation and nutrients are the primary drivers responsible for this transition from grass to shrub dominated landscapes. However, aeolian processes (connectivity) have also been hypothesized as having a critical role influencing the distribution and shifts in dryland vegetative patterns. The focus of this study is to investigate the role of connectivity, and how it influences the vegetative distribution in drylands. In particular this study takes place at the Jornada Experimental range in southern New Mexico on a grassland that was previously used for cattle grazing, but has been left to rest for the last five years. Connectivity modifiers have and control point have been installed throughout 60 (2.5m x 5m) plots that span a range of grass cover (~2% - 44%). This talk will focus in particular on the development of a new close range remote sensing technique that will allow us to quantify changes in organic matter/litter and vegetation by producing 3D models of each plot. One of this study's goals is to determine the efficacy of ConMods in promoting grass growth, establishment, and reestablishment.

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Tick tock, tick tock! How to address the ticking clock of rangeland fragmentation and loss through a new approach to formalizing tenure of land and resources

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Rangeland fragmentation and loss is occurring at an alarming rate due to individualization and land conversion processes driven by multiple causes and influencing forces. At the core of these changes is the ongoing land and resource tenure insecurity that pastoralists face. Traditional pastoral tenure systems are complex, a mosaic and/or layers of different tenure types, made more diverse by pastoralist strategies to access land and resources. Hybrid systems are becoming the norm. This creates increasing challenges for those seeking to support a formalization of pastoral tenure systems in order to secure them. Policy and legislation has failed to provide the means and mechanisms for achieving this and rather, has created problems by promoting tenure systems that conflict with and compromise pastoralism, rather than support it. As the clock ticks and pastoralists continue to loose key "linchpin" resources such as dry season grazing lands, there is an urgent need to change the approach to identifying and protecting these resources first and foremost, through different layers of tenure including formalization as appropriate. Land use planning and spatial analysis of land use, conflicts, and other phenomena can play an important role. With improved land tenure security, risks of investing in rangeland restoration will be reduced and a more secure anchor for developing and improving the production of pastoral and rangelands systems will be established.

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Developing a process for identifying grazing and rangeland science needs for decision-making on federal public lands

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Contributed Oral Presentation

Abstract

Relevant science is essential for effective decision-making across western landscapes, including on federal public lands managed by the Bureau of Land Management (BLM), which cover 1/10th of the United States. Livestock grazing and range management are common actions on federal public lands and represent a significant opportunity for science integration into land management. Our goal was to identify current science needs for informing livestock grazing and range management decisions in the BLM. We worked in a coproduction framework with BLM staff to develop an objective, transparent, and repeatable approach to identifying needs. We developed a novel, multi-faceted analysis approach based on multiple publicly available data sources. We analyzed science and data use in recent BLM livestock grazing and range management decisions, self-identified needs related to grazing and range management in BLM-authored science plans and Resource Management Plans, and challenges to BLM's use of science, data, and mitigation measures about grazing and range management in publicly available litigation documents. As a part of this analysis, we developed a process for identifying and prioritizing potential science needs where we first identified potential needs based on topics that were frequently analyzed in BLM NEPA documents and were challenged in publicly available litigation in DOI Region 7: Wyoming, Utah, Colorado, and New Mexico. Through this process we identified potential priority information needs related to grazing and rangeland management decisions: data about the presence and condition of terrestrial wildlife, science relevant to the potential impacts of these actions on vegetation, and methods for assessing potential impacts of grazing and range management to soils. Ultimately, the BLM will determine which potential needs constitute priorities for action. The agency may use these needs to prioritize funding for new research or science synthesis efforts to strengthen the science foundation for decision-making.

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Invasive brome grasses remain unaffected by multi-year experimental drought and grazing conditions

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Contributed Oral Presentation

Abstract

Invasion threatens ecosystem integrity, harming biodiversity and critical ecosystem services such as ecosystem resilience and stability. This is particularly problematic in the face of climate change. Mixed grass prairies, predominantly utilized as working rangelands, are highly invaded and under threat from increased drought intensity. We evaluated how *Bromus tectorum* and *B. arvensis* (brome) invasion changes under multi-year, multi-intensity drought conditions paired with multiple end-of-season grazing strategies at sites in Wyoming and Montana. At each site, we established 3 blocks, each containing 3 grazing strategy paddocks (destock, stable, and heavy). Within each paddock, 6, 2x4m^2 plots (n=54 plots/site) correspond to 6 drought treatments (control x2, 25%, 50%, 75%, 99% reduced precipitation). We collected species composition and aboveground primary production in 2018 (pre-treatment year), 2019-2020 (drought years), and 2021 (drought recovery year 1) from each plot. We also collected phenology data (percent green) for *B. arvensis* in April-October 2019-2021.

The abundance and productivity of invasive bromes did not vary significantly with drought or grazing strategy. This was particularly surprising given the extreme end of the drought gradient, removing 99% of rainfall. Also surprisingly, the treatments did not impact the relative abundance of invasion either, suggesting bromes responded similarly to the rest of the plant community. However, we found *B. arvensis* tends to brown down sooner under heavy grazing and high precipitation reduction suggesting that while annual changes were not found, within seasonal differences might be occurring. We in part attribute the lack of annual grazing treatment response to the timing of the treatments. As winter annuals, brome maturation occurs early (mid-June), potentially making them resistant to end-of-season (August) grazing treatments. As the climate continues to change, understanding the compounding effects of climate change and invasion will be essential to maintaining the integrity of rangelands.

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Heterogeneity through pyric herbivory as the basis for rangeland conservation

Sam Fuhlendorf

Oklahoma State University, Stillwater, USA

Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Rangelands are often characterized by high variability in space and time. Much of the variability over time is associated high variation in inter- and intra-annual climate patterns. Additionally, these landscapes are largely dependent on disturbance patterns associated with grazing and fire. Over the past several decades these landscapes have been recognized and described as non-equilibrial because of the importance of heterogeneity and non-linear dynamics that can result in multiple steady states. We will outline the conceptual transition from an equilibrium to non-equilibrium perspective and present examples from multi-source data that describes the heterogeneity of these systems in space and time. At a course scale, dominant transitions in these privately-owned landscapes are associated with conversion to cropland and encroachment of woody plants following fire suppression. Management of these transitions are dependent upon a complex social perspective that can positively or negatively influence transitions. At a fine-scale, management and conservation can limit or enhance heterogeneity and the patterns are critical to conservation of grassland ecosystems. Understanding heterogeneity across multiple scales serves as the foundation for future conservation and management of these landscapes in a changing climate. Focusing on the way to promote the interaction of fire and grazing is critical to future conservation.

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Oryx (*Oryx gazella gazella*) presence patterns in a long term grazing study in the Chihuahuan Desert of New Mexico

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Poster

Abstract

A long term grazing study comparing the impact of grazing heritage (Raramuri Criollo) vs. commercial (Brangus) beef cattle on desert rangelands was initiated in 2020 at the NMSU Chihuahuan Desert Rangeland Research Center (CDRRC). South African oryx (*Oryx gazella gazella*) were introduced in the 1970s onto White Sands Missile Range, located ca. 20 miles east of the CDRRC, and oryx are frequently observed in our 5,000 ha study pastures. However, patterns of oryx presence in the grazing experiment pastures have not been determined. Hence, we sought to quantify oryx presence in our study pastures to help clarify: a) their potential impact on our experiment treatments; and b) cattle-, vegetation-, season- and ranch infrastructure- related factors associated with patterns of oryx presence in our experimental pastures. We obtained ca. 2,250 images from 40 trail cameras located in our four study pastures (10 cameras/pasture). Images were collected over a nine month phase repeated in two consecutive years, 2020 and 2021. Annually, images were collected during 3 periods: a) pre-grazing (Dec–Feb), three months prior to placing cattle in the experiment area; b) grazing, when cattle grazed the experiment pastures (Mar–May); and c) post-grazing, the three months after cattle were removed from pastures (Jun–Aug). Grazing occurred in pastures only in 2020; no grazing occurred in 2021 because of severe drought conditions. These data will be compared with fecal pellet counts observed on permanent 100m transects at the camera locations to corroborate relative oryx presence. Additionally, vegetation cover data were collected at the permanent transects to determine potential relationships between oryx presence and plant cover. Our poster will report on oryx presence patterns across our study pastures with respect to cattle presence, vegetation, ranch infrastructure (distance to roads and drinkers), and season of the year.

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Cutleaf Vipergrass (Scorzonera laciniata L.): A New Highly Invasive Noxious Weed Threatening Utah's Range

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Contributed Oral Presentation

Abstract

Cutleaf vipergrass (*Scorzonera laciniata* L.) is a new noxious weed in Utah. It was collected in the Salt Lake Valley in 2013 and in central Utah in 2014. It is spreading rapidly and is found statewide. Contrary to its common name, vipergrass is a dicot in the Asteraceae family. It is a short-lived perennial native to Eurasia and Africa. It is highly invasive, very adapted and is found on rangeland, roadsides and irrigated cropland. It produces hundreds of achenes with pappus that spread by wind. Its mature inflorescence is easily mistaken for common dandelion (*Taraxacum officinale*) and can be confused with western salsify (*Tragopogon dubius*). It grows 1-14" tall, has a taproot and white latex sap. Its long, narrow "grass" like leaves with deep lobes give it a serrated or "cutleaf" appearance. Very little research on control has been found in the literature. Utah State University Extension conducted nine herbicide efficacy trials in range and irrigated alfalfa from 2017 to 2021. Many traditional broadleaf herbicides are efficacious on rangeland, but it is very difficult to control in alfalfa. Randomized complete block design research plots were established and herbicides were applied at standard rates, with adjuvants, and in combinations. Herbicides evaluated in rangeland trials from 2017-2020 that provide good control include, aminopyralid (7 oz/ac) 100%; chlorsulfuron (1 oz/ac) 94%; and triclopyr (1 qt/ac) 92%. Two combinations providing good control achieved include 2,4-D + triclopyr (3 qt/ac) 100%; and 2,4-D (1.5 qt/a) + dicamba (0.5 qt/ac) 85%. Good control was observed for two growing seasons from aminopyralid (7 oz/ac) and chlorsulfuron (1 oz/ac), but not for three. Herbicides that provided unsatisfactory control include, 2,4-D (2 qt/ac) 38%; fluroxypyr (0.7 pt/ac) 33%; dicamba 29%, imazapic (8 oz/ac) 13%; and quinclorac (1 qt/ac) 0%.

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Effects on soil moisture by invasive grasses key for native plant survivorship

Juan-Gilberto García-Cancel, Robert Cox

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Poster

Abstract

Invasive grasses have several ecological impacts that directly or indirectly impact native flora, including effects on soil moisture availability and extraction. Plants able to extract water faster can be better colonizers and can monopolize resources in xeric landscapes. To that end we established a greenhouse experiment to measure the effects of three non-native grasses on the available soil moisture content and therefore plant growth of 3 native plant species. Invasive grasses in this study were two non-native African grasses, buffelgrass (*Cenchrus ciliaris* L.) and Lehmann's lovegrass (*Eragrostis lehmanniana* Nees), and the native, but invasive, Mexican feathergrass (*Nassella tenuissima* Trim. (Barkworth). Native target species were blue grama (*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths), and two woody shrubs; lime prickly-ash (*Zanthoxylum fagara* L. Sarg.), and huajillo (*Havardia pallens* (Benth.) Britton & R.). Plants were grown in the TTU Horticulture greenhouse in Texas Tech in Lubbock, TX during the summer growing season of 2021. Soils were sampled were sampled at the end of the season when plants had been established for several weeks in their respective treatments. We found that buffelgrass presence reduces the presence of available soil moisture. Neither the presence nor density of Lehmann's lovegrass nor Mexican feathergrass influenced soil moisture levels or blue grama survivorship. Presence of buffelgrass affected soil moisture levels and seedling survivorship of blue grama, huajillo and prickly lime-ash in their respective treatments. We hope further studies will investigate the degree to which biomass allocation is affected by the presence of these invasive grasses.

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A holistic perspective on what ecological drought effects on post-fire restoration of burned sagebrush steppe: from the soil, to plant, to cow.

Matthew Germino

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

Water deficits that induce ecological transformation are considered ecological drought, and they are important to rangeland management considering the prevalence of low and variable precipitation across most rangelands. One recognized ecohydrological threshold that is a clear example of ecological drought is the seemingly minor shortfalls in precipitation or increased temperatures after wildfires that can cause stand-recruitment failure in big sagebrush in cold-desert rangelands of western N. America. However, there are a number of other critical ways in which weather variability, including drought, can cause natural or management-induced vegetation transformations as burned rangeland plant communities recover from fire. Prolonged lack of plant-community cover caused by either lack of rain or cold-inhibition of water during early demographic recovery can lead to excessive bare soil and wind erosion, which can be further exacerbated by interactions with resumption of rainstorms and water erosion. Several published studies reveal that wind erosion greatly impacts plant and soil recovery, potentially causing state transitions. In addition to failure of natural or restoration-seed recruitment, drought conditions can greatly complicate the timing of herbicide applications, especially pre-emergents applied to bare soils vulnerable to erosion. Resumption of livestock grazing, in addition to native or natural grazing pressure, can also be complicated by drought, such as by drought-stressed perennial herbs recovering from fire unable to withstand grazing pressure. All of these examples involve threshold-like patterns that can be quantified to inform adaptive management and structured decision making.

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Rancher-Led Collaboratives in the Interior Western US and the Role of Monitoring

Michaela Gold

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Contributed Oral Presentation

Abstract

Due to the complex challenges of rangeland management from fragmented land ownership, land degradation, and more, there has been high conflict for decades between ranchers, land managers, conservation organizations, and researchers on rangelands across the west where ranchers have long been the biggest land user. In order to deal with these challenges, a number of rancher-led collaboratives (RLCs), a subset of a larger movement of community-based collaboratives, have formed since the 1990s. While there have been studies on the effectiveness of these groups, there is limited knowledge about what monitoring data and information is being collected across these RLCs and the successes, barriers, and challenges to their utilization by these collaboratives, including decision-making. I utilized a mixed-method approach to determine the role monitoring plays or does not play for these collaboratives. I conducted interviews with 19 RLCs across the interior west and collected additional information on the monitoring data variables and categories each group collects. As more collaboratives emerge to manage land and natural resources, it will be essential to understand whether the currently-existing collaboratives effectively support rangeland management and conservation. Understanding the prevalence and use of monitoring data is an important way to evaluate the effectiveness of community-led multi-stakeholder collaboratives. As a result of this study, I will present findings on the main themes that came out of the interviews conducted including the key challenges that currently hinder the ability of RLCs to collect, utilize, and manage monitoring data. I will also present the common and unique monitoring data variables/categories collected by the collaboratives in this study. This study seeks to serve as a starting point to improve the use of monitoring data and information by RLCs and an opportunity to facilitate further opportunities for these groups to connect with one another.

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Prevented Feral Swine Population & Costs Model

Simon Gomez, Frannie Miller, Samuel Smallidge, Greg Torell

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Poster

Abstract

The presence and expansion of feral swine in the United States threatens agricultural production, rangeland health, and native wildlife in areas where feral swine inhabit. Of the 33 New Mexico counties, 17 have breeding populations of feral swine. The tremendous adaptability and rapid gestation of feral swine allows populations to increase rapidly. In 2014, given the potential economic and environmental costs caused by feral swine, an interagency group of Federal, State, Tribal, and agricultural entities created an innovative feral swine management program in New Mexico. The approach taken by this interagency group differs from the approach taken by southern states where high levels of private land ownership have resulted in many independent landowners implementing independent ad hoc feral swine management programs. In New Mexico, the high ratio of public to private land allowed for the implementation of a systematic, coordinated management program. To date, it is also the only state where USDA APHIS feral swine data shows a decreasing feral swine population.

One of the problems in analyzing the benefits of removal programs is that managing invasive species while they are widely dispersed is expensive, and its being done at a time that the impact is still relatively low, when viewed at a state scale.

This research created a model of prevented populations utilizing feral swine reproductive and mortality variables. This research has created a policy tool to quantify the economic/ecologic benefits of invasive species removal. The methodology used within this model could also be applied to other invasive species populations throughout the Western United States so as to help derive the benefits of past management efforts.

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Media lunas—a cheap and technologically simple approach to enhancing soil health and resilience on rangelands

Elise Gornish, Trace Martyn

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Contributed Oral Presentation

Abstract

Arid grasslands are essential natural and working systems that encompass over one third of global lands. Land conversion and poor management has led to losses of these systems which contributed to a 10% reduction of net primary production, a 4% increase in carbon emissions, and a potential loss of US $42 billion a year. It is therefore important to restore, enhance and conserve these grasslands to sustain natural plant communities and the livelihoods of those that rely on these arid systems. On an active horse ranch in SE AZ, we installed low cost and technologically simple half-moon shaped above-ground rock structures (media lunas) with the aim to restore grasslands by slowing water flow and erosion on the landscape and improve plant establishment. Within two years, we found differences in plant cover between rock structures of two rock sizes (large and small) as well as controls (no structures). We also found an increase in soil moisture, fungal richness, and spring seedling germination on the rock structures, despite a historic drought in year 1 of the experiment. This presentation will highlight the immense promise of media lunas for low cost rangeland restoration of soil and plant communities.

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Real-time beef cattle monitoring: opportunities for the preconditioning and finishing phases

Vinicius Gouvea

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Automated and real-time techniques to remote monitor cattle have increased the accuracy of decision support tools available for producers in the last few years. The sustainable aspect of increasing food production and animal welfare while reducing environmental loss is probably the main paradigm behind the development of precision livestock management. In summary, sensors allow real-time and automated data acquisition; all the data collected by the sensors are transferred through a network using the internet of things (IoT) to be stored in the cloud, and prediction data analytics using artificial intelligence can provide the producers with decisions support tools. Numerous technologies on precision management are available to support the beef cattle industry, especially on the health status of the herd. Three-axis accelerometers have been used to determine physical behavior and to predict health status (e.g. sick *vs.* healthy calves), especially morbidity from Bovine Respiratory Disease (BRD) in the feedlot, since the activity is reduced in sick calves. Self-contained, indwelling rectal temperature probes can provide real-time information on body temperature to improve the accuracy of current diagnosis methods of BRD. Global positioning system (GPS) can provide the distance traveled by each calve and be used to predict health status. Besides, GPS can provide information on grazing hotspots during the preconditioning phase (e.g. wheat pasture). Infrared thermographic images were an objective method to monitor beef calves for heat stress in research settings. Computer vision systems have been used to predict bunk scores or the amount of feed left in the bunk and improve the consistency of feed calls and bunk management in the feedlot. Electronic feeders/drinkers can provide information on daily intake, frequency of visits to the bunk or drinker, and intake per visit. All these technologies can be used to reduce labor costs and increase productivity in beef cattle systems.

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Adaptive grazing management promotes plant productivity and offtake across the Northern Great Plains

Jessica Grenke, Edward Bork, Cameron Carlyle, Mark Boyce, James Cahill

University of Alberta, Edmonton, Canada

Contributed Oral Presentation

Abstract

The ability of grazing managers to promote ecological goods and services alongside economic sustainability is increasingly in complexity. One proposed solution is a highly adaptive and intensive grazing management approach (hereafter Adaptive Multipaddock Grazing; AMP) which theoretically allows for maintenance of services such as biodiversity alongside increased total plant biomass production. Despite growing in popularity, the operational impacts of AMP on the plant community are poorly understood, particularly in the Northern Great Plains. We surveyed grasslands on 18 working ranches across Western Canada to: 1) determine how AMP grazing influences aboveground primary productivity (ANPP), standing litter mass, and shallow root biomass; 2) determine how these changes influence broader vegetation dynamics of biomass allocation and biomass removal; and 3) test for an effect of AMP grazing on plant community composition and forage species. We answered these questions using a paired study design which coupled AMP ranches with neighbouring adjacent ranches (N-AMP) practicing regionally representative grazing practices. Grasslands under AMP management had higher ANPP (by 620 kg/hectare on average), higher standing litter (by 870 kg/hectare), but did not influence root biomass. Both absolute and proportional biomass removal within AMP systems were significantly higher compared to N-AMP ranches. There was no influence of plant community composition. However, there were higher absolute and relative forage species abundance within AMP systems. Both metrics of forage species abundance corresponded with greater ANPP. We conclude that AMP management strongly corresponds with both increased plant biomass production and offtake. Last, the mechanisms driving these differences under AMP grazing are likely related to increasing relative abundance of forage species. We conclude that there are clear consequences to the plant community under AMP grazing within the Northern Great Plains though further work is needed to investigate the causal factors at work.

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Considerations in the use of herbicides for annual grass control in degraded arid and semi-arid rangeland restoration

Kevin Gunnell[1], Melissa Landeen[1], Wes Maughan[2], Corey Ransom[2]

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Contributed Oral Presentation

Abstract

Chemical control of invasive annual grasses, primarily cheatgrass (*Bromus tectorum*), is one of the primary tools employed to restore degraded rangelands in Western North America. However, herbicides used to control invasive annual grasses also have differential efficacy, different impacts on desirable components of the target community, or inadvertent impacts on the germination of desirable species seeded in conjunction with the chemical treatment. Understanding and leveraging these different attributes of the varied herbicides available is a crucial component in developing successful restoration and integrated pest management (IPM) strategies. We will discuss past, current and ongoing research of some of the most common herbicides used for annual grass control in relation to their use in arid and semi-arid rangeland restoration, particularly their impacts on augmented seeding efforts, in order to outline appropriate areas of use or highlight potential hazards of their use.

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Ranch Drought Plans and Decision Points

Tonya Haigh[1], Brian Alexander[2], Hobbs Magaret[3], Mike Hemovich[4], Jerry Doan[5], Myra Hipke Richardson[6]

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Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

Management decisions during drought can have long-lasting impacts on the ranching enterprise, rural livelihoods, and the ecology of the landscape. This presentation and panel will set the stage for the workshop, linking innovations in forage and drought monitoring with ranchers' processes to sustainably manage drought in their operations. We will introduce the goal of connecting scientific information with ranchers' decision-points and questions through the NDMC Ranch Drought Monitoring Dashboard (https://drought.unl.edu/ranchplan/monitor.aspx), and introduce the ranchers who will serve as panelists and provide feedback on new and existing monitoring and prediction tools.

The panel of ranchers will kick off the workshop by describing their ranch drought plans and decision-points:

- Brian Alexander, Kansas
  Alexander Ranch, in south-central Kansas, has successfully used rotational grazing methods to custom-graze cow/calf pairs and yearlings for the past 23 years. Learn more: https://drought.unl.edu/ranchplan//WriteaPlan/SampleDroughtPlans/SouthCentralKansas-AlexanderRanch.aspx.
- Hobbs Magaret, Oregon
  Sisters Cattle Company, in central Oregon, uses regenerative grazing methods that include finishing cattle on pastures with over 50 plant species and direct-marketing through their website.
- Mike Hemovich, Arizona
  The Bar X ranch, in central Arizona, consists of rolling hills of pinyon pine, juniper and gramma grasses in the south, and ponderosa pines and various grasses in the northern portion. Angus bulls are utilized with Hereford cows in a rotational grazing system to produce black baldy calves which are sold as yearlings.
- Jerry Doan, North Dakota
  Jerry and his family run Black Leg Ranch using Holistic Management with a focus on using grazing to improve soil health as well as quality of life. They also operate a hunting operation, agri-tourism, Audubon-certified beef & bison meats, and a brewery!

- Myra Hipke Richardson, Nebraska
  The Hipke Ranch is a cow-calf operation located in north central Nebraska between the Niobrara and Elkhorn River valleys. The ranch utilizes a variety of perennial and annual forage resources with the goals of improving soil health on annual cropland and native range, and developing a more efficient, adapted cowherd.

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Effects of Pyric Herbivory on Rangeland Forage Quality and Avoided Grazable Areas

Katherine Haile, Laura Goodman, Samuel Fuhlendorf, John Weir, Bryan Murray

Oklahoma State University, Stillwater, USA

Contributed Oral Presentation

Abstract

Pyric herbivory is grazing behavior driven by palatable regrowth following fire. Patch burn grazing managers apply pyric herbivory by burning portions of a pasture and allowing cattle access to unburned and freshly burned areas simultaneously. Other studies have shown that cattle select for burn patches. In this project we strategically burned areas that cattle avoided to modify their behavior and redistribute grazing pressure in a pasture. We also evaluated the effects of patch burn grazing on vegetation composition, structure, forage quality, and minerals. Additionally, because riparian areas are sensitive to grazing pressure, we measured cattle use of these areas before and after burning. Five cows, individually equipped with a GPS collar, were placed in each of the three study pastures during the summer of 2020 and 2021. At the end of the first field season, the collars were removed and the cattle distribution was analyzed using a Hot Spot analysis to determine avoided areas. Two patches (high and low fuel load) were burned in the dormant season and the growing season within each pasture in 2021. Cows were released in the pastures after the dormant season burn. The vegetation composition, nutritional components, and mineral contents were sampled prior to burning and periodically as the patches recovered from fire. The vegetation responses were evaluated among the different burn treatments. Preliminary results show that cows changed their use of previously avoided areas with a significant increase in use once burned. During the first summer, they spent 4% of their time in the avoided areas that we later delineated to burn. After burning, they spent 18% of their time in the burn patches. Cows are successfully drawn to previously avoided areas using patch burning. Pyric herbivory is a useful tool in managing livestock distribution promoting rest or focal grazing depending on the objectives.

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Exploring Grazing Effects on Post-fire Vegetation Recovery Through Time

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Poster

Abstract

The Telegraph Fire in central Arizona burned approximately 190,000 acres during the summer of 2021. There is limited research on effects of post-fire grazing in the Sonoran Desert. The goal of the project is to 1) assess vegetation recovery across environmental gradients, management type, and burn severities, 2) determine the differences in presence and absence of active restoration with seed balls, and 3) assess effects of grazing post-fire on plant communities. Plot locations were determined based on fire severity, ecological site, and environmental variables (slope and aspect). Paired plots in areas with grazing immediately after the fire and no grazing will be used to determine effects of post-fire grazing on vegetation recovery. At grazed plots, exclosures will be installed and removed on a yearly basis for five years to determine grazing impacts at various intervals. Long-term vegetation monitoring locations within the burned area will allow for this study to compare pre- and post-fire vegetation frequency, species composition, and ground cover across multiple fire intensities. While this is research is in the early stages and authors are unable to report direct results at the time of the abstract submission, by the meeting in February, initial data will be collected. Our goal is to spark conversation and learn from other SRM members about their post-fire grazing and vegetation recovery experiences during the poster session.

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Detecting Spatiotemporal Variation of Alfalfa Canopy Height with Drone Imagery

Keegan Hammond[1], April Hulet[1], Ryan Jensen[1], Neil Hansen[1], Bryan Hopkins[1], Samantha Shumate[1], Ruth Kerry[1], Ross Spackman[2], Austin Hopkins[3], Matt Yost[4]

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Contributed Oral Presentation

Abstract

Variable Rate Irrigation (VRI) is a management approach that conserves water by managing irrigations for site-specific management zones within an irrigated field. Alfalfa (*Medicago sativa)* is a crop that demands high irrigation rates in semi-arid regions of the world, making it an ideal crop for VRI. VRI zone specific watering rates are improved when crop canopy height is used as function of crop coefficient. The objective of this study was to use drone imagery to estimate spatiotemporal changes in canopy height of an alfalfa field under center-pivot sprinkler irrigation. The 22.7 ha (56.1 acre) alfalfa field is located in Rexburg, ID, USA, elevation 1518 m (4980 feet). Drone flights were done using a DJI Phantom 4 at 150 m (390 feet) above-ground. The drone was equipped with RGB (red, green, blue) and NIR (near infrared) cameras (7 cm [2.76 inches] resolution) which enabled us to create 3D point clouds of the alfalfa field to estimate plant heights. The drone was flown four times over the season, with the last flight being a bare earth image of the field. Additionally, we manually measured alfalfa plant heights at 66 systematic random sampling points in the field to get ground reference data. The field measurements and point cloud heights were compared using a general linear model. We can see a difference in plant height spatially across the field during each of the flights ($p < 0.05$) (35 - 60 cm [13.78 – 23.62 inches]). The heights were grouped using a k-means clustering to delineate zones. The drone 3D point clouds can be used as an effective tool to estimate spatial variation of canopy heights across variable environments.

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A Novel Approach to Making Rangeland Training Materials Easier to Find and Use

Laura Hamrick[1,2], Sabina Maniak[1,2], Carolyn Kerchof[1], Jason Karl[3], Jeff Herrick[4]

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Poster

Abstract

We present a hybrid approach to organizing digital training materials for rangeland professionals to meet the varied learning needs of different audiences. Users often do not know how to find the training resources that they need, and resources may be presented without sufficient context. On the landpotential.org website, for example, users have reported difficulty finding and utilizing training information in our filterable database. We tackled the challenge of how to organize and present training materials on the website to improve users' ability to find information on relevant topics at an appropriate level of complexity and with enough contextual information to meet their needs. We evaluated many options, including a Learning Management System plugin and a database structure with a filterable list of resources.

Our requirements were that our solution must allow us to present audience-specific curated collections of text and video to users who require a more guided experience, while also allowing the quick location of content for users who know what they need to find. We also require a single location where we can modify content used in multiple locations across the site. This ensures that content is kept up to date uniformly and allows us to maintain our content at scale and over time. We have proposed and are in the process of implementing a hybrid approach that involves creating audience "course pages" with defined learning pathways alongside a database with an improved filtering system. Both structures utilize a WordPress plugin that allows us to keep content synchronized across the website.

While this approach does not have the robust features of an LMS plugin, it is a lightweight solution that should meet users' learning needs and provide greater flexibility in content presentation. We welcome suggestions for improvement and feedback on how others have approached this challenge.

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Global monitoring of land cover and land use

Mattheew Hansen, Peter Potapov, Amy Pickens, Alexandra Tyukavina, Andres Hernandez-Serna, Viviana Zalles, Svetlana Turubanova

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Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

Earth observations from satellite-based sensors offer a systematically acquired, freely accessible global-scale data input for monitoring the land surface. New computing capabilities enable the efficient processing of such data. Given appropriate computing and data inputs, advanced methods for characterizing the land surface can be applied. Such methods require: 1) systematically defined land cover and land use classes, defined by their relevant physiognomic-structural properties and discernable by time-series multispectral data ; 2) remote sensing and image processing knowledge, including the creation of purpose-built features that facilitate characterization of the land surface; 3) application of advanced algorithms appropriate for land surface mapping; 4) domain expertise to train the algorithm, specifically geographic/environmental knowledge for calibrating, trouble-shooting, and iterating model runs; and 5) rigorous validation in assessing product accuracy and confirming area estimation. Here, we present a new map that characterizes key global land covers and land uses from Landsat time-series imagery. Map classes were generated from Landsat time-series imagery and topographic data using per-class variants of training data, spectral features, and algorithms, with results for all classes in the resulting global land cover and land use map validated using good practice methods. Land cover classes included maximum vegetation cover (mapped as a percent per pixel), woody vegetation height (for vegetation >=3m), surface water and permanent ice. Land use classes included built-up land, cropland, and land use associated with tree cover loss and gain (mainly forestry and shifting cultivation, but excluding tree cover loss due to fire. The method is planned for time-series implementation and may serve as an input to assessments of policies designed to balance economic development with the maintenance of ecosystem services.

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Satellite estimates of grass productivity in a heterogeneous Southwestern Rangeland

Taylor Hansen[1], Lara Prihodko[1], Dennis Dye[2], Niall Hanan[1], Wenjie Ji[3], Julius Anchang[1]

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Contributed Oral Presentation

Abstract

Drylands cover approximately 40% of the Earth's land surface but there are relatively few remotely sensed vegetation indices that are tailored to the challenges that come with observing arid and semi-arid rangelands from space. Low and heterogeneous vegetation cover, exposed soils along with a mixture of woody and herbaceous cover present problems for discerning forage abundance and distribution. The novel vegetation index, Normalized Difference Phenometric Index (NDPI), was developed to overcome some of these challenges by taking advantage of the different phenology types typical in dryland landscapes while also minimizing the effects of soils. Shrubs and grasses in particular have different phenology and react to climate drivers differently. We tested the ability of the NDPI to capture the fraction of grass and shrub cover at the Jornada Experimental Range in southwestern New Mexico and examined the ability of the NDPI to represent the spatial variability of precipitation impacts on grass productivity. MODIS/Terra surface reflectance 8-day imagery was used to test the ability of NDPI to separate grasses and shrubs. We calculated NDPI over 16 years, from 2005-2020, on Google Earth Engine. NDPI = $(VI_{p2}-VI_{p1})/(VI_{p2}+VI_{p1})$ where VI is the MSAVI2 Vegetation Index and p1 and p2 refer to distinct phenological periods for grasses (dormancy and maximum greenness). The results of the 16-year NDPI indicate that the novel index effectively discerned between shrub coverage and grass coverage across space and time. The final NDPI map shows accurate spatial representation of grass and shrub coverage. NDPI is an efficient tool for rangeland management that reinforces expectations that satellite-based methodology can be more effective in isolating and monitor grass productivity and rangeland conditions in the Southwest.

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Trends in Common Raven Abundance across Temperate North America over the Last 50 Years, with Implications for Anthropogenic Subsidization and Sensitive Species

Seth Harju[1], Peter Coates[2], Seth Dettenmaier[2], Jonathan Dinkins[3], Pat Jackson[4], Michael Chenaille[2]

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Contributed Oral Presentation

Abstract

Populations of common raven (*Corvus corax*) have generally expanded across North America over the last 50 years, likely concomitant with anthropogenic expansion and development, including livestock ranching and agriculture. Concurrently, ravens can have pronounced negative impacts on other species, for example by reducing nest success of greater sage-grouse (*Centrocercus urophasianus*). We modeled trends in raven abundance using 53 years of Breeding Bird Survey data across all Level 1 and Level 2 ecoregions in the U.S. and Canada. Raven population growth was especially high in the western U.S., with average annual growth rates of 1.033 (95% CrI 1.025-1.042) in the Cold Desert and 1.044 (1.027-1.065) in the South-central Semiarid Prairie ecoregions. This resulted in there being 4.6 times (3.2-6.9) as many ravens in Cold Deserts and 5.7 (3-11.4) times as many ravens in South-central Semiarid Prairies in 2018 vs. 1966. Raven abundance increased by a factor of 8.3 (7.0-9.9) within the range of greater sage-grouse over this time frame. Raven abundances, largely subsidized by anthropogenic activities including those in dryland regions, and potential raven impacts on native prey populations, are significantly higher now than 50 years ago.

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Indaziflam Soil Activity After a One and Two-Year Fallow

Dan Harmon, Charlie Clements

USDA Agricultural Research Service, Reno, USA

Poster

Abstract

In the fight against exotic annual grass invasions in the Great Basin, one of the most effective tools is the use of pre-emergent herbicides. This class of herbicides prevent germinated seedlings from becoming established. They have minimal effect on established perennial plants and residual activity can last from a few months to years. Established plants avoid herbicide damage by having their roots deep into the soil profile below the shallow herbicide soil layer. Indaziflam is the key ingredient in Rejuvra ™, a pre-emergent soil-active herbicide for invasive annual grass control on rangelands. Rejuvra is a cellulose biosynthesis inhibitor (CBI) which can provide long term consistent weed control for up to four years. In northern Nevada pre-emergent herbicides are used to fallow the site, reduce cheatgrass (*Bromus tectorum*) competition and then (post herbicide activity) seed perennial grasses. Perennial grasses provide long term cheatgrass suppression, decrease annual grass fuels and associated wildfire risks. We designed an experiment to measure the activity of herbicide in the soil at various depths after both a 1 and 2-year fallow. We collected soil from two Rejuvra application sites in northern Nevada at 3 depths (0-2", 2-4" and 4-8") after 17 and 29 months from the herbicide application date. Soil was placed in 0.5 quart containers (n=6) in a greenhouse and seeded with cheatgrass and Siberian wheatgrass. Seedling survival was measured for comparisons. Soil from the top 0-2" profile from both sites after 1 and 2-year fallows drastically reduced cheatgrass and Siberian wheatgrass seedling survival (mean establishment = 11%). Survival in the 2-4" and 4-8" soil profile was significantly ($P \leq 0.05$) higher than then 0-2" profile, but did not significantly ($p \geq .05$) differ from control soil (no herbicide) (61% and 69% vs 71% control soil).

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Seed Moisture Content and Forage Kochia (Brassia prostrata) Seed Viability

Dan Harmon, Charlie Clements

USDA Agricultural Research Service, Reno, USA

Poster

Abstract

One of the most profound plant community changes in the Great Basin is the conversion of big sagebrush (Artimesia tridentate) communities to cheatgrass (Bromus tectorum) dominance. Increasing wildfire threats due to cheatgrass fine fuels consumes sagebrush habitat every year. A valuable tool to both create fire breaks and mitigate lost shrub resources is forage kochia (Bassia prostrata). Two releases are widely used in the Great Basin, 'Immigrant' (Bassia prostrata spp. virescens) and 'Snowstrom' (spp. grisea). The earlier released, 'Immigrant' (1984) can have highly varying short lasting seed viability. The more recent 'Snowstorm' (2012) has larger seeds and reports of more consistent seed viability. We were interested what role, if any, seed moisture content plays in predicting seed viability. Proper seed moisture content is known to be important for seed storage. We designed an experiment using three sources of both cultivars and stored them at three temperatures (0C, 20C and "shed" storage) for two years and measured seed moisture content and germination. Looking at all data points (all sources, both cultivars, all storage temperatures) seed moisture was a poor predictor of seed viability ($R^2 = 0.2294$). Analyzing cultivars separately, seed stored at 0C had higher germination rates ('Immigrant' 25%, 'Snowstorm' 52%) than 20C or "shed" storage ('Immigrant' 5% , 'Snowstorm' 17%) and was correlated with higher seed moisture (> 6% vs. < 5% moisture). Interestingly, when analyzing among seed sources within each storage temperature, we observed the opposite, higher seed moisture correlated with lower germination for 'Snowstorm' forage kochia (0C storage: $R^2 = 0.9935$, 20C storage: $R^2 = 0.9732$, "shed" storage: $R^2 = 0.9732$). No correlation was found with 'Immigrant' among seed sources ($R^2 < 0.4$). These results indicate that proper seed moisture (6-7.5%) plays a role in maintaining seed viability but is a poor predictor of viability between seed sources.

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Reclaiming old world bluestem dominated pasture with imazapyr and overseeding

Keith Harmoney

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Contributed Oral Presentation

Abstract

Old world bluestems (*Bothriochloa bladhii* and *Bothriochloa ischaemum*), introduced into the USA for conservation and forage, are an increasing threat to nearby native rangleands. Low rates of imazapyr have been effective at reducing old world bluestems in pasture while allowing many native warm-season tallgrasses and forbs to survive. However, consecutive years of imazapyr pasture application effects on native species survival have largely gone undocumented. On an Ellsworth County, KS pasture site beginning in 2017, imazapyr was foliar applied annually for 3 years in late spring on a 240 acre tract where Caucasian bluestem dominated the vegetative cover. Caucasian bluestem cover was 51.1% prior to application, and was reduced to less than 1% cover during the last year of imazapyr application. During this same time frame, native mid- and tallgrass cover increased from 9.7% to 26.4% while native shortgrass cover decreased from 14.1% to 1.1%. Mid-and tallgrass vegetative cover increased even more from 26.4% to 64.4% following overseeding the year after imazapyr application ended. Although Caucasian bluestem cover was greatly reduced, it was still present in the pasture canopy and will likely increase over time without further management to reduce it’s presence or slow it’s spread.

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TARGETED GRAZING WITH GOATS TO CONTROL EASTERN RED CEDAR: SIGNFICANCE OF TREE HEIGHT

Alanna Hartsfield, Alexander Smart, Lan Xu, Kelly Froehlich

South Dakota State University, Brookings, USA

Poster

Abstract

Eastern red cedar (ERC) (*Juniperus Virginiana* L.) tree encroachment into grassland ecosystems, facilitated by fire suppression and overgrazing, threatens the long-term health of the Northern Great Plains. ERC does not resprout, so trunk bark girdling can effectively kill the tree. Goats browse juniper species through defoliation and debarking, and debarking causes branch death. Targeted grazing with goats could be an emerging ERC control tool; however, little is known about targeted grazing with goats on ERC. The aim of this project is to investigate how goats defoliate and debark ERC of different heights. Moderately stocked (95 $AUD \cdot ha^{-1}$) Spanish cross-bred goats grazed 24-hour periods in each of four replicate ERC-invaded 0.056 ha paddocks (average 117 $trees \cdot paddock^{-1}$). ERC of five height classes, up to 250 cm at 50 cm increments, were permanently tagged in each paddock. Defoliation was measured by volume ($⅓ \cdot \pi \cdot r^2 \cdot h$) reduction (%) from pre- to post-treatment, branch browse was measured as branches browsed (%) below the browse line, and debarking was measured by trunk debarked (%) below the browse line. Tree height was a significant predictor of defoliation ($r^2 = 0.63$, n = 159, $P < 0.001$) and debarking ($r^2 = 0.53$, n = 159, $P < 0.001$). ERC < 100 cm tall were significantly more defoliated ($P < 0.05$, $\bar{x} = 74\%$) and ERC 50-100 cm had significantly more branches browsed up to the browse line ($P < 0.05$, $\bar{x} = 85\%$), while ERC > 100 cm were significantly more likely to be debarked ($P < 0.05$, $\bar{x} = 45\%$). Our results suggest that goats disproportionally defoliate and debark short (1-100 cm) and tall (100-250 cm) ERC trees, respectively. Therefore, debarking by moderately stocked targeted grazing with goats could be applied to create dead branch fuel in tall ERC as pre-treatment for prescribed fire.

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Working with Stakeholders and Using Data to Solve Conservation Challenges

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Wilcox-Strengthening Collaborations Between Researchers and Stakeholders: Linking Data and Management in Rangelands

Abstract

The Wildlife Conservation Society (WCS) focuses on the study, understanding, and conservation of the natural world. The science-based knowledge WCS creates is used by conservation practitioners to strengthen conservation practice, inform conservation policy, and engage and inspire decision-makers and communities to take action to protect wildlife and wild places. In this presentation we share case studies from WCS's Rocky Mountain Program demonstrating how we work with local communities and decision makers to identify research priorities, co-create studies to gain knowledge pertinent to solving key conservation challenges, and use resultant data to inform management and policy. Case studies include projects focused on promoting co-existence between expanding grizzly bear populations and ranching communities in the Northern Rockies, demonstrating the importance of working lands for durable wildlife conservation, and working with Blackfeet Nation to understand how grazing management can enhance the resilience of grasslands to climate change.

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Monitoring of Feral Swine Activity and Potential Contact with Livestock on Rangelands in North Texas

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Contributed Oral Presentation

Abstract

Feral swine (*Sus scrofa*) populations have spread into 35 states in the U.S.A. with an estimated population of 6 million animals. The feral swine population is greatest in Texas, with an estimated population of at least 2.5 million. Disease transmission attributed to feral swine could cripple cattle production and wild game hunting industries. Monitoring swine habitat usage and activity overlap of livestock and wildlife species is needed to predict potential zoonotic disease spread. On a ranch in north Texas that emphasizes both livestock production and hunting, we stratified game cameras through three different ecosites: shallow upland, deep upland, and bottomland. Since June 2021, the cameras have monitored animal movement 24 hours a day. Due to economic importance and prevalence at the site, the species of special interest for image capture are cattle (*Bos taurus*), whitetail deer (*Odocoileus virginianus*), and feral swine. Cattle (n=1071), whitetail deer (n=513), and swine (n=65) images were captured over 600 camera days thus far. Spatially, swine were captured most frequently on shallow upland sites (67%) while deer and cattle were found frequently on deep upland sites (44% and 56%, respectively). Swine activity was greatest between the hours of 4 am and 12 pm with 62% of captures occurring within this time block. Cattle activity was greatest between midnight and noon (64% of captures). Swine activity dropped off once temperatures exceeded 80F (27C). The greatest activity by swine (72%) occurred when air temperatures were between 61F (16C) and 80F (27C). Monitoring will continue through the fall and winter to determine if any seasonal changes in activity occur. Vegetative survey data at camera sites will give further insight into habitat usage and overlap.

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Age Distribution of Rocky Mountain Juniper and Limber Pine in Southwest Montana: Management Implications

Nathaniel Haygood[1], Craig Carr[1], Clayton Marlow[2], Tom Keck[3]

[1]Montana State University, Bozeman, USA. [2]Western Sera, Bozeman, USA. [3]Retired, Bozeman, USA

Poster

Abstract

Woody plant expansion is a significant contemporary issue in rangeland management across the western United States. Observations from pinion pine and juniper systems have shown that this expansion negatively impacts forage production, watershed values, biological diversity, and wildlife habitat. Fire suppression in the 19th and 20th centuries led to west-wide increases in the abundance and density of woody plants and we expect similar patterns exist in limber pine (*Pinus flexilis*) and Rocky Mountain juniper (*Juniperus scopulorum*) woodlands relative to other conifer vegetation types. Few data exist that characterize post settlement vegetation dynamics within this woodland type. To address this information gap, we evaluated the age distribution of limber pine and Rocky Mountain juniper in southwest Montana. We aged 94 limber pine and 184 juniper trees from 39 different sample locations near Norris, MT. A maximum of nine trees were randomly selected at each location from dominant, co-dominant, and sub-dominant size classes, and ages evaluated using a tree-ring count from a core or stem wedge taken at 15 cm above the ground. The results of this study indicated that 95% of trees established after 1920, corroborating our assumption of increased tree establishment following the initiation of active fire suppression. We suspect that there were fewer trees in the area prior to the early 1900s and this speculation is supported by historical photos. More work is needed to fully understand the ecological impacts of increasing tree abundance in this system; however, land managers may consider pine and juniper removal treatments as a component of their management approach. The information generated through this study will contribute to the best available science required for appropriate management practices in these vegetation types.

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Impacts of Pine and Juniper Expansion on Understory Diversity and Abundance in Southwest Montana

Nathaniel Haygood[1], Craig Carr[1], Clayton Marlow[1], Tom Keck[2]

[1]Montana State University, Bozeman, USA. [2]Retired, Bozeman, USA

Poster

Abstract

Since the mid-19th century, pinyon-juniper woodlands in western North America have experienced an expansion in range and density and a corresponding degradation in the provision of ecosystem goods and services including forage production, watershed function, biological diversity and habitat values. In comparison, very few data exist that characterize potential shifts in tree range and abundance within the northern extent of these pine and juniper woodland types including the limber pine (*Pinus flexilis*) and Rocky Mountain Juniper (*Juniperus scopulorum*) type in southwest Montana. Thus, we initiated a study to investigate if: 1) limber pine and Rocky Mountain juniper woodlands show evidence of expansion and increasing density, and 2) the presence and abundance of these tree species have an impact on understory species abundance and diversity. We randomly selected 40, 25x25 m plots that ranged in tree abundance from 64 stems/hectare – 592 stems/hectare across four sites near Norris, Montana. In each plot we evaluated tree size, stem density, tree age, and tree canopy cover and sampled understory vegetation production and cover. Linear regression along with multivariate cluster and ordination analyses were used to evaluate relationships among tree attributes and understory characteristics. There is considerable interest in southwest Montana regarding the ecological impacts of conifer expansion and the information generated through this research will add to the best available science needed to inform and support appropriate land management practices in these vegetation types.

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Assigning monitoring plots to ecological sites using a quantitative keying approach

Alexandra ` Heller[1], Nicholas P Webb[1], Colby W Brungard[2], Jeremy W Schallner[1], Joseph R Brehm[1], Sarah E McCord[1], Zoe M Davidson[3]

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

Ecological site descriptions (ESDs) comprise a landscape classification system used by land managers, agricultural producers, and researchers to organize and interpret site potential and vegetation state transitions. ESDs enable the development and evaluation of site-specific, quantitative benchmarks that can be used to assess resource conditions and trends within the context of biophysical constraints imposed by ecological heterogeneity across landscapes. Monitoring datasets collected on public and private lands in the United States present a wealth of quantitative data that can be used to establish and/or evaluate whether benchmarks for managing ecosystem services are being met at various scales (e.g., regional, ecological site, ecological state). To develop and assess site-specific benchmarks using monitoring data, it is important to first classify monitoring plots to ecological site or ecological site group levels. We present a tool that gathers and organizes ecological site attributes from the Ecological Dynamics Interpretive Tool (EDIT) database, the primary repository of ecological site information, to build quantitative ecological site keys. This tool classifies monitoring plots collected with core monitoring methods to likely ecological sites based on quantitative geomorphic and edaphic attributes. Once plot-level data have been classified into ecological sites, the data can be interpreted to assess ranges of indicators of ecosystem structure, function, and services across landscapes, or used to establish and/or assess whether monitored locations are meeting benchmarks. We present a case study of the ecological site key tool using ESD information from MLRA 35 and monitoring plots in the Rio Puerco region of north-central New Mexico. This tool can be used where ecological sites have been recently developed or updated, where monitoring plots were not assigned to ecological sites in the field, and to generate quantitative summaries of abiotic and biotic indicators to be included in ESDs.

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South Dakota Drought Tool

Emily Helms, Stanley Boltz

USDA Natural Resources Conservation Service, Huron, SD, USA

Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

The South Dakota Drought Tool (SDDT) helps ranchers and managers assess current and future potential grass production for a specific area. The SDDT quickly queries many sources of current precipitation to predict the current and near-future grass production levels. The tool also supplies a suggested percent of normal stocking rate during deficit periods. The user can enter their own rainfall data, and in some cases the SDDT can access the user's own automated weather station. In addition, the SDDT has guidance and a place to record and save the user's drought management plan. It is a spreadsheet-based tool downloaded from the SD NRCS website.

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Can defoliation reduce the abundance of smooth brome? An examination of phenology and defoliation timing.

John Hendrickson[1], Andrew Carrlson[1], Aaron Field[2], Andrea Clemensen[1], Vanessa Yeoman[3]

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Poster

Abstract

Smooth bromegrass (*Bromus inermus* Leyss.) is an introduced, cool-season, perennial grass that has invaded grasslands in the central and northern Great Plains. Anecdotal evidence suggests grazing may reduce smooth bromegrass abundance. However, little is known about the timing of grazing and how it impacts smooth bromegrass persistence. We compared the crowns of smooth bromegrass tillers that were defoliated either once (V1) or twice (V2) in the vegetative stage, in the elongation stage (E), in the reproductive (R) or left undefoliated (C) in three ungrazed exclosures over three years near Mandan, ND. Tillers in each treatment were marked with a different colored wire and excavated in the fall. Tillers were brought back to the laboratory, cleaned and each node position on the crown was categorized as an axillary bud, tiller, rhizome or leaf scar. The tillers were then placed in 0.1% w/v 2,3,5-triphenyl-2H-tetratozolium chloride (TTC) for 24 hours and activity levels on each position recorded. Tillers with inactive node positions were placed in Evan's blue solution to determine viability. Positions that were not active or dead were considered dormant. Year and defoliation impacted the number of node positions, outgrowth and active meristems tiller^{-1}. The R defoliation treatment had more total positions and active meristems than the controls (C). Outgrowth (tillers plus rhizomes) was less in the V2 treatment than the R (1.18 vs 1.83 outgrowth positions tiller^{-1} respectively). This data suggests that defoliation timing can impact the abundance of smooth bromegrass. This information will help managers design targeted grazing programs to reduce this invasive grass.

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Rangeland Assessment and Monitoring for Land Managers: Principles for Deciding Where and When to Collect Field Data

Jeffrey Herrick[1], Emily Kachergis[2], Nika Lepak[3], Brady Allred[4], Shannon Savage[2]

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Poster

Abstract

What is the condition of rangeland? Is it improving? A large and growing number of assessment and monitoring tools are available to rangeland managers. Some are as simple as opening a website and zooming into a particular location, pasture, watershed or even region. Others require making field observations and measurements that may require minutes to hours, in addition to transportation time and costs. Given the broadly available datasets and remote sensing-based products, we have increasingly been asked where and when it's necessary to collect field data, and how detailed, accurate and precise the field observations and measurements need to be. These questions must be addressed in order to efficiently allocate resources available to acquire and interpret the most valuable multiple lines of evidence for a particular objective or question at a particular location or area. To help optimize time spent on field data collection, we present some simple guidelines to help answer these questions. The guidance is summarized in a decision tree, and is based on assessment and monitoring objectives, and soil and vegetation predictions that are now easily accessible through tools such as SoilWeb, LandPKS, and fractional vegetation mapping apps like the Rangeland Analysis Platform, RCMAP, and LandCART.

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USFS Research & Development tribal engagement efforts

Serra Hoagland

USDA Forest Service, Missoula, USA

Padilla-Building Resilience in Indigenous Natural Resources

Abstract

On Nov 15, 2021 the Executive Office of the President Office of Science & Technology Policy Council on Environmental Quality delivered a memo on Indigenous Traditional Ecological Knowledge and Federal Decision Making. Furthermore, during the first day of the White House Tribal Nations Summit the President signed a joint Secretarial Order that facilitates agreements with tribes to collaborate in the co-stewardship of federal lands and waters. Both the memo and the secretarial order reaffirm tribal sovereignty and the need for federal agencies to work in collaboration with tribal governments and practitioners on land stewardship. The US Forest Service (USFS) manages 193 million acres of lands, all of which are ancestral homelands of Native people and the USFS Research and Development (R&D) branch provides novel scientific findings regarding forest and natural resource management. This presentation will focus on the USFS R&D tribal engagement roadmap and highlight other ways in which R&D is engaging with tribal communities and Native people. One important component includes assisting with data collection efforts for the upcoming congressionally mandated IFMAT report that assesses the status of tribal forestry and forest management programs in the US every 10 years. Hoagland serves as one of the core team members for the IFMAT report and will share how the assessment will be incorporating woodland management and non-timber forest products.

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Impacts of Eastern Red Cedar (*Juniperus Virginiana* L.) on Avian Communities in Eastern South Dakota

<u>Jay Holm</u>, Austin Domeier, Alexander Smart, Lan Xu

South Dakota State University, Brookings, USA

Poster

Abstract

Eastern Red Cedar (ERC) (*Juniperus virginiana L.*) is the most rapidly spreading woody species in the Northern Great Plains due to fire suppression and planting in windbreaks. Its encroachment has converted already fragmented grassland into woodland and altered wildlife habitats. There is concern that ERC encroachment may negatively impact grassland-obligate/dependent avian species. In this study, we evaluated avian community composition between ERC-encroached and non-encroached grasslands in eastern South Dakota. Six sites of encroached grassland and six sites of non-encroached grassland were selected in eastern South Dakota. Bird surveys were accomplished by one observer using point counts. The surveys were conducted early in the morning for each site, with three temporal replications; they spanned from July 11 through July 25, 2021. Presence and abundance of each species observed/heard was recorded. Overall, 47 species were observed; 32 were observed in non-encroached sites, and 42 were observed in encroached sites. Species richness, evenness, and Shannon-Wiener diversity index were higher in encroached sites for all three temporal replications. Jaccard's Species Similarity Indices between encroached and non-encroached sites for the three temporal replications were 44.19%, 52.63%, and 51.52%, respectively. Non-encroached sites were dominated by grassland-dependent avian species like Sedge Wren (*Cistothorus platensis*), Bobolink (*Dolichonyx oryzivorus*), Western Meadowlark (*Sturnella neglecta*), and Dickcissel (*Spiza americana*), while encroached sites were dominated by woodland/transitional avian species such as Clay-colored Sparrow (Spizella pallida), American Goldfinch (*Spinus tristis*), Eastern Kingbird (*Tyrannus tyrannus*), and Brown-headed Cowbird (*Molothrus ater*). Our results demonstrate that ERC encroachment significantly impacts avian grassland community compositions by shifting them from grassland-dependent species to woodland/transitional species. Higher richness on encroached sites appears due to heterogeneity of transition phase between two distinct communities. With grasslands being among the world's most threatened ecosystems, our results amplify the importance of management to slow/prevent ERC spreading.

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Managing cattle grazing timing and duration to support multiple ecosystem services in semi-arid rangelands

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[1]Working Lands Conservation, Logan, USA. [2]Utah Department of Agriculture & Food, Randolph, USA

Contributed Oral Presentation

Abstract

Land managers are interested in rangelands that sustainably balance cattle production with multiple other ecosystem services – such as forage, clean water, high quality habitat for wildlife, healthy soils, and thriving ranching communities. It can be difficult, however, to simultaneously balance all such management objectives. One possible solution is to employ rotational grazing, but managers debate whether grazing rotation provides measurable benefits for conservation outcomes. To understand how rotational grazing affects multiple ecosystem services we examined how services varied across gradients of grazing timing and duration in semi-arid rangelands located in northeastern Utah. Our sites include pastures with short- (2-4 weeks), medium- (1.5-2 months), long-duration (4 months) grazing, or no-grazing. Additionally, medium-duration pastures are grazed either early or late in the season. We are finding that grazing duration affects most ecosystem services included in our study. Shorter durations lead to taller forage, cleaner stream water, better sage-grouse habitat, and healthier soils, compared to longer durations. This appears to be due to less grazing and trampling and more time for pastures to rest and recover from disturbance. We are also finding that the timing of grazing can affect erosion control/streambank stability, vegetation recovery, and water quality. These services are controlled by processes that occur in discrete time-periods, such as during active vegetation growth or during mid-summer stream-temperature increases. Our findings suggest that one reason past rotational grazing studies may not offer management solutions that can achieve multiple management objectives is that such studies often lump different grazing rotations into a single treatment. Because of this, including gradients of duration (e.g., short, medium, long) and timing (early, late season) in future rangeland studies may reveal how incremental changes in livestock disturbance contribute to ecosystem service generation. This can offer new ways to balance multiple management objectives in rangelands.

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SRM Targeted Grazier Certification

Claudia Ingham[1], Kelly Anderson[2]

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Poster

Abstract

The Targeted Grazing Committee of SRM now offers Certification of Targeted Graziers in response to requests from SRM members, including land managers who which to use this vegetation management tool and livestock producers who provide specialized grazing services. The process of developing a certification standard began at the 2019 SRM Annual Meeting in Minneapolis and was approved by the SRM Board in November 2019.

Certification of targeted graziers who are knowledgeable, reliable and exhibit ethical business and livestock management practices is warranted and SRM is uniquely situated to offer such a program due to its long-standing commitment to connecting science and management on the landscape. In contrast to industry groups which represent various livestock species or product groups, SRM is a ‘grass roots’ organization which supports initiatives that come from its members and emphasize soil-plant-livestock interactions based on science and the application of best management practices.

This informational poster informs its audience about the interest in and value of certification. It also provides a description of the certification process, how an applicant contacts the Targeted Grazing Committee and the three components of the certification standard. Those components include: 1) a written exam, 2) a portfolio of videos and photos and 3) letters of testimonial. Benefits of certification, requirements of targeted graziers including membership in SRM, fees and services provided to those who earn certification are also described in this educational poster.

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PHENOLOGICAL RESPONSE OF SIDEOATS GRAMA [BOUTELOUA CURTIPENDULA (MICHX.) TORR.] TO CLIMATE CHANGE IN THE STATE CHIHUAHUA, MEXICO

Ireyli Iracheta-Lara, Federico Villarreal-Guerrero, Alfredo Pinedo-Alvarez, Raúl Corrales-Lerma, Carlos Morales-Nieto

Universidad Autónoma de Chihuahua, Chihuahua, Mexico

Poster

Abstract

Phenological data observed on land and satellite data are important tools used to identify the vegetation´s stage. The objectives were to analyze phenological differences of sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.] at the start (SOS) and at the end (EOS) of the season to identify which climatic factor controls the SOS dynamics and to determine if there exist trends of change in SOS and EOS in the state of Chihuahua. The periods evaluated were 2000-2010 and 2011-2019 and the state was classified in three areas: desert, central valleys, and sierra. First, the start (SOS) and the end (EOS) of the phenological stage of sideoats grama was defined from Landsat data during 2000 - 2019 by determining the NDVI. Differences in SOS/EOS in response to temperature and precipitation were analyzed through GLM analysis. The SOS occurred mainly in May and June (average doy=174) and the EOS appeared mainly in October and November (average doy=283). A delay in the EOS was observed for the desert area, implying that the growing season in the desert zone is moving backwards compared to the other two areas. Retardation in the desert area in the spring may be the result of relative water scarcity, although the higher temperature in the spring makes it easier to meet the thermal requirements for vegetation. In the state of Chihuahua both, the SOS and the EOS occurred later in the Desert area than in the Central Valleys and Sierra area, which implies that the growing season in the Desert area experienced a delay, compared to the other two ecological areas. It was concluded that climate variability affects the SOS and EOS dynamics.

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Recent ‘Climatic Climate Change’ on North America’s Prairie Ecoregions

Charles Jackson

New Mexico State University, Las Cruces, USA

Contributed Oral Presentation

Abstract

At least two features of climate prevent us from taking climatic entities seriously. First, like any mountain, prairie, or wetland, climatic entities are ‘notoriously vague things’. Second, climatic entities have no momentary objects or stages. Because climate is something that *only* persists, we never observe it directly. Nevertheless, we have a sense for both climate and climate change. Indigenous peoples have known this for a very long time. And people who live somewhere for a long time eventually come to know it as well. This is why we have come to rely on so-called anomalies, i.e., the deviation of some meteorological entity from a climatic entity reduced to a merely statistical one. But this misses something. Namely, many of the geographically scalar climatic entities that contain us remain absent. Eleven sets of 30-year climatic entities (1981–2010 to 1991–2020) were generated from the gridded Daymet Version 4 maximum temperature annual averages. These objects were discretized with a quadtree algorithm and classified within Trimble eCognition. The ‘climatic climate change’ of cooling and warming objects were summarized across three prairie Level II terrestrial ecoregions within QGIS. Climate change is radically bifurcated on the Great Plains. Climatic warming peaked in the 1983–2012 set, with the warming objects of the High Plains containing ecoregion alone having a median change of 1.61° and a mean change of 1.49°. The area and intensity of climatic cooling are maximal in the 1986–2015 objects. The cooling objects for the three prairie ecoregions have a median change of -0.48° and a mean change of -0.54°. A seasonal analysis is needed next in order to determine whether the contraction of cooling beginning with the 1987–2016 objects results from less intense winter and spring cooling or greater warming in summer and fall and better focus rangeland management.

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Integrating satellite and field measures for improved grazing land management at pasture and ranch scales

Vincent Jansen[1], Jason Karl[1], Heidi Schmalz[2], Mike Hale[3], Jeff Fields[3]

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Contributed Oral Presentation

Abstract

Monitoring and evaluation of management strategies and conservation practices is a cornerstone of adaptive management. However, in grazed systems, it is often difficult to measure the outcomes of management decisions due to climatic variability and spatial heterogeneity of vegetation and livestock use patterns. To help overcome some of these challenges we are seeking ways to integrate remotely sensed data and field data to represent livestock use. In this presentation we will explore the relationships between three different measures of livestock use, 1) remote sensing data, 2) in-field utilization data and 3) livestock GPS data. By relating these measures to one another we hope to better understand both the strengths and weaknesses of the remote sensing and field methods and develop monitoring approaches that integrate the two methods to effectively and efficiently monitor livestock use at the pasture and ranch scale.

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Applications of the Land Treatment Exploration Tool for Adaptive Management

Michelle Jeffries, David Pilliod

United States Geological Survey, Boise, USA

Contributed Oral Presentation

Abstract

Each year, public land managers make decisions regarding reclamation, rehabilitation, and restoration actions that influence landscapes and ecosystems. Many of these decisions involve soil and vegetation manipulations, often known as land treatments. These treatments were historically planned on a case by case basis with decisions about implementation, methods, and operations derived from personal experience of past successes or failures. Modern adaptive management strategies strive to capture this local knowledge through time, to create a comprehensive picture of effective treatment strategies both locally and regionally. In 2017, the U.S. Geological Survey partnered with the Bureau of Land Management (BLM) to create the Land Treatment Exploration Tool to facilitate adaptive management of land treatments. The Exploration Tool taps into a wealth of information about past treatments in the Land Treatment Digital Library (LTDL), a catalog of information about all known treatments on public lands administered by the BLM in the Western United States. The Exploration Tool is designed for resource managers to use when planning land treatments. The tool provides useful summaries of environmental characteristics of planned treatment areas and facilitates adaptive management practices by comparing those characteristics to other similar treatments within a specified distance or area of interest. This presentation will provide an overview of the functionality of the tool and real world examples of how the tool is currently being utilized.

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The Rangeland Analysis Platform: Tools for estimating pasture productivity, year-to-year variability, and stocking rate

Eric Jensen, Brady Allred, Dave Naugle, Matt Jones

University of Montana, Missoula, MT, USA

Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

What are the precipitation or forage production extremes that I should plan for? What's my current drought/forage situation, and how does it compare to other years? What can I expect this year for forage production? Rangeland production can vary dramatically year-to-year and across grazing land units. Having data to evaluate production and variability provides ranchers with valuable information for management decisions. Rangeland Analysis Platform tools draw on nearly four decades of satellite data to deliver pasture-scale assessments in an interactive and easy-to-use format. Custom analyses include: 1) estimates of near-real-time rangeland production for the current year; 2) long term production variability and comparison; 3) stocking rate estimations based on user-defined specifications; and 4) printable reports, maps, tables, and charts so that you can take the data with you. The Rangeland Analysis Platform supplies valuable context that can improve ranch planning, frame expectations, and evaluate outcomes.

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Using Cows to Spread Seeds: How Digestion Affects Germination Rates of Species Critical to Great Basin Restoration

Nathan Jero, Mozart Fonseca, Arturo Macias Franco, Aghata Silva, Tamzen Stringham

University of Nevada, Reno, Reno, NV, USA

Poster

Abstract

Many plant species produce seeds which are eaten and spread by animals, and because substantial portions of the Great Basin are infested with cheatgrass, there is significant interest in ways to reestablish native vegetation in cheatgrass-infested rangelands. Cattle grazing cheatgrass in the fall are typically provided with a protein supplement, which provides a route by which to introduce seeds of desirable species into their diet. In order to assess the viability of using cattle to spread seeds, we performed 4 replicate 0, 12, 24, 48 and 96 hour *in vitro* incubations using rumen fluid from cannulated steers on seeds of crested wheatgrass, Indian ricegrass, Snake River wheatgrass, squirreltail, gooseberryleaf globemallow, Wyoming big sagebrush, and cheatgrass. Following incubation, a 21-day germination trial was performed on a subset of seeds from each incubation. Results were analyzed using nonlinear regression with sigmoidal dose-response models. Germination rates decreased as incubation lengths increased for all species ($p = 0.02$ for Indian ricegrass and < 0.001 for all other species). Previous research indicates that peak rates of seed recovery in cattle feces occurs 24-48 hours after ingestion. Crested wheatgrass and squirreltail maintained high germination rates after 48 hours and are good candidates for fecal reseeding. Yarrow and Snake River wheatgrass had high germination rates at 24 hours but low germination at 48 hours; suitability of these species will depend on seed availability and cost. Germination rates of Wyoming big sagebrush and gooseberryleaf globemallow were reduced to negligible levels by 24 hours, and Indian ricegrass had low germination regardless of incubation length; these species unsuitable for dispersal by cattle. Cheatgrass germination was only slightly reduced by 24 hours, but was estimated to be reduced by 90% after 39 hours. We conclude that the spread of cheatgrass by cattle is possible, but unlikely.

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Virtual Fences are a Promising Tool for Intensive Riparian Livestock Grazing Management

Nathan Jero, Paul Meiman

University of Nevada, Reno, Reno, NV, USA

Poster

Abstract

Many environmental and management problems result from livestock distribution issues, while few are caused simply by stocking rate, and cattle often congregate in riparian zones, causing disproportionate impact. Many tools are available to manage livestock distribution. Virtual fence systems have become available recently and show promise for managing livestock grazing in riparian areas and many other settings. Residual stubble height is often used in riparian zones as an indicator of when it is time to move cattle, and is highly correlated to remaining forage biomass. Animal welfare has been a consideration throughout virtual fence development, and previous research proposes that it is of critical importance that an animal can predict and control receipt of electrical stimulation during interactions with the virtual boundary. A virtual fencing system was deployed on a ranch in northeastern Nevada. A herd of 162 yearling heifers was kept in two subirrigated riparian pastures. The area to which cattle had access was adjusted using virtual fences to create 10 different stocking densities (runs) between 5 and 20 animals/acre. Before and after each run at a given stocking density, overall riparian stubble height was measured , as well as species-specific measurements on Nebraska sedge (preferred forage species) and Baltic rush (avoided forage species). Virtual fence effectiveness was defined as the proportion of boundary interactions where animals were successfully contained. Predictability and controllability were evaluated using the number of electrical stimuli delivered during an interaction. Preliminary analysis indicates that neither stocking density nor stubble height influenced virtual fence effectiveness, predictability or controllability, even when stubble height was below common management targets. This is promising and may indicate that virtual fences are a reliable tool for riparian grazing management across a broad range of conditions. However, these results are preliminary; analysis is ongoing and more complete results will be presented.

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Site Considerations for Resource Management and Conservation: A Brief History

Jamin Johanson

USDA-NRCS, Wasilla, AK, USA

Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

The effects of site features on ecosystem structure, processes, and response to disturbance have long been recognized in the rangeland science and forestry disciplines. Defining ecosystem classes based on site features that drive ecosystem structure and dynamics – such as pedogenic, geomorphic, climatic, and hydrologic processes – provides a scientifically robust framework for organizing ecological knowledge. In addition to making ecological knowledge easier to access and communicate, process-based ecosystem classification and description provides a scientific basis for assessing resource management alternatives and making reasonable inference and predictions. This talk presents a review of rangeland science and forestry literature about the importance of considering site-specific features when designing and interpreting natural resource conservation and research projects, and articulates the process-based foundation upon which current ecological site classification and description efforts are built.

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Preparing Indian Ricegrass Seed for Restoration using Seed Coating Technology

Amber Johnson[1], Sam Knuth[1], Kadyn Allen[1], Maureen Cartwright[1], Alex Larson[1], Kevin Gunnell[2], Danny Summers[2], Brad Geary[1], April Hulet[1], Matthew Madsen[1]

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Poster

Abstract

Indian ricegrass (*Achnatherum hymenoides*) is a highly palatable forage for livestock and wildlife making it a valuable conservation species. Seed dormancy, however, of this species often results in poor or failed plantings. Dormancy strategies of Indian ricegrass are advantageous for the species' long-term survival; however, this strategy does not meet most restoration goals in the Great Basin which requires germination to occur the first year after planting before invasive species occupy the site. Reducing seed dormancy of Indian ricegrass before planting may improve seeding success. We used scarification to reduce physical dormancy and gibberellic acids (GA_3) to reduce physiological dormancy. We scarified seed in a mechanical seed scarifier. We also coated seeds with a slow-release polymer infused with GA_3. As the polymer is broken down, GA_3 is released to the seed stimulating germination. Additionally, to protect scarified seeds from pathogens, we applied a fungicide coating formulated to combat identified seed-borne and soil-borne pathogens. We analyzed the effectiveness of these seed treatments in a lab germination trial and in a spring planting in the field. Three weeks after planting, scarified seed coated with GA_3 and fungicide had 6.4 times higher emergence than untreated seed ($p = 0.02$). Further studies to replicate the field study are being implemented by planting the most successful treatments at additional study sites with three varieties of Indian ricegrass.

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Monarch Butterflies (*Danaus plexippus L.*) Benefit from Variable Grazing Strategies in Rangelands During Extreme Drought

Ellysa Johnson[1], Jason Harmon[1], Torre Hovick[1], Kevin Sedivec[1,2], Ryan Limb[1]

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Poster

Abstract

Rangelands present an opportunity for both livestock production and conservation of biodiversity. Eastern migratory monarchs (*Danaus plexippis L.*) are of particular interest due to their candidacy under the Endangered Species Act. Monarchs are heavily reliant on the milkweed within rangelands of the North America Great Plains. However, it is unclear whether current management goals to maximize cattle production are compatible with monarch conservation and their host plant, milkweed. To determine the compatibility between these goals, we assessed monarch and milkweed responses to different grazing regimes. Specifically, we monitored adult and juvenile monarchs, forbs, and milkweeds in North Dakota mixed-grass prairie rangelands. We evaluated three management approaches: (1) modified twice-over rest rotation grazing, (2) patch-burn grazing, and (3) season-long grazing. During the monitoring period, a substantial drought occurred in the summer of 2021 in North Dakota which influenced the vegetation growth in each management approach. In these conditions, we found that the modified twice-over rest rotation grazing (MTRG) management approach had the highest abundances of all four response variables. Out of a total of 96 adults, 77 juveniles, 69778 flowering forbs, and 17099 milkweed stems, MTRG alone accounted for ~55-65% (53, 44, 39173, and 11044, respectively). Areas that were rested within this management approach did not have cattle present, and seemed to act as a refuge for vegetation during the drought. Our results will continue in the summer of 2022, and will hopefully allow us to compare monarch, milkweed, and forb responses under divergent growing season weather conditions. These findings could have important implications for future monarch conservation and rangeland management under predicted climate change and help better understand the compatibility between monarch conservation and livestock grazing on rangelands.

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Sustainable Rangelands & Livelihoods Through Sustainable Collaborations

Myriah Johnson[1], Stacy Lynn[2], Anna Clare Monlezun[3], Jessica Soule[1]

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Monlezun-Sustainable Rangelands & Livelihoods Through Sustainable Collaborations

Abstract

What if we considered each other and cattle as *partners* in conservation? Could this be a win-win for the livestock and rangeland conservation sectors, resolving the [often] paradoxical objectives of beef production and natural resource management? The goal of this session is to bring together diverse rangeland stakeholders to collaboratively learn about and create innovations for ecosystem and livelihood sustainability through emergent outcomes such as multi-stakeholder groups, research proposals, and collaborative publications. Our presenter team brings diverse research experiences in sustainable livestock-based food production systems. National Cattlemen's Beef Association presenters are engaged in holistic research across the three pillars of sustainability, specifically examining tradeoffs and synergies across all segments of the beef industry. Colorado State University presenters are currently involved in social-ecological research of collaborative grazing management on government-owned conservation lands. Government-owned conservation lands are places where governance meets agriculture, recreation, conservation, and science. We will guide participants as they engage in a unique experiential learning opportunity focusing on the integration and inclusion of diverse values, needs, and perspectives. Identifying research needs and opportunities from diverse perspectives is particularly important in the context of changing climate, changing land use policies and governance, and changing livestock system demographics. Participants will experience the inner-workings of collaborative democratic science where, in addition to participatory research methods, we propose that goals and action items are created collaboratively through a bottom-up approach, emphasizing the role and input of those with "boots on the ground." Outcomes of this session will thus be determined by participants, and may include a multi-stakeholder working group, prioritization of next steps based on in-session needs and interests assessment, and other products that will take these principles and innovations from theory and individual experience into widespread discourse and practice.

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Bobwhite Response to Cattle Grazing in South Texas

Bradley Johnston, Alfonso Ortega-S, Leonard Brennan, Humberto Perotto, Fidel Hernandez

Caesar Kleberg Wildlife Research Institute, Texas A7M University-Kingsville, Kingsville, USA

Poster

Abstract

Range management practices to improve habitat for wildlife by reducing brush and increasing herbaceous plants, coupled with reduced stocking rates, can lead to dense stands of dominant grasses, such as Four-flower Trichloris (*Trichloris pluriflora*). This monoculture of Trichloris creates dense unsuitable vegetation for Northern Bobwhites (*Colinus virginianus*) as well as reduces plant species richness. The objectives of this study are to evaluate the use of a proper cattle grazing regime to maintain or improve bobwhite habitat, as well as develop a management guide that documenting how cattle grazing can be used as a tool to reduce the density and cover of dominant grasses to allow higher species richness. The study area is composed of two pastures, totaling about 2,500 hectares, in Duval County, Texas. One pasture will serve as the control while the other will be grazed to maintain a stubble height between 30 and 40 centimeters (optimal for bobwhite habitat) as needed. We placed 10 grazing exclosures as well as 10 (25 meter) transects within each treatment to determine botanical composition and cover. Double sampling is completed monthly to determine forage standing crop, and percent cover is also recorded along each transect at each meter. Forage standing crop, plant species richness, total plant cover, and forage utilization will be estimated. We began grazing on May 22, 2020, with a herd of 228 mother cows in the treatment pasture. After 109 days of grazing, we achieved the target stubble height, and the herd was removed. Aerial surveys of the study area indicate that quail density on the grazed pasture is roughly 60% higher compared to the non-grazed. The results so far are preliminary however it has the potential to shed light on how bobwhites respond to proper cattle grazing which may be used for managing their habitat across South Texas.

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Field tests of moisture-retaining restoration treatments

Danielle Johnston[1,2], Magda Garbowski[2,3], Cynthia Brown[4]

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Contributed Oral Presentation

Abstract

Restoration of degraded rangelands often fails because of irregular precipitation. Here we report on two abiotic strategies to overcome moisture limitations when establishing desirable plants from seed: super-absorbent polymer (SAP) soil amendment, and creating large pits or potholes. SAPs absorb water when soil is wet and then gradually release it, often reducing plant water stress. Potholes create local microsites of higher moisture and greater shade, facilitating plant establishment and survival in harsh conditions. SAPs were tested in 3 experiments in a total of 5 locations, with mixed results. In an experiment in mesic NW Colorado sites, SAP increased perennial grass establishment at one site, but increased cheatgrass at another. In an experiment at more arid Colorado sites, SAPs increased initial native plant establishment at 1 of 2 sites, but not when combined with a drought treatment, and initial benefits did not translate into any differences 3 years later. Potholes were tested at 12 sites with precipitation ranging from 8 to 18 inches annually, with neutral or favorable results. At mesic sites, potholes performed similarly to drill seeding. Potholes aided the establishment and survival of perennial grasses at two of the most arid sites, outperforming drill seeding. Potholes are a cost-effective and reliable way to improve plant establishment.

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Topoedaphic constraints on woody plant cover potential in a semi-arid grassland

Scott Jones, Steven Archer, Stuart Marsh

University of Arizona, Tucson, USA

Contributed Oral Presentation

Abstract

Rangelands world-wide have experienced shrub proliferation at the expense of grasses. While the process and its drivers are varied, consensus is emerging that interactions among multiple factors are key. The strength of these interactions varies with local constraints imposed by landforms, soils and topography, but how these constraints influence shrub cover change and shrub 'carrying capacity' (maximum shrub cover, MSC) has not been well-quantified. What is the MSC a given landscape might support? Where does present-day shrub cover stand with respect to its potential? Answers to both questions are needed to inform when, where and under what conditions brush management should be deployed to meet conservation goals and objectives.

To address this gap in knowledge, we used high resolution (1-meter) imagery to classify *Prosopis velutina* (velvet mesquite) cover within a 18,200 ha rangeland in Southern Arizona. Shrub cover in this region began increasing in the early 1900s. Assuming the NRCS ecological sites in the region undisturbed by fire or brush management have had sufficient time to reach shrub 'carrying capacity', we analyzed coverage maps to ascertain how topoedaphic variables (i.e. elevation, soil texture and water availability) dictate MSC of *P. velutina.* Results indicate these variables influenced fine-scale MSC, with interactions varying considerably across ecosites. For example, water availability was positively correlated with MSC (slope = 1.33; $p \leq 0.0001$) at the regional scale and on loamy upland ecosites (slope = 1.12; $p \leq 0.0001$) while clayey swale (slope = -1.63; $p \leq 0.01$) and loamy bottom (slope = -.94; $p \leq 0.03$) ecosites had a negative relationship with water availability. These relationships will be enumerated in the context of how such information could be used in conjunction with ecological site descriptions to proactively anticipate and manage shrub encroachment and prioritize the location and timing of brush management.

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Adaptive Multi-paddock Grazing Reduces Diet Quality of Yearling Steers in Shortgrass Steppe

Tamarah Jorns[1], J. Derek Scasta[2], Justin Derner[3], David Augustine[4], Lauren Porensky[5], Hailey Wilmer[6], Edward J. Raynor[7], CARM Stakeholder Group[8]

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Poster

Abstract

Adaptive multi-paddock (AMP) grazing is hypothesized to improve livestock forage quality by helping managers more effectively move livestock between paddocks. Experiments are needed to quantify the influence of AMP on diet quality and composition of free-ranging livestock in heterogeneous, extensive semiarid rangelands. We compared responses of (1) dietary crude protein (CP), (2) digestible organic matter (DOM), and (3) diet composition using fecal DNA (fDNA) metabarcoding in a ranch-scale (3,200 ha) experiment with yearling steers grazing shortgrass steppe from mid-May to early October for 6 years (2014-2019) in contrasting grazing treatments: Collaborative Adaptive Rangeland Management (CARM, a type of AMP using a stakeholder group to make informed decisions on grazing management using data provided both within and across grazing seasons) and season-long, continuous grazing (TRM). These grazing treatments had the same system-level, within-year stocking rate but differed in stocking density (10-fold higher in the CARM treatment). We hypothesized that CARM would increase the diet quality of yearlings by optimizing adaptive paddock sequence and herd rotations based on monitoring data. Grazing season differences for CP were 13-28% higher in the TRM treatment for the 6 years, with significant differences in 3 years (2015, 2016, and 2017). For DOM, grazing season differences were higher in TRM in 4 of 6 years, but were only significantly different in 2015. Across grazing treatments, diet quality declined as the season progressed. Within a grazing season, consumption trends were different between grazing treatments across plant functional groups; however, across the entire grazing season, significant differences in plant functional group diet composition were inconsistent. Adaptive sequencing and rotation of livestock grazing using AMP was unable to overcome diet quality differences that contributed to a consistent 12-16% reduction across years in weight gains of yearling steers in this semi-arid rangeland ecosystem.

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Development and Implementation of an Open-hardware GPS Tracker for Livestock Location Studies

Jason W Karl

University of Idaho, Moscow, USA

Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

GPS-tracking devices are a fundamental technology for quantifying the distribution and movement of livestock across landscapes. While costs of GPS devices have decreased, it is still cost prohibitive to implement a large number of collars per study, or for researchers with small budgets to afford location tracking technologies. The Open-Source Range (OSR) GPS collar was developed to be a low-cost solution to collecting GPS telemetry data for livestock in large rangeland pastures. The primary driver for this project was the need to deploy a large number (>100) of GPS collars to characterize actual herd usage of large landscapes. The basic design philosophy for the OSR GPS collars was to strip out all unnecessary functionality to keep the design as simple, inexpensive, and power-efficient as possible. Ultimately, the initial goal of the project was to develop an open-source Arduino-based GPS tracking device and collar for less than $40 each and that could be easily sourced and constructed. The OSR GPS collar has gone through multiple iterations from initial prototyping to the current version 3 device where the circuit board is produced and assembled overseas, and the final device and housing assembled locally. In this presentation I will describe the process of developing, testing, and implementing the sensor hardware, firmware, batteries, and housings. I will share lessons learned and information for how to get started with open hardware development.

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Visualizing near-real-time and historical rangeland conditions to support adaptive management

Sean Kearney[1,2], Lauren Porensky[2], David Augustine[2], Justin Derner[3]

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Wilcox-Strengthening Collaborations Between Researchers and Stakeholders: Linking Data and Management in Rangelands

Abstract

As rangeland managers seek to accomplish more complex and interconnected objectives, new information is desirable to track progress and adapt to changing conditions across space and time. We present on work from the shortgrass steppe in northeastern Colorado to map near-real-time and historical rangeland conditions using satellite imagery. Specifically, we provide examples of how maps of standing biomass, forage quality, vegetation cover and phenological state (e.g., live vs. senesced) can support adaptive management and monitoring activities. Examples address a range of management-related questions including: When and where might a rotationally grazed herd be moved to capitalize on changing forage quantity and quality? How well can maps of forage conditions predict livestock performance and foraging intensity? Where do we expect to find suitable habitat for ground-nesting birds? Through these examples, we discuss how the multi-stakeholder Collaborative Adaptive Rangeland Management (CARM) project led to the development of these map products, as well as the importance of long-term ground datasets for producing maps that are accurate from year-to-year. We also discuss how interactive visualization tools can complement on-the-ground knowledge, and the opportunities and challenges of web-based tools that can provide direct data access to stakeholders.

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Honey Bee Use of Shelterbelt Tree and Shrub Plantings in the Northern Great Plains

Hailey Keen[1,2], Benjamin Geaumont[2], Torre Hovick[1], Clint Otto[3], Jason Harmon[1]

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Poster

Abstract

Global pollinator declines are affecting both native and managed bee species. Declines in managed honey bee populations are particularly concerning in the Northern Great Plains, the leading region for honey production. Most beekeepers transport their honey bees to the region every spring to build their colonies and produce honey. During this time, early-season resources are critical. Beekeeper returns to the region align with the flowering of various trees and shrubs planted within shelterbelts, tree plantings installed to reduce wind and soil erosion. Therefore, shelterbelts may provide essential resources for honey bees and fill a forage gap. However, limited research has been conducted on early-season foraging and the utilization of resources within these shelterbelts by honey bees. In this study, we identified early-season honey bee-collected pollen to understand the use of shelterbelt resources after returning to the region. Using pollen traps, we collected pollen samples weekly at 15 apiaries in western North Dakota during May and June of 2020. We tested samples to determine which plant families they originated from, and compared these families with the weekly availability of flowering trees and shrubs. We found the highest pollen use of Asteraceae, Brassicaceae, and Fabaceae families. Our results show that in the early growing season, honey bees collected large amounts of pollen from Caprifoliaceae, Convolvulaceae, Cyperaceae, Oleaceae, Pinaceae, and Poaceae. In these months, 35% of the families used by honey bees included mostly trees or shrubs. Our findings suggest the importance of Asteraceae species, specifically dandelions (*Taraxacum spp.*), for honey bees in May and the use of various shelterbelt species including common lilac (*Syringa vulgaris*), honeysuckles (*Lonicera spp.*), and pines (*Pinus spp.)* for supplemental resources. These results can help influence future shelterbelt planting in the Northern Great Plains to make this a more beneficial early-season resource for introduced and native pollinators.

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Juniper's Lasting Legacy: Observing Soil Infiltribility 10 Years After Tree Death

Austin R. Kelly, Pedro Leite, Bradford Wilcox

Texas A&M University, College Station, USA

Poster

Abstract

Woody encroachment has predominated many rangelands across North America, causing significant changes in biological, physical, chemical, and hydrological characteristics often allowing an alternative stable-state to become predominate. Junipers (*Juniperus* spp.) are some of the most widespread perpetrators of encroachment across the Great Plains, gaining a foothold by converting acres of grasslands and savannahs into closed-canopy woodlands due to lack of fire and severe historical overgrazing, particularly in the Edwards Plateau region of Texas. While much research has documented the impact that living trees have on their surroundings, such as increases in soil infiltration and organic matter, much less has been documented about the legacy that these trees leave after death or removal, especially in the semi-arid soils in which they preside. In this study, juniper trees at the Sonora Experiment Station, that were determined to have been killed in 2011, presumably by drought, were chosen as our target plants. Data collection points were chosen both under the once-living canopy of the target plant and in the herbaceous intercanopy, where no trees have been known to grow. Infiltrability of these points was measured using a modified form of the Beerkan method and penetration resistance (a parameter of soil compaction) was measured using a soil penetrometer. The findings determined that topsoil infiltrability was significantly higher under canopies of dead trees than that of the herbaceous intercanopies. Soil penetration resistance was significantly higher in the intercanopies than under the dead trees' canopies. These results suggest that even 10 years after a juniper's death, the positive influences on soil health properties of less soil compaction and increased soil infiltrability stay prevalent, and even rival the rates of living trees. In turn, the process of juniper encroaching and being killed through management practices may be an effective method of soil health improvement.

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Capacity Building For Community Based Conservation and Rangeland Management: Successes and Challenges from the Ewaso Ecosystem of Northern Kenya

David Kimiti

Grevy's Zebra Trust, Nanyuki, Kenya

Contributed Oral Presentation

Abstract

The global wildlife conservation movement has often focused its efforts to protect large, charismatic, or endangered mammals in Africa through increasing security against poaching and improving breeding conditions. In these programmes, community-led habitat management and improvement is often overlooked. The Grevy's zebra is one of Africa's most endangered large mammals and has undergone one of the most substantial reductions of range of any African mammal, declining from an estimated 15,000 individuals in the 1970s to approximately 3,042 individuals in 2018. Land degradation through overgrazing by livestock continues to reduce the productivity potential of Kenya's northern rangelands, which support over 90% of the entire population. It is therefore clear that rangeland health will play a critical role in securing the future for Grevy's zebra, as well as other wildlife and pastoral livelihoods on this landscape. The Grevy's Zebra Trust works with local communities in the Ewaso ecosystem in Northern Kenya to rehabilitate and manage these community-owned rangelands. As part of this programme, the Trust trains community Ambassadors, Scouts, Warriors, and Grassland champions to monitor their wildlife numbers through a Mobile platform, SMART, as well as monitor the changes in their grassland productivity using a Mobile phone application, LandPKS. Our presentation will outline the design and current activities of GZT's Rangelands Programme, the various technological tools we utilize to monitor and evaluate our objectives, and the impact our programmes have had on rangeland productivity. We show that the most successful rangeland interventions have to incorporate indigenous cultural structures and systems in their design phase, and that technology can be used to monitor and evaluate the short and long term impacts of these interventions.

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Fire Drives Patch Selection by Cattle in a Patch-Burn Grazing System

Esben Kjaer[1], Ryan Limb[1], Michael Hamel[1], Benjamin Geaumont[2], Jason Harmon[1], Torre Hovick[1], Kevin Sedivec[1,3]

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Contributed Oral Presentation

Abstract

Patch-burn grazing has become a common practice in range management in the southern Great Plains but is fairly new to the Northern Plains. Patch-burn grazing increases landscape-level heterogeneity on rangeland, promoting biodiversity and reducing the effects of drought on livestock performance. One of the key assumptions of the theory behind patch-burn grazing lacks support that there is no direct empirical evidence that animals preferentially consume more biomass on recently burned areas than other areas found within the pasture or unit. To test this concept, we collected data on the utilization rate of patches by cattle in a patch-burn grazing strategy and compared them to utilization rates in a traditional season-long grazing strategy void of fire from 2018 to 2020. We found that consumption of plant material by cattle was highest (approx. 10 – 20%) in recently burned patches and decreased as time since fire increased ($p < 0.05$). We also found that in every year except 2019, patch utilization in patch-burn grazing increased following fire. However, patch utilization in season-long systems stayed relatively consistent across years such that patches in season-long pastures with high utilization (> 60%) one year had high utilization in subsequent years. These results suggest that in the absence of additional disturbances, grazing patterns from previous years drive patch selection and grazing patterns in the current year. However, disturbances that remove dead plant material exposing new green growth over-ride the influence of previous grazing patterns, driving patch selection. Our results provide empirical evidence that disturbances, such as fire, have a stronger influence on site selection by cattle than do previous year's grazing patterns. This work is among the first to provide evidence of selection for recently burned areas by cattle through the consumption of plant material.

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Management Strategies to Reduce the Thatch Layer Created by an Invasive Grass Species

Esben Kjaer[1], Ryan Limb[1], Benjamin Geaumont[2], Jason Harmon[1], Torre Hovick[1], Kevin Sedivec[1,3]

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Poster

Abstract

Kentucky bluegrass, one of the most influential exotic grasses in the northern Great Plains, invades native communities and suppresses native species. This process is primarily achieved through the build-up of a thatch layer that alters water infiltration and prevents seed recruitment and germination by native plants. While manual removal of Kentucky bluegrass thatch can reduce the impact of Kentucky bluegrass, it is an impractical method at large scales and potentially damaging to the surrounding plant communities. We examined alternatives to manual thatch removal in the form of conventional rangeland management techniques, such as patch-burn grazing, rotational grazing, and season-long grazing. To test these different strategies, we measured thatch depth at multiple points across different pastures invaded by Kentucky bluegrass in southcentral North Dakota. Each pasture was managed with either patch-burn grazing, modified twice-over rest-rotational grazing, or season-long grazing. Both the patch-burn grazing and the modified rotational grazing pastures were designed to increase landscape-level heterogeneity. However, our modified rotational grazing was designed to create heterogeneity through differential grazing intensities as opposed to fire. We found no difference in thatch depth between rotational and season-long grazing (2.59 and 2.60cm respectively, $p>0.05$) However, pastures managed with patch-burn grazing had a thinner thatch layer (1.79cm) than those managed with either rotational or season-long grazing ($p<0.05$). Thatch depth did not vary consistently with either time since fire or grazing intensity. This suggests that a single fire followed by grazing can halt thatch accumulation for several years by removing dead plant biomass and that grazing alone, even at high intensities, had no effect on Kentucky bluegrass thatch. These results suggest that patch-burn grazing is an effective tool in reducing thatch accumulation and may lessen the impact of Kentucky bluegrass on prairies. More research is needed to demonstrate how a reduced thatch layer impacts these prairie communities.

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Promise, Peril and Paths Forward for Payments for Rangeland Ecosystem Services

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Payments for Ecosystem Services (PES) programs promised to “rescue” the environment. Ecosystem services (ES) are benefits from nature to people. PES involve the recipient of a benefit from nature, e.g., downstream users of river water, making a payment or series of payments to the providers of that stream of benefits, e.g., upstream landowners who maintain flows of clean water. Insight from social sciences beyond economics can help PES program designers avoid common pitfalls. These problems include avoiding new negative externalities, which are side-effects of economic activities that impact an uninvolved third party. The issue of misplacing rights and responsibilities entails shifting the responsibility of caring for the ecosystem service to those paying for it. Another PES challenge entails undermining intrinsic stewardship motivation, e.g., caring for land because it’s the moral thing to do rather than because of a payment conditional on that care. PES programs can suffer from prioritizing efficiency at the expense of social equity and excessive monitoring burdens. PES have also been critiqued as inadequately private solutions, i.e., commodifying ES, to a public issue, i.e., environmental quality may impact more than a cohesive set of stakeholders. Potential tools for redesigning PES programs or building new ones that avoid these pitfalls include developing a suite of ES targets, not just one. Designing flexibility into activities funded by the PES program and payments for stewardship, not simply avoided degradation, may help as could co-payments and in-kind payments. Rewarding existing good land stewards, peer monitoring and participatory PES program design processes could overcome some of these pitfalls. Finding socially acceptable ways of enhancing carbon sinks to address the climate crisis could entail PES programs. These tools could help engage drylands stewards to store carbon with locally-adapted approaches that accommodate livelihoods and support biodiversity while respecting social and cultural values.

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Developing state-and-transition models using national ecological monitoring data sets

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

State-and-transition models (STMs) describe persistent plant communities and ecological conditions that are possible (the 'state') within a given abiotic setting (e.g., ecological site) and the drivers that can cause a shift in communities between states (the 'transitions'). Within this conceptual framework, transitions between states are not easily reversed under typical management. STMs are widely used to guide and inform land management decisions, but they are often based on expert opinion and quantitative and qualitative surveys rather than rigorous scientific analysis of broadscale quantitative ecological measurements. Data-driven STMs have been developed for a number of individual ecological sites, but these efforts typically involve intensive field sampling campaigns that are difficult to expand beyond the targeted ecological site due to time and resource requirements.

We leveraged newly available regional maps of Ecological Site Groups (ESGs) for the Upper Colorado River Basin, along with large national databases of field plots that measure vegetation and soil characteristics (collected by the Bureau of Land Management, Natural Resources Conservation Service, and National Park Service), to design a repeatable workflow for developing data-driven STMs for ESGs. We used indicators of ecosystem function, such as observed and modeled soil erosion, and documented transition drivers from existing STMs for component ecological sites to further refine state and transition concepts. We demonstrate this workflow on the Semi-arid Warm Sandy and Loamy Upland ESG in the Upper Colorado River Basin. The workflow described here can serve as transportable framework for development and documentation of data-driven STMs for ESGs regionally and nationally.

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Rangeland management from a designers perspective: potentials for collaboration

Emily Knox

Auburn University, Auburn, USA

Contributed Oral Presentation

Abstract

Landscape architects can trace a complicated history in the western American landscape. Our record is deep and legible in the National Park system, as are more recent entanglements with the rivers, reservoirs and infrastructure that lace the largely arid landscape. But, we have a negligible record in the 330-million acres of public rangeland that weave together these far-flung figures. These working landscapes have always been approached through the lens of management and almost never through the lens of design.

Outmoded management strategies grounded in the rigid tenets of progressive conservation have had a variety of well-documented, adverse impacts in rangeland landscapes, many still legible today. The most devastating impact, from the perspective of someone trained in design, is the many ways in which that ideology stifled creativity in the people managing these diverse landscapes. Reframing rangelands as designed, not through typical modes in which a building is sited or a tree planted but by hundreds of years of interaction between animal and terrain guided by cultural practices, ecological conditions, and political oversight, may create opportunities for that creativity to return, creating space for novel approaches and outcomes.

First, this presentation will argue that, though perhaps not intentionally, those working in rangeland landscapes are already engaging in acts of design everyday. Second, it will present how landscape architects have played significant roles in productively engaging similar landscapes, like rivers, coasts and infrastructures throughout the country and world. Finally, through a presentation of case studies and drawings, it will suggest how the tools of the designer - specifically drawing, mapping and modeling - might present fruitful opportunities for collaboration with ranchers, scientists and non-profit organizations as they seek out novel approaches to engage these vast, complex landscapes.

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Drought and Fire Effects on a Kentucky Bluegrass Invaded Northern Great Plains Grassland

Chantel Kobilansky, David Toledo, John Hendrickson, Andrew Carrlson

USDA-ARS-NGPRL, Mandan, USA

Poster

Abstract

Drought and Fire Effects on a Kentucky Bluegrass Invaded Northern Great Plains Grassland

Chantel Kobilansky, David Toledo, John Hendrickson, Andrew Carrlson

The northern Great Plains have seen an increase in Kentucky bluegrass (*Poa pratensis* L.) since the early 1990s. This species is now present throughout the northern Great Plains and has become dominant in many grasslands. Despite the extent of invasion and the impact of Kentucky Bluegrass, there is limited information regarding impacts of long-term drought and prescribed fire impacts on plant communities invaded by Kentucky bluegrass. We report on a Rain Intercept Shelter experiment that was established in 2016 at the Northern Great Plains Research Laboratory in Mandan, ND to assess how plant community composition of bluegrass invaded grasslands are affected by drought and burning. Drought treatments were designed to intercept 30% and 60% of precipitation and fall burning treatments were implemented in three of the 5 years of the experiment. Stand counts and canopy cover estimates were taken twice a year. Our results show that prescribed fire tended to reduce cover of Kentucky bluegrass and increase cover of native grasses. The combination of drought and burning appears to also favor native plant species. Results suggest that potential changes in climate and/or reintroduction of prescribed fire into this grassland system can alter the trajectory of invasion of Kentucky bluegrass.

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Incorporating Process-Based Erosion Model Erosion and Water Budget Risk Statistics into State and Transition Models (STMs)

Michael Kucera

USDA_NRCS, Lincoln, USA

Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

The presentation will focus on incorporating erosion and water budget risk statistics into state and transition models (STMs). Process based erosion models Wind Erosion Prediction System (WEPS) and the Water Erosion Prediction Project (WEPP) allow conservation planners to examine water budget (runoff, irrigation, plant transpiration, infiltration and evaporation), wind erosion (saltation, creep, and PM10) and water erosion (soil detachment, sheet and rill erosion, sediment transport, and sediment deposition) estimates over a 100-year simulation period for WEPP and 50-year time frame for each year of the crop rotation for WEPS. Planners can examine how much and how often erosion and water losses depart from the average, thus providing producers and landowners a risk assessment of their chosen management from extreme weather. Clients can base planning decisions utilizing current climate data projections to determine how effective conservation systems during years of drought and heavy rainfall based on risk rather than long-term annual average.

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Potential impact of compost amendments and associated microbial diversity on dry rangeland soils

Steve Kutos, Eva Stricker

University of New Mexico, Albuquerque, USA

Poster

Abstract

Dry rangelands in the southwest United States have been affected by both overgrazing and climate change. These disturbances have led to ecosystem alterations including increased ground temperatures, soil degradation, and shifted vegetation patterns. Utilizing organic amendments such as compost might be one way to buffer these effects to provide healthier soils, ecosystem resilience, and ensure rancher livelihoods. Compost is a slow-release nutrient fertilizer that also introduces microorganisms expected to provide vital ecosystem services. These microorganisms can be crucial to plant productivity, survival, and nutrient acquisition, and they may also be important for long-term carbon storage. We set up a field experiment with nine plots in the northern Chihuahuan Desert. In Spring 2021, we added compost from biosolids or manure to six of these plots. We hypothesized that the differences in microbial communities in each compost may affect soil characteristics differently. In spring 2021 we sampled soils in these plots to classify soil characteristics and phospholipid fatty acids (PLFA) biomarkers (a representative view of the microbial community). PLFA data show distinct microbial communities between the soil and composts. Both composts had higher bacteria-to-fungi ratios than the soil (compost: ~22:1, soil: ~14:1). Soil microbial biomass was dominated by gram-negative bacteria (~50%) followed by Actinomycetes (21%) and gram-positive bacteria (18%); with lower amounts of fungi (~6%). The biosolid compost had 1.5X more fungal biomass, 2.5X higher gram-negative bacteria biomass, and 4.5X higher gram-positive bacteria biomass than the soil. The manure compost also had a 3.5X higher gram-positive bacteria biomass than soil. In fall 2021 we found that soil aggregate stability increased (1.5X), and soil infiltration rate slightly decreased (1.2X) in either compost addition versus the control plots. Overall, we found compost addition and associated microbial diversity can impact soil characteristics. Next steps include classifying and linking microbial community composition to shifting soil characteristics.

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Methods to Reduce Runoff, Erosion, and Increase Plant Establishment for Pipeline Restoration

Jarrett Lardy[1], Thomas DeSutter[1], Miranda Meehan[1], Kevin Horsager[1], Nathan Derby[1], Aaron Daigh[1], James Staricka[2]

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Contributed Oral Presentation

Abstract

Energy development and construction, specifically construction of natural gas pipelines, has expanded across western North Dakota within the Williston Basin (Bakken and Three Forks formations). This expansion challenges reclamation when vegetative plant establishment is limited post-installation. Limited vegetation establishment increases soil erosion, water runoff, and provides an environment with the potential to allow invasive plant species to encroach, resulting in numerous, expensive attempts of reseeding right-of-ways. This study examines three seed-preparation methods near Williston, ND, and their effects on water runoff, sediment loss, and vegetation establishment under rainfall simulation during a severe drought in a semiarid climate. The treatments used in this study were wood-fiber hydromulch, land imprinting, wheat-straw crimping, the combination of hydromulch and imprinting, and bare ground (control), all on 2% and 5% slopes within the same catena. Rainfall simulations were completed in September 2020, and again in June 2021 to examine the treatments over time. Crimping straw, one the most economical options, was the only treatment which reduced runoff long-term with an equivalent depth of 0.7 cm of water, compared to 1.8 cm of water for the control. However, hydromulch and imprinting with hydromulch were the only treatments which reduced sediment load, both reducing erosion by over 58% when compared to the control. Plant establishment was not significant for any treatment, likely due to the severe drought conditions. Cover is necessary in times of drought when plants fail to establish, with straw crimping being the best option during an extended drought.

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Effects of Cattle Trampling on Sclerocactus wrightiae

David Lariviere, Val Anderson, Robert Johnson

Brigham Young University, Provo, USA

Poster

Abstract

Wright fishhook cactus is a small barrel cactus found endemically in south-central Utah (Benson, 1966; Welsh et al., 2003). Sixteen years after its discovery, in October of 1979, the U.S. fish and wildlife service (USFWS) labeled the cactus an endangered species, siting its very limited range, population size, and the prevalence of poaching by international cactus hobbyists (USFWS 1979). Since the time of its listing, impacts of the presence of cattle have also been identified as an existential threat to the species (Spector, 2013; USFWS 1985, 2005).

The effects of cattle trampling on endangered plants have been a management concern since the late 1980's (Schemske et al. 1994). Cactus in particular appear to be a particularly sensitive group to this (Godinez-Alvarez et al., 2003). However, the response of cacti to the presence of cattle is not clean cut. Saguaro (*Carnegiea gigantea* Engelm) and a species of pincushion cactus (*Mammillaria dixanthocentron* Backeb. ex Mottram) have been shown to decrease in population size in the presence of cattle (Ureta and Martorell, 2009) (Pierson et al., 2013). However, the common beehive cactus (*Coryphantha werdermannii* Boed.) and an endangered pincushion cactus (*Mammillaria hernadezii* Glass & R.A. Foster) both favored disturbed conditions caused by cattle and increased in their presence (Ureta and Martorell, 2009). While a previous study on Wright fishhook cactus indicated that disturbance had no effect on individual fitness over two years (Bates et. al., 2019). Clearly the response to grazing and disturbance is highly variable among cactus genera and even species. With this study, we seek to understand the response of Sclerocactus wrightiae to cattle trampling.

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Regeneration in plant communities: Unpacking the impacts of drought on seed banks and recruitment in grazed working lands

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University of Colorado, Boulder, USA

O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

The combination of extreme drought and disturbance can lead to amplified risk of vegetative turnover in rangelands – often towards less desirable, short-lived plant species. Plant regeneration likely plays a critical role in plant community response and recovery from drought, but prediction is complex; the supply and fates of seeds in the seed bank may depend on interactions between initial vegetative composition, grazing management, and drought.

In this presentation, we pull together work from several experiments in a semi-arid rangeland (Boulder, CO, US) to ask: 1) How do seed banks respond to combined drought and grazing pressures?; 2) Which species are most likely to recruit quickly from the seed bank under drought (and why?); and 3) What could these shifts in seed banks and recruitment dynamics mean for rangeland responses to drought?

Key results. Seed banks were dynamic (both within and across years), but experimental drought and grazing had clear impacts on different aspects of seed bank composition. Even though the vegetation is perennial-dominated, drought was associated with rapidly increasing proportions of annual-biennial seeds (in some cases, over half of the seed bank). At the same time, results from a related common garden study suggest that species with large and non-dormant seeds – including several short-lived exotic species – have higher recruitment probabilities from seed even when drought is a limiting factor. These mechanisms could explain the broader shifts in community composition that we observed under combinations of grazing and drought.

Conclusions. Regenerative processes will be critical in anticipating the responses and recovery of rangeland plant communities in a drier future. By understanding drought-related mechanisms of seed bank turnover and recruitment (especially in the context of grazing), we can make smarter decisions about how we manage and restore for the future of rangelands.

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Wildfire Fuel Mapper - resources to help landowners reduce fire hazards, manage vegetation and build rangeland resilience

Stephanie Larson

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

Four years after catastrophic fires that changed Sonoma County, California forever, the University of California Cooperative Extension (UCCE) developed and launched the Wildfire Fuel Mapper (WFM), wildfirefuelmapper.org, a comprehensive toolkit to assist landowners in planning and implementing vegetation management. The WFM provides northern California landowners and land managers with a set of tools, resources, and information to help reduce fire hazards, manage fuels and protect people, ecosystems, and infrastructure. Landowners use the WFM to learn about wildfire mitigation and the long-term rangeland resiliency; empowering them to take an informed and proactive approach to preparing for wildfire. The WFM creates report based on a set of static maps, assisting users to better understand their land's assets and assess fire hazard based on the different landscape elements. These map elements include vegetation type and density, physical topography, and fuels.

Managing our landscapes is a critical climate adaptation and mitigation strategy; not only reducing wildfire risk and related GHG emissions, but also promoting healthy rangelands that can continue to sequester carbon, capture water and provide essential ecosystem services. The WFM allow landowners to prioritize areas for vegetation management practices that will lead to improved forage production, wildlife habitat, carbon storage and ecosystem benefits. A subsequent benefit to the reduction of GHG emissions emitted during catastrophic wildfires.

The WFM toolkit connects landowners with resources, professionals, specialists, and funding opportunities for vegetation management practices. Future plans include expanding to other regions, building a connected network of managed, healthy rangelands that are resilient to future fires. Large-scale regional project across multiple counties ensures greater impacts in terms of GHG mitigation, carbon sequestration, and overall rangeland healthy and long-term ecosystem services. UCCE will monitor, measure, and quantity environmental and climate impacts of vegetation management strategies that reduce fire hazards, manage vegetation and build rangeland resilience.

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Predicting cheatgrass and bulbous bluegrass green-up using ground measurements and remote sensing applications in eastern Idaho

Daniel Lauritzen[1], April Hulet[2], Karen Launchbaugh[3], Jim Sprinkle[3], Jason Karl[3], Sergio Arispe[4], Eric Winford[1]

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Poster

Abstract

The sagebrush (*Artemisia* ssp.) steppe ecosystem is one of the most endangered ecosystems in the western U.S. due to multiple threats including non-native annual grass invasion and increased frequency and size of wildfires. Livestock grazing has been suggested as a tool to reduce fine fuels and promote sustainable native plant communities on rangelands, however, proper stocking density and timing of livestock grazing is critical. Predicting a time when livestock grazing is applied to target non-desirable grass species such as cheatgrass (*Bromus tectorum*) and bulbous bluegrass (*Poa bulbosa*) while limiting negative impacts on desirable perennial grasses is needed. Our objective was to predict cheatgrass and bulbous bluegrass green-up using soil moisture/temperature, weather, and remotely sensed imagery. Our study sites are located near Pocatello and Malad City, ID within intact sagebrush steppe communities at 5000ft elevation. At each site, weather sensors and SoilVUE 10 (Campbell Scientific, Inc.) were installed. Wingscapes cameras (Moultrie) were placed at each station and programmed to take 12 megapixel photos with temperature and time imbedded every hour from 6am to 10pm for two months during potential green-up conditions. Near-infrared satellite imagery from Landsat was processed using the NDVI index. Remotely sensed data was compared to ground measurements to assess plant green-up and identify potential metrics (e.g., soil moisture and temperature) that may be beneficial to land owners and management agencies when implementing targeted grazing on cheatgrass and bulbous bluegrass in intact sagebrush steppe plant communities.

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Native black grama (*Bouteloua eriopoda*) and invasive Lehmann lovegrass (*Eragrostis lehmanniana*) response to experimental drought

Erik Lehnhoff, Sherri Buerdsell, Brook Milligan

New Mexico State University, Las Cruces, USA

Poster

Abstract

Global climate change is expected to result in increased temperatures and greater variation in precipitation. In the desert southwest of the United States, climate change may result in drier conditions. Lehmann lovegrass (*Eragrostis lehmanniana*) is an introduced grass from South Africa that has extensively colonized the southwestern US, including black grama (*Bouteloua eriopoda*) grasslands. While both *E. lehmanniana* and *B. eriopoda* evolved in arid conditions, drier conditions may influence this invader-native system in unforeseen ways. Using a combination of precipitation pivot point and drought sensitivity analysis, we compared responses of *B. eriopoda* and *E. lehmanniana* to altered precipitation regimes including long-term drought treatments in the northern Chihuahuan Desert, New Mexico. Precipitation pivot point is the critical point in precipitation below which plant percent cover decreases and above which it increases, and drought sensitivity is the change in area covered, mm^2, per change in precipitation, mm. These measures elucidate the direct response of biomass to drought. Mean precipitation pivot points based on monsoon precipitation (July 1 – September 30) were 62.5 mm and 63.7 mm for *B. eriopoda* and *E. lehmanniana,* respectively. Estimated mean annual (October 1 – September 30) precipitation pivot points were 108.6 mm and 108.5 mm for *B. eriopoda* and *E. lehmanniana,* respectively. *Bouteloua eriopoda* mean drought sensitivity was 4.71 $mm^2\ mm^{-1}$ and *E. lehmanniana* mean drought sensitivity was 1.56 $mm^2\ mm^{-1}$. Results suggest that despite *E. lehmanniana*'s reputation as being invasive in the arid southwest, it is unlikely that extended drought will benefit *E. lehmanniana* over *B. eriopoda*. Rather, both species may decline under extreme drought.

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Woody detritus decomposition in a shrub-invaded Sonoran Desert grassland

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Poster

Abstract

It is uncertain whether shrub-invaded grasslands are a net carbon (C) source or sink. Much of this uncertainty reflects limited understanding of how shifts from grass to woody plant dominance influences organic matter decomposition, particularly the woody detrital (WD) component. Furthermore, “brush management” in shrub-encroached areas generates large pulses of WD inputs whose fate is largely unknown. Shrub-invaded grasslands are also high flux environments that experience lateral translocation of soils via wind and water. WD is thus distributed across diverse microclimatic settings that influence its decomposition. We aimed to quantify how WD size influences its rates and dynamics of decomposition in microhabitats with contrasting radiant energy regimes and levels of soil cover. A factorial field experiment tested two competing hypotheses: that WD decomposition would occur more rapidly 1) in shrub patches where soil nutrients and microclimate are more favorable to decomposer communities or 2) in inter-shrub areas where it is exposed to higher temperatures and levels of UV radiation.

Wooden dowels in three diameter classes (0.8cm, 1.6cm, and 2.9cm) were placed on the soil surface or buried to a depth of 0.5 cm (to mimic soil-litter mixing) beneath shrub (*Prosopis velutina*) canopies and in intercanopy areas. Mass loss was influenced by soil coverage, WD diameter, termite activity, and time ($P < 0.0001$). Termite activity was the major contributor to mass loss, especially in subcanopy, buried placements. Decomposition was highest beneath shrub canopies (mean $k = 0.31y^{-1}$) and lowest in open intercanopy areas ($k = 0.15y^{-1}$), and higher for buried samples ($k_{\text{buried}} = 0.24\ y^{-1}$) than for samples on the soil surface ($k_{\text{surface}} = 0.21\ y^{-1}$). Landscape- and broader-scale assessments of WD decomposition, C-flux and turnover in shrub-invaded grasslands will need to include a spatial weighting of shrub cover and its change through time and rates of soil-litter mixing.

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Woody plant encroachment of grassland and the reversibility of shrub dominance: Erosion, fire and feedback processes

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Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

Many grass-dominated ecosystems in dryland regions have experienced increasing woody plant density and abundance during the past century. In many cases, this process has led to land degradation and declines in ecosystem functions. An example is the Chihuahuan Desert in the southwestern United States, which experienced different stages of shrub encroachment in the past 150 years. Among a wide variety of mechanisms to explain the grass-shrub transitions in this dryland system, soil erosion (both wind and water) and fire are particularly well studied. This paper synthesized recent developments on the drivers and feedbacks in the process of shrub encroachment in the Chihuahuan Desert through the intercomparison of two Long Term Ecological Research (LTER) sites, namely Jornada and Sevilleta. Experimental and modeling studies support a conceptual framework which underscores the important roles of erosion and fire in woody plant encroachment. Collectively, research at the Jornada LTER provided complementary, quantitative support to the well-known fertile-islands framework. Studies at the Sevilleta LTER expanded the framework, adding fire as a major disturbance to woody plants. Conceptual models derived from the synthesis represent the general understanding of shrub encroachment that emerged from research at these two sites, and can guide management interventions aimed at reducing or mitigating undesirable ecosystem state change in many other drylands worldwide.

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Estimating rangeland herbaceous biomass in west Texas using high spatial resolution images

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Poster

Abstract

Rangeland herbaceous biomass is critically important in livestock production and fire management, and its accurate estimation is essential to land managers for rangeland management. However, it is challenging to accurately estimate rangeland herbaceous biomass as rangelands are heterogeneous and their productivities can be highly variable. In this study, higher spatial resolution (0.23m) remote sensing images were used to estimate the herbaceous biomass in a 5000-acre research ranch in west Texas. Original bands including blue, green, red, and near-infrared bands, and the derived spectral indices such as Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI), Modified Soil Adjusted Vegetation Index (MSAVI), and Optimized Soil Adjusted Vegetation Index (OSAVI) were used to indicate rangeland conditions. Mean and variance of original bands with 5*5 moving window were used to extract vegetation texture by using Gray-Level Co-Occurrence Matrix (GLCM) analysis. The remote sensing image was first classified to extract herbaceous vegetation in rangelands, and then the herbaceous biomass was estimated using the random forest machine learning algorithm. 70% of the field samplings were used as training data, and 30% of those were used for testing the model. Preliminary results showed that the overall accuracy for image classification was around 95%. More than 75% of the variations in rangeland herbaceous biomass can be explained by the model. Vegetation indices, especially NDVI and OSAVI, performed better than original bands and textural indices in estimating rangeland herbaceous biomass. These findings highlight the potential of applying the random forest algorithm for rangeland biomass estimation and provide support for evaluating rangeland conditions.

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An instrument for objectively characterizing livestock grazing management systems

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Contributed Oral Presentation

Abstract

The ability of alternative grazing management approaches to maintain or enhance rangeland productivity and soil health continues to be a vigorously debated topic in the literature (Briske et al. 2008; Augustine et al. 2020; Mosier et al. 2021; Teague and Kreuter 2020). Most grazing management studies have characterized grazing systems using grazing intensity parameters such as stocking rates, stock density, number of paddocks, and frequency of movement between paddocks (Roche et al. 2015). However, such descriptors fail to adequately quantify management complexities inherent in dynamic grazing systems. In addition to regulating grazing intensity, the use of adaptive management is equally critical to the success of grazing management under changing environmental conditions (Williams et al. 2010; Teague et al. 2013). However, like grazing intensity metrics, user-friendly management adaptivity metrics to compare alternative grazing management strategies are lacking. The lack of objective metrics and guidelines for accurately distinguishing alternative grazing management strategies may be a significant explanatory factor for the conflicting results of past grazing management studies. My research aims to develop an instrument consisting of novel metrics for grazing intensity and management adaptivity that is capable of distinguishing between various grazing management strategies. The instrument will allow researchers to more precisely define the level of grazing intensity and management adaptivity being applied in livestock grazing management systems, which will enable researchers to more accurately evaluate the biophysical implications of various grazing management strategies. The implementation of this novel characterization tool in research projects will also lead to more robust evidence indicating what specific levels of grazing intensity and management adaptivity are necessary for maintaining or enhancing rangeland resilience, soil health, ecosystem services and sustained ranch profitability. Finally, the dissemination of validated instrument will enhance communication among scientists, extension personnel, and producers regarding grazing management practices.

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Watershed rehabilitation using rainwater harvesting and shrub establishment methods in Northern Afghanistan

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Poster

Abstract

Watershed rangelands in Northern Afghanistan provide various ecosystem services that support the livelihoods of local people, but they are now highly degraded essentially due to the continuous high grazing pressure and recurrent droughts. Effects of shrub establishment method enhanced by water harvesting techniques to rehabilitate degraded rangelands have not been well addressed. Therefore, the objective of this study was to evaluate the impact of direct seeding and transplanting of seedlings in combination with semi-circular bunds on growth, yield, and survival rate of four shrub species (*Atriplex halimus*, *Atriplex nummularia*, *Atriplex lentiformis*, and *Maireana brevifolia*). The results showed that growth attributes and biomass production of shrubs were consistently greater in the transplanting compared to direct seeding. On average, the plant length, width, height, volume, cover, and biomass production of transplanted shrubs were greater than direct-seeded shrubs by 24.3, 8.6, 8.7, 121.5, 13.8 and 34.1%, respectively. Transplantation of seedlings improved the biomass production and growth particularly for *A. nummularia* and *A. halimus*. Biomass production of transplanted seedlings was highest for *A. nummularia* (1313.5 g DM/plant) and *A. halimus* (800 g DM/plant). There was a strong correlation between plant biomass production and volume ($R^2_{\text{Plant volume}} = 0.88$) for the shrub *A. nummularia*, indicating that plant volume is a key variable for assessing biomass production for these species. Additionally, survival rate was greater (100%) in transplanting versus direct seeding (67%) for Atriplex species. However, the survival rate of *M. brevifolia* was 100% in both planting methods, suggesting that based on better survival this halophytic plant has great potential when restoring degraded rangelands. Collectively, on the basis of better growth rates, yield, and survival, transplanting *A. nummularia* and *A. halimus* may enhance shrub establishment and contribute to the rehabilitation of degraded areas.

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Extreme fire increases American burying beetle abundance in large-scale grasslands and collapsed *Juniperus* woodlands

Alison Ludwig[1], Caleb Roberts[2], Daniel Uden[1], Erica Stuber[3], Dillon Fogarty[1], Dirac Twidwell[1]

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Contributed Oral Presentation

Abstract

Woody encroachment is listed by the NRCS as one of the leading threats to wildlife conservation in the Great Plains. The federally-threatened American burying beetle (*Nicrophorus americanus*) represents one of those species imperiled by woody encroachment, yet no scientific research has shown successful management to increase beetle populations threatened by woody encroachment. In Nebraska, the Loess Canyons Experimental Landscape was formed in 2005 to restore grasslands and aid in the conservation of the American burying beetle. This long-term experimental landscape was established to improve the distribution and availability of grassland habitat, prevent habitat loss associated with woody encroachment by *Juniperus virginiana*, and prevent reductions in American burying beetle populations. Using 13 years of annual beetle survey data and a multi-scale landcover dataset, we determine the distribution, abundance, and habitat preferences of the American burying beetle in the Loess Canyons. A Bayesian N-mixture model was used to quantify whether population abundance trends are meeting conservation objectives and a Bayesian latent indicator scale selection (BLISS) method was used to determine at which scale landcover covariates most influenced American burying beetle abundance. American burying beetle populations increased 55% in the Loess Canyons over the timeframe of this study. Populations were most abundant in areas of high perennial grass and forb density that had been restored with prescribed fires. Beetles had strong negative associations with cropland cover up to 0.5% and tree cover greater than 10%. The Loess Canyons Experimental Landscape provides the first evidence showing increased population responses of the American burying beetle resulting from large-scale ecological restoration efforts with fire. Future conservation outcomes may be reliant on large-scale conservation of intact grassland habitats threatened by woody encroachment.

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How the Addition of Compost to Arid Soil Can Improve Plant Growth

Jared Luna, Steve Kutos, Eva Stricker

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Poster

Abstract

It can be difficult to grow food in places that are becoming more arid due to climate change, so managers need tools to improve plant productivity. In an effort to understand how plant growth is affected by soil amendments in desert rangelands, we developed a study to test the use of compost additions to dry rangeland environments. We selected three ranches across New Mexico ranging from a Chihuahuan desert to a southern Rockies grassland. At each site we added two distinct types of compost, one composed of biosolid and the other manure, to six plots ($n=3$) along with three control plots. We collected baseline data for each ranch as well as collected the first-year data for one of the sites. Data showed that aboveground and belowground biomass across each site was significantly different ($p<0.05$). In year-one, we observed a pattern in aboveground biomass in which biosolid compost resulted in triple the amount of plant growth compared to controls. We also observed that plots with manure compost resulted in twice as much aboveground plant growth compared to the control plots. Additionally, this compost was much less varied compared to the biosolid compost ($p=0.16$). We observed similar patterns with belowground biomass as root growth with plots with biosolid compost had 2X more biomass than controls, with manure-based compost intermediate ($p=0.24$). Overall, this data revealed that an influx of nutrient- and microbe-rich soil can have positive effects on high desert plant growth. This is useful for ranchers and other agricultural industries as plant growth necessary for livestock may be increased with the addition of compost.

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Use of Waterboxxes to Improve Shrub Establishment on Mine Land Reclamation Sites

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Session in which you are presenting

Contributed Oral Presentation

Abstract

The reclamation of mines and associated waste sites can improve site aesthetics and ecosystem function. In the mountain west region of the United States, mining activities often occur in zones dominated by native shrub cover. The restoration of shrubs into these areas has proven to be challenging. Outplanted shrub seedlings can experience high mortality during the first year, particularly as plants are stressed during the summer drought period. This study evaluated the use of Waterboxxes® as a tool for establishing seedlings on a reclaimed waste rock pile. The Waterboxx works by harvesting precipitation and humidity from the air into a polypropylene reservoir and then slowly releasing the water to the seedling. We planted 480 seedlings comprised of seven native shrubs, with and without a Waterboxx, in the fall of 2020 and spring of 2021. Species planted included, *Cercocarpus ledifolius*, *Quercus gambelii*, *Rhus glabra*, *Pinus monophylla*, *Atriplex xanescens*, *Purshia tridentata*, and *Rhus trilobata.* Survival was greater with Waterboxxes® than without for five of the seven species. Visually, there was greater growth in six of the seven species. Based on the results obtained, Waterboxxes® appear to be a viable method for most species in improving the establishment of shrubs on mine land overburden sites. Future research is merited for testing this technology on other mine land reclamation areas.

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Tackling the challenges of well pad reclamation with communication and cooperation

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Schladweiler-Reclamation and Restoration Issues in Arid Environments of the Southwestern United States

Abstract

Achieving successful reclamation following oil and gas development in the western US is a critical land management action for ecosystems, industry, and the American public, although it can be challenging, costly, and protracted. These efforts are made difficult by dry conditions, challenging soils, heterogeneous landscapes, competing multiple uses, and a complex and variable set of regulations and management objectives. Currently, reclamation monitoring and "success" standards can vary greatly across BLM offices, resulting from vague policy and guidance, as well as unique land use plans associated with each office. In the past year, scientists at the USGS have drawn on the practical expertise of staff from the BLM field offices to address specific reclamation needs. The result of this communication and cooperation was the development of two unique projects. For the first project we quantified a suite of plant, soil, and landscape measurements, from a chronosequence of ~200 plugged and reclaimed well pads on BLM land, to understand the degree of ecological recovery of sites from each field office. The second project was the creation of a handbook that includes guidelines for surface management of oil and gas development, including operations, reclamation standards, and monitoring methods. Together, these projects will establish the current state of reclamation success for each field office and will create a consistent and standardized workflow for oil and gas reclamation, including clearly defining the reference used to create ecologically relevant benchmark standards. The joint effort to improve oil and gas reclamation monitoring is not only essential to meet the BLM's mission to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations, but will also enhance responsible and effective land management practices.

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Quantifying the Impact of Pinyon-Juniper Removal on Curl-Leaf Mountain Mahogany Stands and Potential Mule Deer Habitat

Alexa Lyons, Devon Snyder, Jason Gundlach, Tamzen Stringham, Kelley Stewart, Franco Biondi

University of Nevada, Reno, Reno, NV, USA

Poster

Abstract

Curl-leaf mountain mahogany (*Cercocarpus ledifolius*), a widespread species in Nevada, provides critical winter habitat for mule deer (*Odocoileus hemionus*) populations and serves to stabilize soil and fix nitrogen on sites where it is common. This evergreen, shrub species has also been commonly used to estimate fire return intervals in shrub steppe ecosystems. Despite its ecosystem value and management utility, there remain several understudied aspects of this species in the Great Basin region. One of these is its response following the removal of singleleaf pinyon (*Pinus monophyla*) and Utah juniper (*Juniperus osteosperma*) in ecosystems where these trees have expanded. Thus, five sites have been established in the Desatoya Mountains in central Nevada, a range representative of the Great Basin, to examine how removal of pinyon and juniper (PJ) may affect the abundance of curl-leaf mountain mahogany, changes in associated understory vegetation composition and quality of mule deer habitat. This body of knowledge will also contribute to the understanding of curl-leaf mountain mahogany ecosystem dynamics and therefore ecological site potential, ecosystem function, response to disturbance and management. State-and-transition models across multiple Major Land Resource Areas in Nevada will be able to be updated with this knowledge. Anecdotal field observations suggest an increase in curl-leaf mahogany recruitment on PJ treated sites and positive responses from understory vegetation. Use of treated sites by mule deer, cattle and wild horses also appears to increase with PJ removal. This study is aimed at providing BLM, other land management agencies, and private stakeholders a better understanding of appropriate management for curl-leaf mountain mahogany including fire rehabilitation, enhancement of wildlife habitat, and livestock grazing.

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Knowledge and Attitudes Toward Rangelands, Woody Encroachment, Grazing, and Fire: Development, Validation, and Use of a Survey

Maria Macik[1], X. Ben Wu[1], Morgan Treadwell[1], Laura Goodman[2], Jenny Keshwani[3], Erin Ingram[3], Bryan Yockers[4], Nate Poling[1]

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Contributed Oral Presentation

Abstract

Student and public knowledge and attitudes toward science have long been measured using a variety of tools, including surveys instruments. Additionally, researchers in specific disciplines, such as physics and chemistry, have designed surveys to measure changes in attitudes and knowledge of disciplinary content. When such surveys are designed with the intent to establish a standardized measure of knowledge and attitudes, rigorous psychometric testing is conducted to validate the surveys. Currently, most methods seeking information about the public's knowledge and attitudes toward rangelands include interviews and surveys. However, few (if any) rangeland attitude and knowledge studies investigate the psychometric properties of the surveys used in data collection. The Prairie Project developed, validated, and used an instrument to measure change in student and public knowledge and attitudes toward rangelands, woody encroachment, grazing, and fire. These concepts were of particular interest because Prairie Project scientists are exploring the impact that strategies, such as multi-species grazing and use of fire, have on the management of woody plant encroachment – a serious threat to the rangelands of the Great Plains. A panel of experts designed a Likert-scale survey as a pre- and post-assessment of attitudes and knowledge toward these concepts. The Prairie Project aims to foster such changes through the use of educational approaches and outreach activities. The survey was pilot tested with both high school and college students across Texas, Oklahoma, and Nebraska. To establish the psychometric validity of the instrument, it was administered to a representative sample of 107 students in high school through college in the pilot testing phase. Confirmatory factor analysis and subsequent refinement by experts yielded a 25-item instrument with five factors and a good statistical fit. Results of the validity testing will be shared, along with the survey instrument.

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Locating Sheep and Shepherds in the 21st Century: An Online Photo Voice Project

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Poster

Abstract

This study uses photo voice, a participatory research method, to consider the question: how do sheep and shepherds fit into the 21st century around the world? Over millennia, range sheep production systems have proven adaptable to dynamic climate and weather, resource stewardship, and social conditions. Today, global rangeland-based sheep systems produce meat, milk, and wool, serve as a tool in ecosystem management, and help sustain rural cultures and livelihoods. However, range sheep and sheep people face old challenges, like animal health management and co-existence with predators -- and new risks, like changes in climate, land use, access to rangelands, global markets and public desires for rangeland management. We conducted a photo voice project with people involved in sheep production through an online survey platform. We used network sampling, and asked self-identified shepherds 18+ years to share and caption up to three photos that best illustrate their perspective on the question "how do sheep and shepherds fit into the modern world?" We also asked them open response questions related to: a) how are sheep and sheep peoples are adapting to new and persistent challenges?; b) what contributions and lessons do range sheep systems offer the rangeland science and management community?; and c) what role do sheep and shepherds have in food systems, biodiversity conservation, and land management for future generations? Participants were asked to share their names in order to receive credit for their ideas. We organize the photos and open responses into qualitative patterns, and discuss the potential of creative, participatory research methods and generative conversation that locate a place for sheep and their people in the 21st century.

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Climate Impacts, Management Challenges, and Opportunities on U.S. Northwest Rangelands

Anna Maher[1], Mary Rowland[2], Chad Boyd[3], Kirk Davies[3], Holly Prendeville[4]

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

Rangeland management may be in a continual state of transition over the next decades or centuries as Earth's climate system transitions to new steady states. The Northwest (NW; Idaho, Oregon, and Washington) region of the western U.S., with its unique combination of wet irrigated meadows and semiarid shrublands, may not be as heavily affected by climate shifts as other areas in the West. Although, transformation has occurred or is occurring in some areas, e.g., establishment of the cheatgrass (*Bromus tectorum* L.)-wildfire cycle and juniper expansion in parts of eastern Oregon and Idaho. Also, managers in the NW that have not yet experienced the climate extremes seen in other areas may have lower adaptive capacity and sense of urgency to invest in options such as increasing water storage capacity and active fuel load management. Cattle producers depend on public land forage and management, with an estimated 85%, 75%, and 50% of the total acres for beef production in Idaho, Oregon, and Washington, respectively, being publicly owned. Many iconic wildlife species, including the Greater Sage-Grouse (*Centrocercus urophasianus*), also depend upon these public lands. Current and expected increases in frequency of more severe droughts and wildfire in the NW exacerbate current public rangeland management issues and increase risks of vulnerable ecosystems crossing ecological thresholds. Successful climate adaptation may require major investments in infrastructure and activities like water storage, new grazing designs, and fuel treatments *before* rangeland managers think they are needed, based on current observations. How can NW rangeland managers embrace this level of uncertainty and change and still be effective? This talk reviews the current state of our understanding of climate change-related impacts on NW rangelands, presents related public land management challenges, and describes opportunities for effective rangeland management in a changing climate.

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Audubon's Conservation Ranching Initiative

Aaron Maier

Audubon Rockies, Fort Collins, USA

Contributed Oral Presentation

Abstract

Grasslands are among the most imperiled ecosystems in the world. Only 20% of our original North American prairies and grasslands remain intact while less than 3% are formally protected. Birds are feeling the effects: America’s grassland birds have declined more than any other bird group in the continent—some species by as much as 80%. Several species of grassland birds are projected to lose half of their remaining populations in the next 25 years. To combat these alarming declines, Audubon is enlisting and assisting America’s ranchers, the stewards of our remaining grassland landscapes, in implementing Conservation Ranching practices on millions of acres of grassland and rangeland in the Great Plains and American West. Audubon is working with producers to develop Habitat Management Plans (HMPs) that implement regenerative approaches to grazing as well as other bird-friendly practices, such as controlling invasive species and native plant interseeding. HMPs aim to meet the needs of the full array of grassland bird species by providing habitat across the ranch. Audubon measures the effectiveness of these practices by monitoring bird diversity and abundance, vegetation change, and soil health. The purpose of this presentation is to present an overview of Audubon’s Conservation Ranching Initiative.

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Cattle or Goats for Control of Problem Plants

Robin Malik[1], Scott Kronberg[2], Kathleen Yeater[3], John Hendrickson[2], Kevin Sedivec[1]

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Contributed Oral Presentation

Abstract

Targeted grazing by livestock can effectively address vegetation management challenges, such as controlling invasive weeds, and has become an increasingly popular management strategy. Our objective was to determine if cattle and/or goats are effective targeted grazers when fed an ad libitum ration of high-quality hay and high-energy grain along with the targeted plants, as high-quality diets may help detoxify chemicals in invasive weeds leading to increased consumption. We explored the intake behavior of goats and cattle with wormwood sage (*Artemisia absinthium*), Canada thistle (*Cirsium arvense*), and western snowberry (*Symphoricarpos occidentalis*). In addition, we evaluated if their intake changed when the plants were offered both individually and simultaneously, potentially indicating preference. Cattle (n=10) and goats (n=10) were each fed 100g of each plant species individually for 3 days (per species) and then fed all species collectively for 3 days. Data was evaluated separately from each animal species due to intakes for cattle were often near zero but very high for the goats (i.e. disparate distributions), thus there were unequal variances from the two species' data. Familiarization intakes of each plant species (when each fed separately) were investigated as a covariate, but did not add information to the statistical models, and the day-to-day effect in the intake study were best fit with independence covariance structures based on comparison of Information Criteria. Cattle consumed more Canada thistle than western snowberry and wormwood sage ($P<0.01$), which they rarely tasted on all three days of the trial. However, goats generally consumed at similar levels and large amounts of all plant species ($P=0.07$). Pre-exposing cattle to the plant species with high-quality hay and high-energy grain did not lead to greater consumption of those plant species; whereas the goats' consumption was higher indicating they will likely control these weeds better.

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Back to the Future: Using Historical Records to Assess Plant Community Shifts Along an Elevation Gradient in a New Mexico Sky Island

Marisa Mancillas, Lara Prihodko, Sara Fuentes-Soriano

New Mexico State University, Las Cruces, USA

Poster

Abstract

Contrasting current and past plant species geographical distributions across elevation gradients is critical for understanding biogeographic response to climate change in the southwest United States. Plants in the southwest may respond differently to increasingly hot and dry conditions as many species already live at their physiological limits. In this study, we will perform the first biogeographical comparison of historical and modern plant species occurrences in the Organ Mountains "Sky Islands" of southern New Mexico. We will combine plant species occurrence records in the Organ Mountains from the past 130 years of herbaria metadata, historical species lists, and agency monitoring data. Occurrence data will be analyzed for trends in landscape position (e.g. elevation, slope, aspect) and plant community dynamics (e.g. richness, abundance, diversity, ecosystem structure). By integrating these data, we expect to reveal trends in elevation shifts among plant species as well as local extirpations, new invasions, sensitive taxa, and threatened populations. This work can inform management decisions, supply models for plant community response to climate change in the southwest, and initiate long-term monitoring of the Organ Mountains through the lens of historical ecology.

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Science co-production to improve reclamation efforts on energy-impacted arid landscapes.

Rebecca Mann[1], Katrina Lund[2], Luke Mattson[2], Michael C. Duniway[1], John Bradford[3], Seth Munson[3], Miguel Villarreal[4], Robin Reibold[1], Sasha Reed[1]

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Schladweiler-Reclamation and Restoration Issues in Arid Environments of the Southwestern United States

Abstract

Much of the drylands of the western US are impacted by current and historic energy and mineral exploration and development due to ongoing public demand and technological advancements. Following the completion of these projects, reclamation practitioners are charged with restoring desirable ecosystems but face a broad suite of challenges. These include the harsh physical and biological conditions of arid landscapes (limited and variable precipitation, low-fertility soils, and non-native species), as well as impacts from extreme disturbance (soil compaction, salinization, depletion of soil biota) and issues of practicality faced by industry (financial barriers, time constraints, limitations in expertise). Although tools and research efforts are emerging to aid decision-making for dryland management, comprehensive field research targeting the specific challenges and opportunities for reclamation on energy-impacted land is lacking. In this presentation, we 1) review the USGS Southwest Energy Exploration, Development, and Reclamation (SWEDR) project, focusing on recent efforts to co-produce research on energy-impacted landscapes throughout the West, and 2) discuss reclamation challenges and potential solutions at a study located on the Uranium Mill Tailings Remedial Action (UMTRA) Project in Moab, UT. This USGS-led effort, in collaboration with the Bureau of Land Management, the US Fish and Wildlife Service, and the Department of Energy, has installed several study sites in Utah, with additional sites anticipated for Colorado and New Mexico. These use a common study design based on the USGS RestoreNet framework to addresses critical barriers to reclamation success (low soil fertility, limited moisture, depleted seedbanks and soil microorganisms), by testing tactics such as seed mixes, surface modifications, and biological and chemical soil amendments. At UMTRA, additional treatments integrate on-site resources, including locally-produced amendments and irrigation. This expanding study network will inform reclamation efforts in western arid landscapes and creates opportunities to share ideas and results among partners within the reclamation industry.

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Changes in Spring Creek Bank Elevation With and Without Grazing

Clayton Marlow

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Contributed Oral Presentation

Abstract

Maintenance or improvement of streambank structure and shape can be considered the over-arching goal of riparian grazing management. Years of research and observation indicate that while trampling damage can be lessened improvements following changes in grazing management are relatively small. This pattern reinforces earlier arguments that measurable improvements in bank stability require frequent if not long periods of rest. However, the most common metric of bank stability has been an assessment of trampling levels (see USDA MIM methodology) rather than actual measurement of change. Rather than using this subjective approach we began tracking actual streambank elevation in November 2018. Treatments were conventional grazing practices and protection from grazing. While grazing occurred annually it varied in intensity and season depending on ranch livestock handling needs. Bank elevation was measured at monumented stations each spring, summer and fall. After 3 years of seasonal monitoring, we found no change in bank elevation attributable to either grazing or protection from grazing. The lack of response may be due to minimal sediment deposition because of little to no over bank flooding within this spring creek channel. This suggests that riparian grazing management for spring creeks may have to be different from conventional recommendations for channels that experience frequent flooding.

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Morphological and nutricional diversity of Wolftail Grass [*Muhlenbergia phleoides* (Kunth) Columbus] populations in Chihuahua, México

Jaime Neftalí Márquez-Godoy[1], Raúl COrrales-Lerma[1], Alan Álvarez-Hoguín[2], Federico Villarreal-Guerrero[1], Eduardo Santellano-Estrada[1], Alfredo Pinedo-Álvarez[1], Carlos Raúl Morales-Nieto[1]

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Contributed Oral Presentation

Abstract

Wolftail grass (*Muhlenberia phleoides*) is a native grass of forage importance in northern Mexico, however, its variability in terms of forage attributes is unknown. The objective was to characterize the morphological and nutritional variability of 30 populations of wolftail grass in the state of Chihuahua. The ecotypes were evaluated ex situ under natural conditions. The characterization was carried out the second year of establishment through the variables, foliage height, plant height, stem density, leaf width, leaf length, tiller diameter, forage yield, leaf-stem ratio, crude protein, lignin, dry matter, hemicellulose and cellulose. Morphological data were analyzed with multivariate techniques through principal components, cluster analysis and multivariate analysis of variance. For the nutritional data, analysis of variance and comparison of means with Tukey's grouping was performed. Finally, a correlation analysis was performed between the morphological and nutritional variables. The first three CPs explained 82.38% of the total variation. Hierarchical cluster analysis identified four large groups, which were different from each other ($P<0.0001$). Regarding the nutritional analysis, populations only presented differences ($P <0.05$) in the crude protein variable. However, the association of morphological and nutritional variables separately did show a correlation ($p <0.05$). The variability that Wolftail grass presented allows us to infer that there is morphological diversity among populations of the state of Chihuahua, however, the nutritional variables did not present a great difference between the populations of this species. It was found that the populations of group I can be considered suitable materials for the production of forage and seed. Regarding the nutritional composition according to the registered values of PC and LIG, it is deduced that wolftail grass can present a forage value that ranges from fair to good, however, it is advisable to determine its digestibility.

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Quantifying the Effects of Rangeland Conversion to Orchards on Species Diversity

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Contributed Oral Presentation

Abstract

Rangeland conversion has been increasing over time, with most land use changes typified by conversion to cropland and urbanization. In California, the Central Valley region has seen the highest conversion rates with over 20,000 acres of rangeland converted every year to cropland between 1983 and 2008. While it is generally recognized that widespread conversion of rangeland impacts ecosystem services, little work has been done to quantify the effects of conversion on specific ecosystem function parameters. This study is part of a larger multidisciplinary project whose goal is to quantify changes to multiple ecosystem function variables, and socio-economic factors driving rangeland conversion. In this part, we sought to measure the differences in plant species diversity between rangelands, and conventional and regenerative almond orchards. We documented plant species diversity by germinating seedbank soil core samples from three (3) rangeland sites, and four (4) almond orchards. Half of the orchard sites were under regenerative production and half conventional. Within each system, we had two age cohorts (old and young trees). Preliminary results showed that species diversity and forage value differed between rangelands, regenerative orchards, conventional orchards, and between young and old orchards. In California understanding species diversity in orchard systems has become more important especially now with the possibility of orchards going fallow due to groundwater limitation because of persistent drought conditions, compounded by the passing of the Sustainable Groundwater Management Act (SGMA) which seeks to curtail unlimited water depletion by restricting groundwater pumping.

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Quantifying the Landscape Configuration and Composition of Tamaulipan Thornscrub in South Texas using UAVs

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Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, USA

Poster

Abstract

Tamaulipan thornscrub is a subtropical semi-arid vegetation community that provides valuable habitat ecologically and economically across south Texas and northern Mexico. The focus of my research is to use unmanned aerial vehicle's (UAVs) to quantify the landscape configuration and composition of Tamaulipan thornscrub across south Texas. My specific objectives are 1) use spectral signatures to identify different brush species present in the vegetation community 2) calculate the composition of brush species found in Tamaulipan thornscrub 3) quantify the landscape configuration across south Texas for Tamualipan thornscrub. For this research, I established two study sites in the Tamaulipan thornscrub range and will fly a UAV with a multispectral camera at two altitudes 50 meters and 100 meters above ground level (AGL). We will also use collector and a handheld GPS unit to identify thornscrub species and their locations in 5 m x 5 m quadrants throughout the sites. Orthomosaics created will be used to determine spectral signatures for specific vegetation present in the thornscrub community. Digital libraries will be created for Tamaulipan thornscrub vegetation, that can be used to classify imagery. These libraries will also be used with Sentinel-2 imagery to classify thornscrub vegetation at a larger scale. Allowing us to quantify the landscape configuration and distribution of Tamaulipan thornscrub across south Texas, this research will show the potential use of very-high resolution imagery acquired from UAVs in rangeland management studies. This is one of the first studies that will help quantify the composition and spatial distribution of Tamaulipan thornscrub in south Texas, which may be used for selecting locations where habitat management practices may be applied to yield better results.

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The Global Rangelands Atlas: a contribution to enhanced commitment to rangelands restoration

Bora Masumbuko

IUCN, Nairobi, Kenya

Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Rangelands are places of inspiration and beauty that cover more than half of all the land on earth and support millions of people known as pastoralists, including herders, shepherds, ranchers and conservationists. Rangelands are highly diverse, they provide high value ecosystem services, including biodiversity conservation, climate regulation, water and food supply. The neglect of rangelands in restoration actions is exposing rangelands ecosystems to more degradation and risks, which can lead to considerable losses of soil organic carbon and contribute to climate change. It is within this context that a Global Rangelands Atlas was launched in May 2021 by partner institutions - ILRI, IUCN, FAO, WWF, UNEP and ILC. The Atlas was primarily developed to document and raise awareness on the importance and on the economic, ecological and social values of rangelands, as well as their different ecosystems. The Atlas provides a big picture of rangelands, showing where in rangelands various values and risks are present; it shows that 54% of all land on earth are rangelands. This will help build momentum for rangeland restoration through concerted action between governments, rangeland users, private investors, scientists and others. It will also contribute to our efforts to protect, restore and increase investments and commitment to rangeland restoration.

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Grasslands in Glacier National Park: Consequences of New and Altered Disturbances

Nicolas Matallana-Mejia, Melinda Smith

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Poster

Abstract

Native grasslands are experiencing the highest rate of conversion to human-dominated use of all biomes, making them the most endangered biome on the planet. This land conversion coupled with climate change disrupts natural disturbances that shape grasslands. There is an effort to reintroduce historic disturbances to grasslands, however in systems where multiple drivers have been significantly modified, reintroduction of disturbances have the potential to cause harm if restoration practitioners do not assess baseline conditions. The grasslands in Glacier National Park, Montana, USA (GNP) represent an ecotone between mixed-grass steppe and montane assemblages, which have largely been ignored in the literature. Often considered a pristine system, important disturbances like fire and large mammal grazing have been largely removed or altered, and new disturbances such as human development have been introduced. Recently, efforts have begun to reintroduce bison, a historic keystone species for these grasslands. To guide reintroduction efforts, Park Biologists are interested in understanding the status and trends of these grasslands to establish a baseline for bison reintroduction. We assessed status and trends in grassland plant community composition, woody encroachment and exotic invasion in 70 grassland plots surveyed recently and 20 years ago.

Initial survey showed large variation in composition across plots in GNP's grasslands, including mixed-grass steppe and montane species. General trends show consistency with the literature for grasslands that have experienced fire exclusion and human disturbance. We discovered significant woody encroachment over the 20-yr study period in the form of trees and shrub species either establishing or increasing in cover. Increase in invasive cover was found in certain areas of the park, usually related to proximity to disturbance. Our results provide insights into the roles of fire and human disturbance in GNP's grasslands, and have important implications for bison reintroduction and future management of GNP's grasslands.

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Sage-Grouse Demographic Rates and Population Dynamics in the Great Basin

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Contributed Oral Presentation

Abstract

Greater sage-grouse (*Centrocercus urophasianus;* sage-grouse) are an ecological indicator species for sagebrush (*Artemesia spp*.) ecosystems in western North America. Sage-grouse populations have experienced concomitant reductions in abundance and distribution throughout their range with losses of sagebrush habitats and are a species of high conservation concern for managing wildlife agencies. The Great Basin contains ~25% of populations range-wide and recent studies indicate more substantial declines here than compared to other areas across the range. Using radio- and GPS-telemetry methods, we monitored 15 sub-populations of sage-grouse (>1,700 individuals) across Nevada, Idaho, and California during 2008–2021 to examine demographic processes driving population dynamics within the Great Basin. Specifically, we developed integrated populations models within a Bayesian framework to refine estimates of specific population vital rates and annual change in abundance (N), population growth (λ), and subpopulation recruitment (R – the per-capita rate that new breeding females were added to the population) using a joint likelihood and temporal inference that accounted for natural population oscillations. Since 2008, our model estimated an average annual λ of 0.94 (95% credible interval [CRI], 0.87–1.02), with substantial variation across sites, resulting in substantial declines in population abundance within the Great Basin and across specific subpopulations. Estimated annual survival varied substantially by field site, but most estimates, and some reproductive rates, were lower than estimates reported elsewhere range-wide which may be explained by effects of drought, wildfire, and other threats unique to the Great Basin. While sage-grouse populations are known to exhibit natural oscillations in abundances through time, the prolonged population declines since 2008 in our study indicate potential conservation concern within this region. These findings are preliminary, are provided for timely science and are subject to change.

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LandPKS "Habitat" Module expanded to include 125 species across North America

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Poster

Abstract

LandPKS is a free, open-source app for managers to access localized information about their land. The "Habitat" module in LandPKS has been expanded to include information for 125 North American species, including rare and sensitive amphibians, birds, mammals, reptiles, insects, plants, and fish. The project team selected the set of rangeland species for which habitat is a limiting factor, and grazing management can influence habitat quality and quantity. The LandPKS "Habitat" module provides science-based habitat information that can be used to develop ranch goals, guide management actions, and create monitoring plans. Based on location, the app displays which of the 125 species may occur in the area and includes a table summarizing habitat requirements. Any soil and vegetation data collected by the user at the location is shown in the table and allows the user to see how their land condition compares to the needs of the species. Factsheets in English and Spanish offer more information, including how to identify the species, ideal habitat, and tangible actions a landowner might take to improve habitat for the species.

A link to a story map will demonstrate the habitat module's functionality and how ranchers and other land managers can use the information to modify land management and find supporting materials on the LandPKS website.

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Application and Reflections: Using Virtual fence technology to manage cattle grazing on the Santa Rita Experimental Range

Brandon Mayer, Andrew Antaya, Brett Blum, Sarah Noelle, Larry Howery, Joslyn Beard, Aaron Lien, Amber Dalke, Mitch McClaran, George Ruyle

University of Arizona, Tucson, USA

McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Advances in technology hold the potential to revolutionize entire industries, but implementation and adoption are bound by our understanding of the intrinsic limits and constraints involved in their use. One such technology is virtual fencing, which uses an animal's GPS location to remotely locate and control the movements of trained animals. The virtual fence systems work by associating auditory and electrical stimuli, and train animals to avoid established barriers when prompted with the auditory cue. This holds enormous implications for range livestock production operations and land stewardship. Virtual fences can be used to sub-divide pastures, replace damaged fencing, or restrict animal access to roadways or ecologically sensitive areas. By controlling the size of pastures, virtual fencing promotes mob grazing which can be used as a management tool to target fine fuels or invasive species. Though virtual fencing holds great promise, knowledge of when the applications can be used and under what conditions it is most effective are poorly understood. Conditions can vary with topography, plant community, and even cellular coverage. Each influence how effectively animals can be trained and overall impact to the producer's ability to update and maintain dependable fencing. Using lessons from the Santa Rita Experimental Range's implementation of virtual fencing, we'll discuss potential limits of the technology and necessary considerations when planning to deploy virtual fencing.

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Climactic Changes and Location Trends of Drying Springs in the Upper Arkansas River Subbasin, Colorado

Sarah McClernan

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Contributed Oral Presentation

Abstract

The Upper Arkansas River Subbasin is the principle producer of water for the Arkansas River. Land Managers have observed a trend of reduced flow and drying springs throughout the subbasin. Spring inventories were conducted in the 1980s and 2010s. Drying springs were examined in two investigations. 1) Spring locations from the 2010s spring survey were analyzed to determine location trends on the landscape including elevation, ecological zone, and bedrock geology data. 2) The 1980s spring inventory was compared to the 2010s spring inventory to investigate climatic factors causing springs to become dry. Temperature, Palmer Drought Severity Index, Palmer Hydraulic Drought Severity Index, mean annual precipitation, and maximum snow water equivalent were climactic factors investigated. 36% of springs were reported dry from the 2010s spring inventory. Shared commonalities in locations of dry springs were elevations ≤2,700 m., locations in the Foothill Zone, and residing above impermeable geology. The comparison between the 1980s and 2010s spring inventories showed 41% become dry, 4% stayed dry, 52% stayed wet, and 3% became wet. Climactic data indicated a trend of becoming hotter and more arid with reduced precipitation and snowpack. The main factors related to drying springs locations were elevation, precipitation, snowpack, and temperature. Springs are vulnerable to becoming dry with reduced snowpack and increasing temperatures. Higher elevation springs are less affected since snowpack, precipitation, and temperature has not been reduced to a critical level to affect spring condition. As reduced snowpack is predicted to affect high elevations in the future, mid-elevating springs are expected to be put at further risk of becoming dry. Mountain springs support local ecosystems and continued monitoring is important to estimate water security issues and the effects of local climate warming.

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FeatherFlame: An open-source, DIY wildland fire behavior measurement system

Devan McGranahan

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Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

Accounting for wide variability in biological responses to wildland fire requires scientists and managers alike to make meaningful measurements of fire behavior, at appropriate scales and with sufficient replication. Unfortunately, costs of proprietary, commercial systems for measuring fire behavior often limit the type and amount of data collected. Here I describe FeatherFlame, a system for recording, logging, and processing temperature data obtained via K-type thermocouples deployed prior to burns. Built around an open-source Arduino microprocessor, the basic system reads temperatures from multiple thermocouples and writes data in an easy-to-use format on a removable microSD card, for less than US$100 per channel. Connecting multiple thermocouples allows users to analyze novel information in time-temperature data, such as using flame front arrival times and trigonometry to calculate rate of spread. Examples of script in the R statistical environment are provided to facilitate data import and analysis, including rate of spread calculations and determining heating curves for input into soil heating models.

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Climate Resilience and Mitigation through Land Management: Compost Application to Improve Carbon Sequestration

Shaun McGrath[1], Alexia Cooper[2], Jennie DeMarco[3]

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Poster

Abstract

Climate change threatens rangeland resiliency in part due to more frequent extreme weather patterns such as lasting droughts. Rangeland soils have the potential to mitigate climate change by sequestering up to 90 million metric tonnes of carbon (C) annually, depending on management styles and degradation. Ongoing research on rangelands in Gunnison, Colorado have found that 2 inches of biosolid compost application increases resiliency by improving soil water holding capacity (WHC) and plant productivity and has tended to increase the mean residence time (MRT) of soil C, the average amount of time C stays in the soil before reemission to the atmosphere. C stocks in different soil fractions have further implications on mitigation potential since the light particulate organic matter (lPOM) has a shorter MRT than the heavy fraction (HF). MRT of C in soil fractions has not yet been determined at these research plots in Gunnison. The objectives of this project include calculating the MRT of C in different soil fractions to determine the potential of compost amendments as a climate mitigation tool and monitoring the lasting impacts on soil WHC and plant productivity. WHC was collected biweekly throughout the 2021 growing season and species diversity was determined at peak season during July. Two soil fractions, lPOM and HF, were separated from bulk soil using density fractionation, where these fractions will then be analyzed for C stocks. Allometric equations for *Alopecurus pratensis* L. and *Juncus balticus* L. were created to estimate plant biomass at one of the three research sites, revealing a trend towards increased plant biomass in treated plots. If C stock analysis reveals larger stocks in the HF compared to the lPOM, then we hope this research will inform new carbon capture policies that incentivize land managers to amend their rangelands with compost for climate resilience and mitigation.

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Hide and Don't Seek: How Broad-Scale Juniper Removal, Mesopredator Habitat Use, and Sage-Grouse Nest Site Selection Influence Depredation Risk

Sarah McIntire[1], Pete Coates[2], Tracey Johnson[1]

[1]University of Idaho, Moscow, USA. [2]United States Geological Survey, Dixon, USA

Poster

Abstract

Expansion of western juniper (*Juniperus occidentalis*; hereafter juniper) into sagebrush (*Artemisia spp*.) steppe plant communities is a well-documented threat to greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) populations. Sage-grouse using habitats where juniper is present experience reduced nest survival, though the exact mechanisms driving this pattern remain unclear. Sage-grouse have a high rate of nest failure due mostly to depredation. Previous research has proposed sage-grouse choose nesting sites that offer concealment against predators that use visual cues to discover nests but not those that use olfactory cues. Juniper trees potentially facilitate avian nest predators by providing extra perching opportunities. However, alternative hypotheses examining how mammalian mesopredators are associated with juniper cover have not been investigated. Unlike avian predators, mammalian mesopredators rely on visual and olfactory cues to locate sage-grouse nests. Therefore, risk to sage-grouse nests could be affected by broad-scale habitat use by mammalian mesopredators and microhabitat nest site characteristics that affect availability of visual and olfactory cues to predators. Removal of juniper from sagebrush communities is becoming an increasingly common method of attempting to restore and improve sagebrush habitats for sage-grouse, therefore it is critical to understand how mesopredators respond to these management efforts. We sought to establish how landscape factors, including juniper cover and mesopredator habitat use, in addition to microhabitat features at nest sites influence nest predation rates for sage-grouse. We conducted our research in southwestern Idaho where a large-scale juniper removal project began in 2019. We evaluated broad-scale habitat characteristics including proportions of juniper cover and habitat use rates by mesopredators and collected data on both visual and olfactory concealment characteristics at sage-grouse nest sites (*n*=91) to determine effects on predation risk for sage-grouse nests. We will provide results on sage-grouse nest success in relation to juniper removal. Findings are preliminary and provided for timely best science.

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The Effects of Broad-Scale Juniper Removal on Habitat Use by Mammalian Mesopredators

Sarah McIntire[1], Pete Coates[2], Tracey Johnson[1]

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Contributed Oral Presentation

Abstract

Over the past 150 years conifer trees have expanded into sagebrush (*Artemisia spp*.) steppe ecosystems. Over time expansion of conifer reduces sagebrush cover and alters soil hydrology, leading to broad-scale changes in composition and structure across the landscape that have implications for wildlife populations. Numerous conifer removal projects are currently underway to improve habitat for declining species, most notably the greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse). Removal of conifer trees is predicted to reduce predation by avian predators though little is known about how predation by mammals may respond to large-scale conifer removal. We conducted our study in southwestern Idaho where a large-scale western juniper (*Juniperus occidentalis*; hereafter juniper) removal project began in 2019. Juniper removal mostly occurred in areas with canopy cover ≤ 20%. As a first step to addressing how predation rates on sage-grouse by mammals may be affected by juniper removal, we sought to examine how landscape features, including measures of juniper expansion and removal, influence habitat use in sage-grouse nesting habitat by mammalian mesopredators. To determine mesopredator habitat use, we deployed trail cameras (n = 80) from April-July in 2019-2021. Cameras were randomly placed across the landscape stratified by phase of juniper cover as defined by Miller et al. (2005). We used Microsoft AI to identify images with animal detections and human observers to further refine detections to species. We will estimate probability of habitat use for five species of mesopredator using multi-season, single-species occupancy models: coyote (*Canis latrans*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), and American badger (*Taxidea taxus*). We will present results on mesopredator habitat use in relation to juniper cutting as a first step to evaluating sag-grouse nest survival responses to juniper removal. Findings are preliminary and provided for timely best science.

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Explorations of heritage vs conventional cattle in a changing climate

Matthew McIntosh[1,2], Lara Macon[2], Matt Redd[3], Andres Cibils[1], Rick Estell[2], Shelemia Nyamuryekung'e[1], Santiago Utsumi[1], Alfredo Gonzalez[2], Andrew Cox[1], Glenn Duff[1], Jeremy Schallner[2], Sheri Spiegal[2]

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

Multiple lines of evidence suggest that heritage Raramuri Criollo (RC) cattle, a biotype with over 400 years of naturalization in the harsh landscapes of the Mexican Copper Canyon, could offer producers a novel means of meeting sustainability and production goals on southwestern rangelands in the face of a rapidly dwindling forage supply and a hotter, drier climate. Compared to conventional breeds (e.g. Angus), RC cows and steers have been documented traveling farther per day and exploring larger areas over multiple seasons, ecosystems (Chihuahuan Desert, California chaparral, and Colorado Plateau), and physiological states. Likewise, RC cows have a lighter body weight and tend toward more even grazing distribution and fewer re-visitation rates during critical periods of the year when rangelands are most vulnerable to overgrazing - suggesting a potentially lighter footprint on soils and vegetation. Raramuri Criollo cows, compared to conventional counterparts, express a unique “follower” mothering style, which allows cows more freedom for daily exploration. Rarármuri Criollo also tend to exhibit better heat tolerance by maintaining/regulating internal temperatures, possibly because of body size, hair length, hide color, and behavioral tendencies. Use of RC genetics may present production opportunities related to reduced supplemental feed inputs and potentially lower overhead costs compared to conventional counterparts, while still producing marketable crossbred calves that wean and finish at saleable weights with acceptable carcass traits. This assemblage of studies suggests that RC genetics could be well suited to emerging climate change driven conditions on southwestern ranches because of their unique foraging behaviors and physiology, different resource requirements, and theoretical ability to produce more pounds of weaned beef per pound of cow vs conventional biotypes. Future work will seek to determine what role RC cattle might serve in mitigating climate change impacts and how they could fit into niche and conventional beef production systems.

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Real-time LoRaWAN precision ranching technologies: What we've learned

Matthew McIntosh[1,2], Shelemia Nyamuryekung'e[1], Andres Cibils[1], Santiago Utsumi[1], Richard Estell[2], Andrew Cox[1], Danielle Duni[1], Vinícius Gouvêa[1], Carolina Brandani[1], Glenn Duff[1], Qixu Gong[1], Tony Waterhouse[3], John Holland[3], Huiping Cao[1], Laura Boucheron[1], Huiying Chen[1], Sheri Spiegal[2]

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

We tested a precision livestock farming (PLF) system deployed across 4000-ha of Chihuahuan Desert Rangeland (trial 1; T1) and 130-ha of wheat pasture (trial 2; T2) over three (March-May 2020) and one month (October 2020), respectively. The PLF system included a LoRa WAN Kerlink® iStation gateway, deployed either using solar power and WiFi Backhaul communication or off-grid power and Ethernet connection. Tested sensors were Abeeway® Industrial trackers (IT) and Decentlab® sensors to monitor precipitation and water level in a cattle drinking trough. In T1, the battery power of IT deployed on beef cattle (n = 43) dropped from 100 to ~35% over the three-month trial and GPS data packets programmed to be recorded at 15-min intervals were recovered at ~0.08 – 1.3-hour intervals yielding between 46 to 80% of expected GPS fixes. Variation in GPS data acquisition was associated with distance to the gateway base station and oscillations in solar power and backhaul WiFi signal. In T2, stationary IT deployed either indoors (n = 5) or outdoors (n = 6) were programmed to collect GPS locations and acceleration data at 1-min and 15-min intervals, respectively. More frequent and reliable GPS data packet acquisition was recorded with IT deployed outdoors (in T2; bias = 5.20 m) compared to IT deployed indoors (in T2; bias = 17.76 m) and those deployed in T1. Except for a few cases of background noise, accelerometer data were almost non-existent due to the static deployment of IT in T2 (power-saving function). Results from our case studies suggest the feasibility of mounting a fully operational LoRaWAN system for PLF on extensive rangelands. Our studies also identified areas for improvement of LoRa WAN infrastructure and data communication, analysis and visualization to further enhance uses of real-time biosensing of animals and monitoring of ranching infrastructure in commercial PLF applications.

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Do Invasive Plants Affect Diversity and Livestock Performance in Heterogeneous Grassland? The Effect of Sericea Lespedeza (*Lespedeza cuneata*) Invasion and Mitigation on the Tallgrass Prairie.

Nicholas McMillan[1], Samuel Fuhlendorf[1], Robert Hamilton[2]

[1]Oklahoma State University, Stillwater, USA. [2]The Nature Conservancy, Pawhuska, USA

Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Simultaneously meeting livestock production, biodiversity, invasive plant species mitigation, and periodic fire-disturbance objectives is a persistent dilemma plaguing many grassland managers and livestock producers. Altering fire-timing (e.g., moving from dormant to late-growing season burning) or integrating herbicide application into fire management regimes are hypothesized to decrease invasive species abundances without negatively affecting livestock production or biodiversity. However, large-scale, replicated experimental evidence linking invasive species abundance or mitigation practices to cattle performance is lacking across complex grasslands. We manipulated eight large (333 – 766 ha) experimental landscapes managed with fire and grazing (i.e., pyric herbivory) to test how dormant (i.e., March-April) and growing (i.e., August-September) season fires, targeted herbicide application (i.e., low dose, conservation-oriented), and invasive species abundance (namely *Lespedeza cuneata*) affect cattle performance and plant species diversity in the tallgrass prairie. We collected cattle weight gain data from each landscape from 2018-2021, and plant composition data from 2019-2021 at scales ranging from the 0.1m^2 plot to the landscape. Cattle gained less weight in landscapes burned during the growing season compared to those burned during the dormant season, and following up patch-burns with our specific targeted herbicide application did not increase cattle performance. Moreover, *L. cuneata* abundance did not affect cattle performance or plant species diversity at the experimental landscape scale. To date, pyric herbivory is the only management regime known to simultaneously insulate livestock producers from losses during times of change, promote biodiversity, and restrict some invasive plant species like *L. cuneata*. Invasive species effects on ecosystems may not always be negative, and change with scale. If managers are to meet multiple objectives and buffer against future uncertainty, we must move away from the historically dominant either-or approach, and toward heterogeneity-based strategies for grassland management.

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Evaluating the Cumulative Effects of Livestock Grazing on Wildlife with Integrated Population Models

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Contributed Oral Presentation

Abstract

Livestock grazing is acknowledged as a shaping force in temperate grassland ecosystems, with documented positive and deleterious effects on wildlife depending on a variety of grazing and site factors. Historically, research investigating the impacts of livestock grazing on wildlife has been limited to examining how grazing affects only a single vital rate in isolation. Using a two-stage class, female-based integrated population model (IPM), we examined whether three grazing management regimes (season-long, rest-rotation, and summer rotation) differentially impacted population growth rates of sharp-tailed grouse (*Tympanachus phasianellus*) in western Montana. We estimated 14 vital rates related to survival and fecundity and examined whether subtle cumulative effects of livestock grazing were present but not detected in prior analyses focused on single vital rates. We found significant cumulative impacts of grazing regime on population growth rates despite observing no significant effects on individual vital rates. Our results suggest that small but 'non-significant' effects of livestock grazing management on population vital rate may sum to meaningful effects on population viability. The IPM framework encourages comprehensive investigations into the influence of covariates on critical components of species life histories and can assist in guiding management decisions in a world of limited resources.

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The quest for the best: Comparing biomass methods in a semi-arid rangeland

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Poster

Abstract

Introduction: Aboveground biomass is a key ecosystem function of interest to rangeland researchers and practitioners alike but measuring it accurately can pose a significant challenge in semi-arid grasslands due to their short stature and high structural and spatial heterogeneity. Current methods often involve destructively harvesting and weighing biomass from a smaller, subsampled area. However, this method is time intensive and less feasible for monitoring long-term established plots. Here we tested eight methods for estimating biomass (Leaf Area Index, Normalized Difference Vegetation Index, Greenness Index, visual cover estimates, height measurements, Robel Pole measurements, and a combination of heights and cover). To resolve how these biomass estimation techniques differ, we asked: 1) Which method most accurately captures biomass variation at the one-meter square level? 2) How does the use of different proxies impact the estimated effect of drought in an experimental setting?

Results: To answer the first question we compared the accuracy of each method across 18 validation plots in a semi-arid grassland (Boulder, CO). We found that the hand-held LAI meter best predicted biomass. However, in the absence of such technology, combining vegetative cover estimates with height measurements also produced a strong relationship. Established methods like sub-sampling smaller portions of biomass explained less of the larger-scale biomass variation between plots. To answer the second question, we compared these methods in estimating experimental drought effects in the same system. Although methods performed differently in the validation plots, the estimated effect of drought and our confidence around it were similar across most methods.

Conclusions: Methods that capture the complex structure of the vegetation, such as LAI and combined cover and heights are the most accurate for understanding fine scale differences in aboveground biomass. However, when comparing across larger, drought-induced differences in biomass, many estimation methods may deliver similar results.

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Recycling manure from beef feedlots: Environmental outcomes and perspectives from operators

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

A critical component of the manureshed vision requires manure transfer from large feedlot operations (nutrient sources) to areas where manure nutrients can be sustainably used (nutrient sinks), be it cropland, pasture, or range. We review the costs and benefits, experienced and perceived, of manure transfer from beef feedlots to nutrient sink areas. We frame manure transport along a gradient of options, from aspirations of circularity in nutrient flows across supply chains, to local exchanges that current dominate the industry. Through interview data of feedlot managers at ten major US feedlots, we expand upon the current reality of manure nutrient cycling, documenting the short transport distances that are the current norm (less than 20 mi from feedlot) as well as insight into transport constraints: hauling/labor costs, regulations, market forces, and variable nutrient quality of the manure product. We then explore new frontiers for beef feedlot manure application, including application to rangelands to mitigate degraded site conditions, experience with manure treatment systems that remove key constraints to transport, and key case studies confirming strong demand for innovation in manureshed management.

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Plant Recruitment Effectiveness of Connectivity Modifiers Along a Dryland Shrub Encroachment Gradient

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Poster

Abstract

Woody plant encroachment is occurring across dry rangelands globally. In particular, shrub encroachment can transition a historically arid or semi-arid grassland to a shrubland through reduction in grass cover by a disturbance, or altered conditions, to create favorable environments for shrubs. As shrub encroachment and infilling increases, bare plant-interspaces also increase causing a higher degree of connectivity on the landscape. Connectivity, as applied in drylands, describes the ability of materials to move from one place to another on the landscape through wind and water transport. The purpose of this research is to compare the recruitment of vegetation found in actively placed connectivity modifiers (ConMods) as they compare to background recruitment where no ConMods are present. This can give us a better outlook on how effective the use of ConMods are for dryland restoration. To measure these differences, connectivity modifiers were installed along a grassland to shrubland gradient, and recruitment of individuals was recorded two years after installment. Our broad results showed that the number of individuals found in the ConMods were similar to background levels. This pattern was also apparent when looking only at the abundance of grass individuals. Although the recruitment of forbs in the ConMods was slightly greater than background levels, this difference was not statistically significant. However, these relationships varied when comparing the recruitment found in both the ConMods and the background along the grassland to shrubland gradient. Interestingly, the only recruitment of shrubs that were observed were solely in the ConMods and not the background vegetation. This work indicates that over 2 years, ConMods can be beneficial for dryland plant recruitment and restoration, but the effectiveness can vary depending on the extent of shrub encroachment and may be complicated by enhanced recruitment of undesired species.

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Drafting of NESH Part 632

Aaron Miller[1], National Ecological Site Team[2], Ecological Site Standards Committee[2]

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

The National Ecological Site Handbook (NESH) provides guidance to developers of Ecological Site Descriptions for the purpose of correlating ecosystem dynamics to every soil survey map unit component. Although most Sites are not yet past the Provisional stage of development, efforts to achieve nationwide Approved status will likely take decades. Much of the challenge still lies in our ability to include alternative land uses into our State and Transition Models (STM) such as crop, pasture, or urban types. Our ability to provide consistent guidance of all land uses will pave the way for states and regions with heavy agricultural and alternative land management to start including more comprehensive Ecological Site concepts across their Major Land Resource Areas and Land Resource Units.

A first draft of NESH Part 632 is under development by the Ecological Site Standards Committee, a workgroup overseen by the National Leader for Ecological Sites and housed under the Soil and Plant Sciences Division of the Natural Resources Conservation Service of USDA. Part 632 is intended to provide clear definitions of alternative land uses within the context of how they differ from reference land uses and conditions, and a rationale for their inclusion in the STM. Subparts will be included for each alternative land use category that will guide developers to draft unique ecological states that describe associated dynamics. General guidance will also help to distinguish states from phases, and identification of transition mechanisms and pathways between them. A strong emphasis will be made to recognize and preserve traditional, local, and regional methods that ultimately lead to clear, consistent decisions in best agricultural practices and conservation strategies.

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The Value of Stewardship

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Contributed Oral Presentation

Abstract

Public and private rangelands in Alberta are managed under a stewardship model, where public and private lands are a patchwork that is often managed as a single land base, providing landscape-level connectivity, supporting the maintenance of large tracts of rangeland habitat and the ecological goods and services they provide.

Crown land grazing leases are a time-tested mechanism to conserve rangeland landscapes and their ecological goods and services. The successful long-term management of Alberta's rangelands under this stewardship model has been recognized in the South Saskatchewan Regional Plan (Government of Alberta, 2017), which highlighted the historic and continuing stewardship role that livestock producers have on biodiversity conservation on private and public grazing lands, noting that:

'…carefully managed cattle grazing and traditional ranching practices on long-term grazing leases contribute to the ecological health of large tracts of the continent's finest remaining native grasslands. Good stewardship and proper grazing management has helped to retain much of the existing healthy native and intact rangelands.'

Leaseholders accept responsibilities and costs required by legislation to effectively steward the range resource. These lands are managed under a multiple use mandate where leaseholders are required to maintain fences, improve rangeland, develop watering systems, manage recreation and industrial access, and ensure that lands meet stewardship standards as a legislated condition of their disposition. These activities and requirements are undertaken at the cost of the leaseholder, which is unique relative to other Canadian jurisdictions.

A Value Estimate Report concluded that $69.88 million in value is provided to the province of Alberta on an annual basis by grazing leaseholders. As grazing cattle are used to maintain rangeland ecosystem function and wildlife habitat values on public lands, it is difficult to see a scenario where this value could be provided in any other way that would be more cost effective.

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The Use of Novel Seed Coating Technology to Increase Germination and Even Distribution of Sand Dropseed (Sporobolus cryptandrus Torr.) in Restoration Seed Mixes

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Contributed Oral Presentation

Abstract

Sand dropseed (*Sporobolus cryptandrus* Torr.) is a drought resistant, prolific seed producing warm season perennial that is native throughout North America. Considered a pioneer species in disturbed sites, sand dropseed has been widely used for erosion control in the Intermountain West and short-grass prairies of the Great Plains. Sand dropseed can quickly spread throughout disturbed areas after being established due to a single floret being able to produce up to 10,000 seeds. Although these seeds are small and light, measuring between 0.75 to 1.2mm long, which may lead to uneven distribution in seed mixes when being planted. The objectives of this study are 1) does coating sand dropseed with R-Coat (wood flour, cellulose, calcium bentonite) effect its distribution in seed mixes, and 2) does an R-Coat coating effect germination percentages compared to scarification and stratification. Seed distribution samples were taken for seed mixtures that contained non-coated sand dropseed and coated sand dropseed. Samples were collected by attaching germ bags to the end of four seed drill drop tubes. A total of 5 passes were made with each seed mixture (n=20). Germ bags were then collected, were each one was inspected for total amount and distribution of sand dropseed throughout each bag. A total of 6 different germination treatments were tested, which include: no treatment, chemical scarification, moist stratification, R-Coat only, scarification + R-Coat, and moist stratification + R-coat. A total of 125 seeds for each treatment were split into 5 blocks (n=5) and place in a germination chamber set at 25°C, with 12-hour day and night cycle. Signs of germination were checked every 2-3 days over a 31-day period. The addition of an R-Coat coating to sand dropseed in seed mixtures could possibly help with evenly distributing sand dropseed when planting, as well as increase overall germination.

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Cowboys and nomads: Shared lifestyles, similar challenges

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Contributed Oral Presentation

Abstract

Nomadic pastoralists of the Himalaya, Tibetan Plateau and Mongolian Steppe have been raising livestock for thousands of years. As such, there is a wealth of traditional ecological knowledge and experience with livestock and grazing management that has been acquired over millennia. In recent decades, traditional nomadic pastoral systems across Asia have undergone profound transformations due to political, socio-economic and ecological factors. In Mongolia, livestock numbers have increased almost three-fold in the last thirty years, with overgrazing now a serious issue and the sustainability of current livestock production practices being questioned.

Livestock production on the rangelands in the Northern Great Plains is less than 160 years old. The hey-day of cattle on the open range was in the 1880s. Over stocking of the range led to degradation and drought and severe winters led to changes in how livestock were managed and the birth of range science. In the last 50 years, significant developments have been made in livestock and grazing management that has improved range condition and livestock productivity. Yet, ranchers on the Great Plains continue to face challenges with drought, winter storms and low prices for their livestock just like nomads in Asia.

Despite the differences in their respective livestock production systems, the vast distance between the ranges they ride across taking care of animals and the contrasting cultures, the nomads of the Asian Steppes and the cowboys of the Northern Great Plains speak the same basic language. They share an interest in wide-open spaces, productive grasslands, healthy livestock, good horses and a strong sense of community. They also face many of the same challenges raising livestock.

This presentation will illustrate - with paired photographs – shared characteristics of American cowboys' and Asian nomads' cultures and discuss ways for these livestock-raising people to learn from each other.

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Regional Differences of Rangeland Plant Communities in the Nebraska Sandhills

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Poster

Abstract

The Nebraska Sandhills ecoregion is an important native mixed grassland in the central Great Plains, providing many ecosystem services as well as prime grazing land for cattle. Within the Sandhills, there is a diverse suite of management practices that are in place on working ranches that may influence plant community composition across the region. In 2021, we collected data on 14 ranches with diverse management strategies distributed across three precipitation zones: the western Sandhills (422-483 mm.), central Sandhills (483-559 mm.), and eastern Sandhills (559-635 mm.). On each ranch, three study pastures were selected, within which three study sites were established on upland Sands ecological sites. Cover, frequency of occurrence, and dry-weight rank data were collected at each site. Using principal components analysis, approximately 51% of the variability in plant species frequency of occurrence across the ranches was attributed to regional differences in the locations of the ranches. Regional differences in plant communities were primarily found between the western region compared to the central and eastern Sandhills regions. Species observed more ($p \leq 0.05$) frequently in the western region compared to the central and eastern regions included prairie sandreed (*C. longifolia*), sand dropseed (*S. cryptandrus*), and blue grama (*B. gracilis*); whereas, species observed more ($p \leq 0.05$) frequently in the central and eastern region included little bluestem (*S. scoparium*), Scribner's rosette grass (*D. scribnerianum*), western ragweed (*A. psilostachya*), stiff sunflower (*H. pauciflorus*), Wilcox rosette grass (*D. wilcoxianum),* switchgrass (*P. virgatum*), and prairie rose (*R. arkansana*). This research highlights regional differences in vegetation species composition within the Sandhills that have not previously been documented in the scientific literature. Further research is needed to understand how management influences plant community dynamics within the different precipitation regions in the Sandhills.

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History of Seeding “Immigrant” and “Snowstorm” Kochia

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Poster

Abstract

There is a long history in range management of seeding introduced species with the intent to rehabilitate landscapes. Some of the most widely spread and successful grasses were imported from the Siberian steppe habitat (e.g., *Agropyron cristatum*, *Agropyron desertorum*, and *Agropyron fragile*). Hailed as the “alfalfa of the desert,” a semi-shrub that was valuable forage to both livestock and wildlife, *Kochia prostrata* ssp. *virescens* was first brought to the United States in the 1960s for study and released in 1984 as “Immigrant” kochia. In addition to improving forage, Immigrant kochia was praised for its ability to resist and recover from fire by reducing fine fuels through competition with *Bromus tectorum*, staying green later into the fire season than other perennials, and its ability to resprout. By the 1990s, it was a recommended for planted-fuel breaks, known as greenstrips, alongside the introduced wheatgrasses from its native habitat. However, the low stature that made it so appealing for reducing fuel loads also made it less available for winter browse in deep snow. Therefore, breeding of another Siberian subspecies, *Kochia prostrata* spp. *grisea*, began in 2002 to develop a taller cultivar that was released under the name “Snowstorm” kochia in 2012. This 60% taller shrub produced 70% more forage and a higher crude protein than Immigrant. After nearly 40 years since the release of Immigrant kochia and a decade since the release of Snowstorm kochia, there is little information about how widespread these species are in rangelands or if their use has been increasing or decreasing over time. Using seeding records of the Bureau of Land Management from the USGS Land Treatment Digital Library, we examined the number, size, and timing of seedings for both shrubs across four states: Idaho, Nevada, Oregon, and Utah.

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INCREASING THE PRODUCTIVITY OF DEGRADED PASTURES OF THE FOOTHILL ZONE OF UZBEKISTAN

Tolibjon Mukimov[1], Rustam Muradov[2], Nuraddin Ruziboev[3], Musurmon Norkulov[4]

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Abstract

In order to increase the productivity of degraded lands, reproduction practices were applied by artificial seeding on degraded farm plots "Holtyraev Oybek HC" within the framework of the UNDP-GEF Project "Sustainable use of natural resources and forestry in key mountain regions important for globally significant types of biodiversity." During 2018-2021, the state and use of the created 2-hectare primary seed production site is being monitored.

This type of pasture mainly develops plants such as *Carex, Poa bulbosa*, other ephemeroids and ephemeral. The top layer of the soil is firmly bound by a *Carex* and *Poa bulbosa*. The pastures of the Adyrs are overgrown with weeds that are not eaten by plants *Psoralea durpaseae, Peganum harmala*. The average annual yield of pastures is low – 0.25-0.35 t/ha. In 2019, long-term drought-resistant forage plants with a productive longevity of 15-20 years were planted to demonstrate various technologies for restoring degraded lands. *Kochia prostrata*, the yield of feed mass and seeds is 1.2-1.4 t/ha. *Ceratoides eversmanniana*, the yield of dry feed mass –1.12-1.25 t/ha, seeds-0.12-0.17 t/ha. *Artemisia* on many pastures, the basis of feed is wormwood with a yield of 0.8-1.0 t / ha. *Atriplex undulata* with a yield of 0.78 t/ha of dry weight. *Agropyron Gaertn* yield of air-dry feed mass of 8.6-1.4 t/ha. The seed yield is 0.1-0.15 t/ha. *Onobrychus chorossanica Bge.* it is one of the highly nutritious forage plants with a yield of 0.1-1.5 t / ha.

The creation of a plot of drought-resistant perennial forage crops will allow obtaining about 240 kg of seeds from 2 hectares and using them in the future to improve degraded pasture areas. Additionally, you can get 3.0-3.2 tons of dry weight from a plot of 2 hectares, which will allow you to have a stable feed base throughout the year.

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Bromus tectorum's plant soil feedback influence on competition and nitrate in the northern sagebrush-steppe

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Contributed Oral Presentation

Abstract

Bromus tectorum is a dominant annual grass invader, but the mechanisms of its success are not fully understood. *Bromus tectorum*'s early senescence and resultant litter provide continuous fuel loads across the shrub interspace, initiating the primary invasion mechanism via a positive fire feedback in the Great Basin. Plant soil feedbacks (PSF), whereby *B. tectorum* alters nitrogen availability for later growing species, provides another invasion mechanism. Southwestern Montana represents the northern extent of *B. tectorum*'s range and has no history of fire-induced positive feedbacks. We investigated the PSF of invaded and un-invaded soils on *B. tectorum*'s competitive ability and soil nitrate availability. *Bromus tectorum* was grown with *Agropyron spicatum* in a soil conditioning greenhouse experiment, replicated twice. In phase one, pots were inoculated with either *B. tectorum* invaded or un-invaded field soils and further conditioned by growing either *B. tectorum* or *A. spicatum* in monoculture for 12 weeks. In the second phase, pots were seeded with *B. tectorum*, *A. spicatum* or both, and grown for 12 additional weeks. Resin strips in the rooting zone (0-8cm) of *B. tectorum* and *A. spicatum* were used to measure nitrate accumulation over the duration of the second phase. *B. tectorum* was more productive in self vs. other-conditioned soil. Conversely, there was no evidence of a PSF for *A. spicatum*; its biomass was not affected by invaded or un-invaded soils, but was decreased by the presences of *B. tectorum*. Soil nitrate was reduced in both soil types when *B. tectorum* was present, compared to *A. spicatum*. Our study provides evidence of a non-fire induced invasion mechanism, via a positive PSF, that potentially explains *B. tectorum*'s persistence and competitive ability at the northern limits of its range.

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The effects of livestock grazing duration and timing on soil health and carbon

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Contributed Oral Presentation

Abstract

In the western U.S., publicly-owned rangelands provide ecosystem services of economic, environmental, and societal importance. Balancing these to satisfy diverse stakeholders is challenging but necessary to develop sustainable agroecosystems. We examined how managing the presence, duration, and timing of livestock grazing can meet this challenge while promoting good rangeland stewardship and supporting producer livelihoods. In particular we looked at how these factors affect soil health and carbon (C) sequestration by measuring soil infiltration, bulk density, and C stocks in upland and riparian areas on semiarid rangelands in northeastern UT. We found that across dominant vegetation and soil types, upland infiltration did not vary by grazing duration or timing but bulk density did. Bulk density, on average, was highest in early-season short-duration pastures and lowest in late-season short-duration pastures, likely due to the water content of the soil when the pastures were grazed. In riparian areas, on average, infiltration was highest and bulk density was lowest in exclosures that experienced no grazing and also in time-controlled short-duration pastures. This was likely due to the absence of livestock or the relatively short time livestock were present on pastures. Soil C data are forthcoming, and we expect to find patterns that complement our infiltration and bulk density data. We expect C stocks will be largest in riparian areas compared to uplands, and more specifically in exclosures and time-controlled short-duration pastures compared with pastures grazed for longer durations. Such results would suggest that reducing the duration of grazing and shifting its timing are effective strategies to improve soil health and increase C stocks. If so, focusing on managing grazing duration and timing may provide a model of sustainable rangeland management benefitting all stakeholders of public lands by promoting good stewardship of natural resources.

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What determines the effectiveness of Pinyon-Juniper clearing treatments? Evidence from the remote sensing archive and counter-factual scenarios

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Contributed Oral Presentation

Abstract

In the intermountain western US, expansion of Pinyon (*Pinus edulis)* and Juniper (*Juniperus spp.)* woodlands (PJ) into grasslands and shrublands is a pervasive phenomenon, and an example of the global trend towards enhanced woody growth in drylands. Due to the perceived impacts of these expansions on ecosystem services related to biodiversity, hydrology, soil stability, fire prevention, and livestock forage, mechanical and chemical PJ reduction treatments have been a long-standing practice in the region. More recently, PJ reduction practices have come under enhanced public scrutiny, due to potential impacts on PJ-dependent wildlife, risk of erosion due to soil disturbance, and cost effectiveness due to variable rates of long-term success. Moreover, there is growing interest in understanding the biotic, abiotic, and management conditions under which PJ reduction treatments are effective. Here, we evaluated PJ reduction treatment outcomes leveraging large, curated databases of land treatments, new remotely sensed fractional cover time-series products, gridded climate and soils data, and analytical approaches adopted from the econometric literature. From 302 treatment events and 1569 distinct treatment polygons we found evidence that treatments reduced tree cover and largely increased shrub and perennial herbaceous cover for 10 or more years. However, treatments were also associated with increases in annual, likely non-native, herbaceous cover. Importantly, we noted treatment outcomes varied by landscape context, with some soil and geomorphic settings exhibiting consistent returns to pre-treatment conditions within 10-15 years, and others exhibiting more persistent changes in functional type composition. Despite the overall trends we observed, there was considerable unexplained variability in outcomes from treatment to treatment, highlighting the need for caution and attention to local geomorphic and biological context in planning future treatments.

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Can Cattle Tracking Data Predict Forage Utilization Patterns?

Kelsey Nelson, Derek Bailey, Colin Tobin

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Contributed Oral Presentation

Abstract

Livestock grazing can disproportionately affect areas of the landscape that contain rugged terrain, preferred vegetation or areas near water. Areas where livestock congregate, commonly referred to as ‘hot spots’, can create problems for land managers and are often detrimental to rangeland health and related ecosystem services. Technological advances are facilitating development of real-time livestock tracking, which could remotely monitor spatial movement patterns of livestock. The objective of this study was to determine if livestock movement patterns can be used to predict forage utilization patterns. We tracked 29 cows in a 1096 ha pasture and 32 cows in a 312 ha pasture for 1.5 months in central Arizona. The number of global positioning system (GPS) positions within1.5 ha polygons surrounding randomly selected utilization measurement sites were calculated to determine if we could predict utilization from nearby cattle use. We did not detect ($P > 0.10$) a relationship between the number of GPS positions in the corresponding polygon and associated vegetative utilization measurement in either pasture. However, hot spot analyses of the cattle spatial movement patterns in the two pastures revealed relatively even grazing distribution. Measured utilization varied from 10-35% across the pastures. The range in both the dependent (measured utilization) and independent (nearby GPS positions) variables was likely insufficient to detect a relationship. Additional research including pastures with uneven grazing distribution is needed to determine if GPS tracking can be used to monitor and predict forage utilization patterns.

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Climate Extremes Influence How a Bird Selects Habitat and Moves Across the Landscape

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Contributed Oral Presentation

Abstract

Climate change is predicted to increase the intensity and frequency of climate extremes, impacting the survival and population dynamics of species. Landscape heterogeneity has been found to be important at reducing the impacts of climate change through providing thermal refuge and moderating temperatures. Because movement is a fundamental characteristic of life, understanding how animals move across the landscape during climate extremes will be critical to their conservation. As sedentary species are predicted to be more negatively impacted by climate extremes, we used the Northern Bobwhite (*Colinus virginianus*; hereafter bobwhite) as a model to study how a sedentary animal selects habitat and moves through the landscape in response to climate extremes. We collected global positioning system data on bobwhite across western Oklahoma during 2019–2020 and paired these data with meteorological and vegetation data. We used a generalized linear-mixed modeling approach to analyze hourly points and 12-hour paths. We found that bobwhite selected denser tree cover and higher normalized difference vegetation index values during periods of hotter air temperatures across different levels of solar radiation intensity. Bobwhite selected denser shrub cover as air temperature increased during medium and high average wind speed. The movement of bobwhite was most limited when air temperatures ≤ 0 °C occurred, regardless of normalized difference vegetation index variance. Bobwhite moved further as normalized difference vegetation index variance and air temperature increased. Our findings suggest that bobwhite select habitat differently during different climate extremes reinforcing the need to manage for heterogeneity. Further, the interaction between climate and habitat influences movement. Areas with increased heterogeneity may cause animals to increase their movement to move to areas on the landscape with suitable thermal refuge. As climate change continues, our research suggests that we will need to rethink how to manage landscapes to accommodate sedentary animals during extreme climate events.

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Symposium Synthesis and Way Forward for the IYRP

Maryam Niamir-Fuller[1], Jim O'Rourke[2], Layne Coppock[3], Ann Waters-Bayer[4]

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

This IYRP symposium has had two components: (1) Virtual workshops involving IYRP stakeholders designed to make progress on IYRP planning and global integration; and (2) a hybrid in-person/virtual seminar focused on scholarly contributions illustrating IYRP background, key issues, research approaches, new technologies, and collaborative opportunities to tackle rangeland and pastoral challenges worldwide. In this presentation IYRP representatives will synthesize key outcomes from both components and offer a way forward.

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Update on IYRP 2026 Workshop Outcomes

Maryam Niamir-Fuller[1], Ann Waters-Bayer[2], Barbara Hutchinson[3], Jim O'Rourke[4]

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

During the week prior to the in-person SRM conference in Albuquerque for 2022, virtual workshops were held involving IYRP stakeholders from across the 11 global regions. Objectives broadly included making progress on IYRP planning and global integration. This activity is a follow-up to deliberations initiated at the virtual XI International Rangelands Congress held during October, 2021. In this presentation workshop facilitators will outline the major outcomes from the workshops and offer goals for the next round of engagement.

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The impact of earthen berms on vegetation patterns in a semiarid rangeland watershed

Mary Nichols

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Contributed Oral Presentation

Abstract

Across the American Southwest rangeland water development and conservation work have altered topography and changed runoff patterns. Innumerable water supply, soil moisture enhancement, and erosion control structures have been constructed to intercept surface runoff and beneficially increase local vegetation and limit sediment transport. However, because such structures alter runoff patterns, they can be considered a disturbance with broader scale impacts on vegetation patterns. The effects of 181 earthen berms constructed in the early to mid-1900s in the uplands and floodplains of the Altar Valley in Southern Arizona, USA were quantified based on a supervised classification of grass, shrubs, and bare soil that was performed using 2016 orthographic imagery. Many of the berms have failed and are breached or flanked. For berms that are intact, grass and shrub cover were higher upslope in comparison with vegetative cover in proximal downslope runoff shadows. Correspondingly, the amount of bare soil was higher downslope of berms. This study points to the role of conservation structures in adding additional complexity to already heterogeneous landscapes by creating patchwork assemblages of vegetation and bare soil proximal to earthen runoff and erosion control berms.

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Use of Seed Coating Technologies to Improve Curl-leaf Mountain Mahogany (*Cercocarpus ledifolius*) Seed Germination and Emergence in Mine Overburden

Emily Nielson[1], Brad Geary[1], Matthew Madsen[1], April Hulet[1], Kate Ruebelmann[2], Alex Larson[1]

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Contributed Oral Presentation

Abstract

Mining plays an important role in the development of societies globally, but its practice can pose risks to the surrounding ecosystem. One impact associated with open pit mining is the alteration of natural landscapes. The purpose of this study is to minimize the visual impact of mining through revegetation of a mine overburden site with *Cercocarpus ledifolius* (curl-leaf mountain mahogany). We tested several seed treatments to induce timely germination of *C. ledifolius* for use in revegetation at both amended and unamended mine overburden areas. Treatments in these areas included acid scarification, fungicide seed coating, gibberellic acid (GA_3) seed coating, and hydrophobic seed coating, and all combinations of these treatments. These were seeded in furrows in Fall 2020. Data collected in Spring 2021 suggests that the most promising treatments for *C. ledifolius* is the GA_3 coating and the GA_3 and hydrophobic combination coating. In unamended overburden areas, the GA_3 and GA_3 and hydrophobic combination coatings produced an average of 2.05 and 1.59 times more seedlings per meter than the untreated seed respectively. In amended overburden areas, the GA_3 and the GA_3 and hydrophobic combination coatings produced an average of 1.32 and 2.46 times more seedlings per meter than the untreated seed respectively. Treatments of GA_3, and the GA_3 and hydrophobic combination coating are being tested again in a field trial implemented in Fall 2021. If results remain consistent, the use of GA_3 and the GA_3 and hydrophobic combination coatings will be recommended for use with *C. ledifolius* in the revegetation of disturbed areas.

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Varying physiological responses of grassland communities to interactive effects of drought and fire

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

Woody encroachment drastically alters grassland ecosystem function. The shift toward woody-dominance is expected to impact grassland carbon cycling and storage, as well as plant-mediated water fluxes. Climate warming is projected to increase the frequency and intensity of drought events, the results of which will likely interact with land-management strategies (i.e., burn frequency) to impact the trajectory of woody encroachment in grasslands. To better understand these dynamics, we constructed passive rainout shelters over intact shrub-grass communities in watersheds with varying fire frequencies (1-year, 4-year) at Konza Prairie Biological Station. Drought shelters reduced ambient precipitation by ~50%. From 2019-2021, we have monitored physiological responses of an encroaching clonal shrub (*Cornus drummondii*) and a dominant C_4 grass (*Andropogon gerardii*) at the leaf-level (gas exchange rates, water potential, turgor loss point) and the whole-plant level (aboveground biomass, root system hydraulic conductance).

Photosynthetic rates and midday leaf water potentials (Ψ_{leaf}) for both species were generally lower under drought shelters, and this trend was more pronounced in the 4-year burn treatment. Similarly, the turgor loss point (π_{TLP}) for *C. drummondii* was lower under drought shelters compared to control shelters, particularly in the 4-year burn. π_{TLP} declined by >0.3 MPa over the course of the 2020 growing season, indicating that *C. drummondii* was able to tolerate increasing water stress. Root-system maximum hydraulic conductance (K_{max}) was higher in *A. gerardii* than in *C. drummondii*, particularly in the 1-year burn treatment. Interestingly, *A. gerardii* had higher K_{max} in control shelters (compared to drought shelters), but *C. drummondii* had higher K_{max} in drought shelters. This indicates diverging root system responses to decreased water availability.

Lower photosynthetic rates, Ψ_{leaf}, and π_{TLP} in drought shelters indicate that water stress is occurring in both species, particularly in shelters that are burned less frequently. As these treatments continue, we expect to see greater impacts of water stress on leaf-level physiology, and potentially negative impacts on the ability of *C. drummondii* to resprout following fire in the 4-year burn treatment. These results indicate that multiple external pressures (drought + fire) are needed to reverse grassland-to-shrubland transitions in temperate grasslands.

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Effects of drought on early seedling growth of dryland grass and shrub species on intact and wind-eroded soils

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Poster

Abstract

Shrub encroachment is a common form of land degradation in global arid grasslands that is often attributed to changes in disturbances (e.g., overgrazing) interacting with topoedaphic and climatic factors. Various direct/indirect effects of grazing may shift the balance to favor shrubs, but their relative importance remains unclear. It has been well documented that wind erosion post grazing depletes topsoils, thus reducing soil water and nutrient availability. Here, we tested whether early growth of shrub and grass seedlings grown on wind-eroded and intact soils may be differentially affected by drought. We conducted a greenhouse experiment including one shrub (*Prosopis glandulosa*) and two grasses (*Bouteloua eriopoda* and *Sporobolus airoides*) grown on winnowed and intact soils under control (CK, brought to field capacity every other day), medium drought (MD, 80% of CK), and severe drought (SD, 50% of CK) treatments. Grass and shrub seedling growth was monitored, and biomass was harvested.

In well-watered conditions (CK), plant biomass was comparable between soil types or slightly greater on winnowed for all species. In the reduced-watering regimes (i.e., MD and SD), above- and belowground biomass declined, with the decrease being greatest among seedlings on winnowed soils, particularly for *S. airoides* grass. However, root-to-shoot ratios of seedlings on two soil types were similar in all watering treatments in all species. Grass height was reduced on winnowed soil under limited watering, whereas that of *P. glandulosa* shrub was comparable. Grass leaf area was also reduced when watering was limited, more so on winnowed soils than non-winnowed. Our results suggest that grass and shrub early growth is adversely affected by drought, and more so for grasses grown on winnowed soils. Thus, shrub seedlings could outperform grasses on winnowed soils when soil moisture is limited, subsequently promoting shrub dominance in grasslands with wind-erodible soils.

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“Sandblasting” as a driver of shrub encroachment in arid grasslands: Evidence from a portable wind tunnel experiment

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Contributed Oral Presentation

Abstract

The transition of grassland to shrubland is a widely observed form of land degradation in drylands worldwide. This state-change has been commonly ascribed to grazing shifting the competitive balance in favor of shrubs, but underlying mechanisms are poorly understood. It has been well-documented that grazing-induced reductions of vegetation cover in arid regions intensifies aeolian transport. We hypothesized that grass species are more susceptible to the resulting “sandblasting” (i.e., abrasive damage by wind-blown particulates) than shrubs, thus contributing to the shift from grass to shrub dominance. To test this, we conducted an experiment at the Chihuahuan Desert Jornada Basin LTER site in 2018 and 2019. Three grass (*Bouteloua eriopoda*, *Sporobolus airoides*, and *Aristida purpurea*) and three shrub (*Prosopis glandulosa*, *Atriplex canescens*, and *Larrea tridentata*) species representing contrasting growth-forms were targeted. Potted plants were subjected to different levels of sandblasting in a portable wind tunnel, and their ecophysiological responses were quantified.

Sandblasting caused: 1) a decline in photosynthetic rates and the efficiency of Photosystem II in shrub and grass species, but more so in grasses; 2) substantial increases in daytime and nighttime stomatal conductance in grasses but not shrubs; and 3) a marked decline of water use efficiency in grasses, but only a slight decline in shrubs. Furthermore, the duration of these ecophysiological changes was more prolonged in grasses than in shrubs. Overall, our results suggest that grasses are ecophysiologically more vulnerable to sandblasting than shrubs. The differential response of shrub and grass functional types to aeolian transport could eventually alter vegetation dynamics and promote the dominance of shrubs over grasses in arid grasslands where grazing disruption of ground cover amplifies aeolian transport of soil. Sandblasting could thus be an overlooked driver of the shrub encroachment in wind-erodible drylands.

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Review of North American and Global Donor Organizations Supporting Dry Land Research and Outreach to Tackle Climate Change Impacts – Opportunities for New Collaborations.

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

This presentation will inform IYRP and SRM members regarding funding sources that could generate collaborative IYRP projects in the USA and IYRP member countries. Many US federal agencies, private donors, and international organizations spend millions of USD to 1) further understand the mechanisms of climate change, 2) develop mitigation strategies to reduce greenhouse gas emissions, 3) adapt to the consequences of climate change, and 4) develop mechanisms to manipulate Earth systems to counter detrimental changes to climate. Financial support for these strategies in the US include funding at the federal level, e.g., the Department of Agriculture's Forest Service's national and regional programs to reduce fire fuel loads; Tribal level, e.g., the Native American Agricultural Fund; state level, e.g., California's various agency programs to combat wildfire and large-scale erosion; and in local municipalities, e.g., the city of Reno, Nevada's, local fire stations supporting livestock fuel-reduction studies. Other funding with a focus on carbon sequestration include traditional sources like the US National Science Foundation and private donors such as the Bill & Melinda Gates Foundation. Build Back Better legislation under consideration in the US Congress contains significant climate-change investments. Internationally, United Nations agencies dedicated specifically to environmental R&D are the UN Environment Programme (UNEP), Global Environment Facility (GEF), and the Green Climate Fund (GCF). Other global agencies have environment programs within their traditional mandates, including FAO, IFAD, UNDP, World Bank, Asian Development Bank and European Union. Policies for climate-change investments are driven by the UN Framework Convention on Climate Change (UNFCCC), Conferences of the Parties (e.g., COP26) and annual reports from the Interagency Panel on Climate Change (IPCC). Investments respond to national government initiatives, in collaboration with government agencies. Big donor organizations look for government partners, whose agencies provide access for IYRP members to engage with potential donors.

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Native Grassland Restoration in the Edwards Plateau Region of Texas

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Poster

Abstract

Developing successful restoration techniques for native plant communities in anthropogenically-altered landscapes is critical for the conservation of rapidly declining biomes globally. Restoring native grasslands is often a target of many restoration efforts because grasslands have experienced greater declines in their historic distribution than most biomes around the world. Although region-specific restoration techniques exist throughout the North American Great Plains, there has been limited research in the Edwards Plateau region of Texas, where semi-arid rangelands have experienced decades of degradation and loss of herbaceous vegetation communities. In this research, combinations of restoration techniques will be tested to assess their efficacy in promoting native herbaceous vegetation within fallow agricultural fields in Menard County, Texas, USA. Sites were assessed and selected for restoration based on brush encroachment status and soil type. A total of seventy-two 404 m2 plots were randomly assigned one of three native seed mix treatments (high diversity [26 species mix], low diversity [8 species mix], or control), one of two site preparation treatments (disking or control), and one of two herbicide application treatments (Roundup PowerMAX® or control) using a split-split-plot experimental design. The plots are monitored at permanent quadrats where plant density and diversity are measured three times a year for two years (2021-2022). Our goal is to develop region-specific recommendations to enhance restoration success of disturbed lands in the Edwards Plateau Ecological Region of Texas for land owners and management agencies.

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Ecohydrologic Relationships in Juniper- and Sagebrush-Dominated Landscapes

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Poster

Abstract

The significant expansion of juniper (*Juniperus* spp.) during the last two centuries has disrupted important ecological functions and hydrologic processes occurring in many watersheds throughout the western U.S. This watershed study comprises an area of approximately 1000 acres and includes one sagebrush-dominated (after 90% juniper removal), one juniper-dominated watershed, and a riparian valley. The wet season in the study area occurs between September and April, with most of the precipitation occurring as snowfall. Multiple hydrologic components including streamflow, springflow, soil moisture, tree transpiration, groundwater level, and weather parameters were evaluated. Also, different vegetation features such as tree canopy cover, species frequency, and forage production.

Results show restoration of hydrologic flows in the form of greater soil moisture levels and an increase in shallow groundwater residence time in the treated watershed. Evapotranspiration, followed by deep percolation, accounted for the largest portion (83% to 86% of annual precipitation) of water output for both watersheds. Springflow and streamflow rates were generally greater at the treated watershed. Snow-dominated years showed greater amounts of groundwater recharge and deep percolation than years where a larger portion of precipitation fell as rain, even when total annual precipitation amounts were similar. A significant amount of rainfall was intercepted by juniper canopy (up to 70%). Perennial grass cover was positively correlated with changes in soil moisture, whereas juniper cover was negatively correlated with soil moisture content. Shallow groundwater response observed in upland and valley monitoring wells indicates there are temporary hydrologic connections between upland watersheds and valley locations during the winter precipitation and spring runoff seasons. Shallow groundwater recharge showed a 4-to-6-week delayed response in wells located in a downstream valley when compared to upland well locations.

Study results provide valuable information towards understanding ecological and hydrological relationships in sagebrush and western juniper-dominated landscapes.

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Using plant physiology to determine drought resistance and resilience in rangeland bunchgrasses

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O'Connor-From Plant Cells to Landscapes: Understanding Ecological Drought Responses to Help in Adaptive Management and Restoration of Rangelands

Abstract

Rangeland plants are no strangers to dry conditions and have life history strategies that allow them to persist even while water stressed. However, their ability to establish, reproduce and produce viable seed varies immensely by functional group and species. Understanding the mechanisms behind rangeland plants' survival can be accomplished through measuring physiological traits and then modelling the data to either predict or describe the pattern at larger scales. Here we present two studies in the Great Basin Sagebrush Steppe that address how water stress influences 1) seedling physiology of *Elymus elmoides* and *Pseudoroegneria spicata*, two native perennial bunchgrass species, and 2) the reproductive physiology of *Elymus elmoides* and *Agropyron cristatum*, one native and one non-native perennial bunchgrass species used in restoration. We found in the first study when water was withheld that both native bunchgrass species took three days to stop photosynthesizing and were extremely stressed based on chlorophyll fluorescence results. After withholding water for 7-days we re-watered all of the seedlings and *E. elmoides* recovered fully within 2-days, while *P. spicata* never fully recovered even after a week. In the second experiment, during a naturally occurring drought we found that water improved optimal photochemical yield (Fv/Fm) in both *E. elmoides* and *A. cristatum* flag leaves and seedheads. While watering did not improve the light response of either species, *A. cristatum* always maintained higher electron transport rates at saturating light levels than *E. elmoides*. These studies highlight the need for understanding the physiological ecology of our perennial bunchgrass species being used for restoration. Too often restoration efforts are unsuccessful because of abiotic stress and we should look for ways to help improve material selections for restoration through physiological metrics.

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From big data to action: Prioritization of restoration and management at the ranch-scale using remote sensing tools

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Contributed Oral Presentation

Abstract

Threats to sagebrush ecosystem function such as invasive annual grasses and conifer encroachment are tremendous in scale and expanding rapidly. With limited resources and capacity to address these ecosystem stressors, strategic prioritization of restoration and management activities at regional and local scales is necessary for effective project planning and implementation that delivers positive ecological, social, and economic outcomes. The availability, utility, and accuracy of remote sensing tools that can support this type of planning and decision making are increasing rapidly. Examples of tools that are being promoted and applied in eastern Oregon include the Rangeland Analysis Platform, Threat Based Land Management and Oregon SageCon Invasives Initiative Geographic Strategy. However, concrete examples of how decision support tools can be used to inform project planning are limited. Using The Nature Conservancy's Juniper Hills Preserve in Crook County, Oregon as a case-study, we demonstrate how remote sensing products can support project area prioritization for invasive annual grass control and conifer removal. Integrating local manager knowledge and experience, we prioritize project areas with the management objectives of 1) maintaining or improving sagebrush plant community condition and function, 2) reducing hazardous fuels that may contribute to large-scale, uncharacteristic wildfires, and 3) facilitating climate adaption by increasing connectivity of the most resilient habitats on the property.

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Effects of temperature and lunar phase on the movement velocity and distance traveled from water by Corriente cattle.

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Contributed Oral Presentation

Abstract

During periods of high ambient temperature, cattle grazing behavior may be altered, requiring changes in management practices. The objective of this study was to determine the effect of temperature on movement velocity and distance traveled from water. From June to October 2019, a total of 22 Corriente cows in two different herds near Prescott, AZ, grazed five different pastures varying in size from 312 to 1096 ha. Repeated measures analyses were used to evaluate hourly averages of distance to water and travel velocity with pasture and temperature as fixed effects. A separate analysis evaluated these dependent variables at night and added the lunar phase as a fixed effect. There was a non-linear relationship between distance traveled from water and temperature ($P < 0.05$) for 4 of the 5 pastures evaluated. There was also a non-linear relationship between velocity and temperature ($P < 0.05$) for 3 of 5 pastures. Cattle traveled at a lower velocity and remained closer to water in high temperatures. Cattle traveled farther from water during periods of high temperature (daily maximum temperature) during the full moon ($P < 0.05$) but remained closer to water during high temperatures during the new moon ($P < 0.05$). Ambient temperature plays an important role in the spatial grazing patterns of cattle, especially when high temperatures are above normal.

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Moisture abundance and proximity mediates seasonal use of mesic habitat and survival of greater sage-grouse broods

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Contributed Oral Presentation

Abstract

Water is a critical and limited resource in the arid West, but water availability is projected to decline while demand increases from growing human populations coupled with extended duration and severity of drought. Mesic habitats provide important resources for wildlife, including greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse), a species of conservation concern in sagebrush ecosystems. Understanding how wildlife use these crucial habitats is necessary to inform future water management. We evaluated brood-rearing habitat selection and brood survival of sage-grouse in Long Valley, California, an area where water rights are primarily owned by the city of Los Angeles and water is transferred out of the area to the Los Angeles Basin, with some also used locally to irrigate for livestock. This represents a unique balance between the needs of wildlife and people that could increasingly define future water management. In this study, greater sage-grouse broods moved closer to mesic area edges and used more interior areas during the late brood-rearing period, selecting for greener areas after 1 July. Mesic areas were particularly important during dry years, with broods using areas further interior than in wet years. Brood survival was also positively influenced by the availability and condition of mesic resources, as indicated by variation in normalized difference vegetation index values, with survival peaking just inside the edge and remaining high further inside compared to outside mesic areas. Our results highlight the importance of large mesic areas for greater sage-grouse during the critical late brood-rearing period. This study demonstrates the implications of large-scale anthropogenic water manipulation, and the balance between local irrigation and inter-basin water transfer to benefit other regions, from the context of an important species that relies on functioning sagebrush ecosystems within the American west. These findings are preliminary, are provided for timely science communication and are subject to change.

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Cattle diet selection on upland Sandhills Rangelands during the growing season

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Poster

Abstract

The Nebraska Sandhills is diverse and complex ecosystem comprised of different topographic positions (i.e. slopes and interdunes) that influence grazing distribution, plant species composition, and cattle diet selection. The first objective of this study was to evaluate forage quality of individual species from three plant functional groups (i.e. warm-season grasses, cool-season grasses, and forbs/shrubs) on native rangeland within the Hillside pasture (160 ha) at the UNL Gudmundsen Sandhill's Laboratory. Forage quality samples were taken from 4 warm-season grasses, 5 cool-season grasses grass, 1 forb, and 2 shrubs. Samples were collected every 7-15 days from mid-May to early August in 2020 and 2021. The second objective of the study was to evaluate diet composition of cattle grazing (n = 40) within the pasture during the growing season using fecal DNA barcoding (fDNA). Fecal samples were collected from 7-8 cows every 10-20 days from early June to late-July in 2020 and 2021. When averaged across the growing season, CP of forbs/shrubs was 3.3 and 2.9 percentage points greater than cool-season grasses and warm-season grasses ($P < 0.05$). However, there were no differences ($P > 0.1$) in CP between warm- and cool-season grasses or functional group x collection date interactions. Diet selection as determined by fDNA indicated that cattle obtained most of their dietary protein from cool-season grasses (43.6% ± 1.5) and forbs (29.1% ± 1.5), while shrubs (13.0% ± 1.5) and warm-season grasses (3.5% ± 1.5) contributed significantly less ($P < 0.01$) to the cattle diets. This research highlights the influence of time during the growing season on forage quality and cattle diet selection within the Sandhills.

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Effects of cattle grazing on floral resources in California oak rangelands are context-dependent

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Contributed Oral Presentation

Abstract

Wild insect pollinators are declining globally due largely to land-use changes, including habitat degradation and loss. This has serious implications for human food security and ecosystem function. Bees pollinate over 75% of flowering plant species, including crops that make up 35% of the world's food supply. While much recent work has centered on understanding how cropped systems affect bees and pollination services, relatively little attention has focused on another widespread agricultural production system: rangelands. This is true despite the fact that livestock grazing is the most common use of grasslands world-wide, and many of these grasslands, including those in western North America, support a diverse and abundant bee fauna. We hypothesized that livestock grazing can impact wild bees through various mechanisms, including through alteration of flowering plants and associated floral resources (nectar). We investigated the relationship between cattle grazing, flowering plant composition and density, and total floral resource availability using paired grazed and ungrazed sites in an oak savanna system in California. Further, we considered whether the topoclimatic context of our sites mediated the effects of livestock grazing. We found that livestock grazing had either a positive or negative effect on flower abundance, diversity, and floral resource availability, with magnitude and direction of effects varying across topoclimatic contexts. Livestock generally had a positive effect on floral resources under more arid conditions and a negative effect under wetter, cooler conditions. Effects appear driven largely through indirect pathways, notably altered dominance and competition among plant communities. Our results demonstrate that moderate grazing may benefit pollinators and pollination services under drier conditions and when grazing reduces cover of dominant, low-resource plant species. These findings have important implications for the management and protection of plant and pollinator biodiversity on western rangelands, and for ranch managers aiming to maximize ecosystem services and rangeland production.

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Induced meandering watershed restoration using rock structures to decrease ephemeral arroyo erosion on southern Arizona rangelands

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Poster

Abstract

In southern Arizona rangelands, the channelization of ephemeral water flows can result in the deepening of water tables, declines in local soil moisture, loss of vegetation, and a negative feedback cycle of watershed degradation. In 2011, landowners, land managers, and scientists in the Altar Valley of Arizona collaborated to design and construct a system of treatments for halting headcuts, raising channel beds, increasing floodplain area, enhancing vegetation diversity and density, and stabilizing a quickly degrading road within a 1,300-acre area. Treatments included media lunas, one-rock dams, baffles, Zuni bowls, rolling dips, and brush structures; data on vegetation and channel structure have been gathered since the project's inception in 2012. Here, we evaluate the efficacy of the treatments ten years after installation, focusing on trends in vegetation substrate. We also provide a summary of findings to support a ten-year data reporting event and planning for future phases of this project, as well as realistic applications that may be effectively and efficiently applied on a larger scale. This project illustrates that utilizing the knowledge and resources of a variety of stakeholders including private landowners and agricultural operators can provide positive collective impacts.

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Increasing the Germination Rates of Gambel's Oak (*Quercus gambelii*) to Improve Mineland Restoration

Ethan Ostraff, Matthew Madsen, Christopher Miller

Brigham Young University, Provo, USA

Poster

Abstract

Gambel's Oak (*Quercus gambelii)* is an ecologically important species that provides food and shelter for many wildlife species. Additionally, in areas impacted by disturbance *Q. gambelii* is often the first woody perennial species to reestablish. The use of this species could be beneficial for the reclamation of mine sites in mountain shrubland areas of the western United States. However, due to the recalcitrant nature of *Q. gambelii* acorns (i.e. seeds that do not survive after drying or freezing), viability can quickly be lost after the acorns are harvested. Our goals for this study are to improve the germination rates of acorns by applying a seed coating that will help maintain the moisture content in the acorn and promote germination and plant growth. A study was implemented during the fall of 2021 on a mineland-rock dump in central Utah. Seeds were treated with and without a bio complete compost seed coating, within a randomized block design, with seven replicates. Trials were also conducted in the laboratory in Petri dishes, where we found the seed coating had faster rate of germination and increased total germination by 69% in comparison to the control. Field data will be collected in the spring of 2022 and analyzed in conjunction with results from our laboratory research.

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Plant Life Span and Persistence of Soil Seed Banks Predict the Emergence of Herbicide Resistance in Noxious Weeds

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Contributed Oral Presentation

Abstract

Plant control methods have been developed to reduce weed species that are often problematic in agricultural systems. However, these methods can create new challenges, such as herbicide resistance. Determining which plant traits are associated with herbicide resistance can assist managers in identifying species with the potential to develop herbicide resistance and to better understand factors contributing to the development of herbicide resistance. We used random forest models to model herbicide resistance of noxious weeds as a function of ten biological and ecological plant characteristics. Using model results, we created a ranked assessment of the “risk” that current, non-resistant noxious weed species may become resistant in the future. Three noxious weed characteristics, plant life span, seed bank persistence, and occurrence in riparian or wetland microsites predicted herbicide ‘resistance’ with 87% accuracy. Species with persistent seed banks and with short life spans (i.e. annuals) that occurred outside of riparian or wetland areas were most likely to develop herbicide resistance. Short life spans indicate short generation times enabling faster evolution for herbicide resistance. Persistent seed banks may increase the survival of resistant genotypes within a population or may be co-selected as an alternate form of escape from control methods. Species occurring in riparian or wetland microsites may be a case of ‘avoidance’ rather than resistance as managers avoid applying herbicide in these areas. Currently, 47 of the noxious weed species analyzed in this study are herbicide resistant and our models identified an additional 63 species with traits that are highly associated with herbicide resistance, potentially indicating species that are at risk of developing resistance under conducive conditions. Further data-driven analyses with more species and plant traits from around the world could help refine current risk assessment of herbicide resistance development.

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A tale of two corbiculate Apids: Comparing floral resource visitation between managed honey bees and native bumble bees on North Dakota grasslands

C. K. Pei[1], Torre Hovick[1], Ryan Limb[1], Jason Harmon[1], Ben Geaumont[2]

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Contributed Oral Presentation

Abstract

Managed and wild bee populations have undergone declines in recent decades, affecting pollination services beneficial to humans and plant communities. Multiple pressures exist on bee populations including invasive plant species reducing and changing the floral resources available to bees. Many native bees may not be able to utilize these novel resources, even though they can provide sufficient forage for the European honeybee. North Dakota is the largest honey producer in the U.S. and its grasslands host over 300 native bee species. Additionally, invasive grasses and forbs have a high prevalence across ND, but there is a lack of understanding how or if these exotic plant species impact native bees. Our objective was to determine the relative importance of plant species to honeybees and bumblebees, the closest native relatives to honeybees, using data collected from a statewide survey of bees across ND grassland communities. We performed netting surveys at three sites in each of the 53 counties in ND yearly from 2017-2020. From this dataset of 2,544 surveys, we show the total floral visitations of both bee groups and also compare the visitations in surveys that had both honeybee and bumblebees present to determine if visitation differs under co-occurrence. We captured 9,570 honeybees and 2,235 bumblebee workers from 10 species. Honeybees and bumblebees were present in 41.9% and 29.0% of surveys, respectively, and co-occurred at 17.1% of surveys. Honeybees visited 87 plant species with 6,294 visitations to exotic species and 3,276 to native. Bumblebees visited 84 species with 670 and 1,565 visitations to exotic and native plants, respectively. Floral resources used by honeybees are of interest to ND honeybee producers. However, this information can demonstrate the importance of native floral resources for all bees and show grassland managers the importance of promoting land management practices that enhance native floral resources.

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The Grassland Bees of North Dakota: Results from a statewide survey effort provides North Dakota with first-of-its-kind dataset for the state

C. K. Pei[1], Torre Hovick[1], Ryan Limb[1], Jason Harmon[1], Ben Geaumont[2]

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Poster

Abstract

Evidence of global bee population declines has spurred concerns for further reductions in bee diversity and their associated pollination services to both crops and natural plant communities. However, these declines may only be reliably detectable with more and better data from underrepresented regions. In particular, areas of the Northern Great Plains, USA are depauperate in native bee data over both space and time, limiting the ability to track pollinator trends or create informed policies. Additionally, several bumble bee species of conservation concern have a potential presence in the region, but there is a lack of current data on these species. We implemented a statewide survey of bees on North Dakota (ND) grassland systems with the objective to obtain current and comparable information on bee diversity across the state with special attention on species of conservation concern. We surveyed at three grassland sites at each of the 53 ND counties yearly from 2017-2020, keeping one site per county the same across years. Every site was visited twice each season with two observers, resulting in 2,544 netting and plant surveys at 477 grassland sites managed by both public agencies (n=346), private landowners (n=124), and other groups (n=7). Additionally, we supplemented netting surveys with passive trap surveys at 69 sites. We captured 38,059 bees from approximately 318 species across surveys. We also collected information on four bumblebee species known to be declining in other regions, including two species currently under review for federal protection. In addition, we provide the first look at bee richness mapped across ND with species-specific information on distribution, phenology, and diets of native bees in the state. Considering the increasing attention to global bee declines, this information is essential for bee conservation and management in ND grasslands while representing this region in greater bee conservation efforts across North America.

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The Native Plant Initiative at South Dakota State University

Lora Perkins[1], Amanda Bachmann[2], Arvid Boe[1], Krista Ehlert[1], Maribeth Latvis[1], A. Joshua Leffler[1], Candace May[1], Madhav Nepal[1], Brett Owens[1], Alexander Smart[1], Lan Xu[1], Jennifer Zavaleta Cheek[1]

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Poster

Abstract

Historically, native grasses and forbs were abundant and diverse across the Northern Great Plains (NGP). Native plants are the critical foundation for soil health, provide erosion control, and support insects, pollinators, birds, and other wildlife. Loss of native plants began in the 19th century with poor management of grasslands and rapid encroachment of invasive plants. Early attempts to hold back invasion consisted of simply removing occasional non-natives from a background of native plants. Now, however, our grasslands are so heavily impacted that management can be envisioned as restoring native plants in a background matrix of invasive species. Further, so few grasslands remain that we need to maximize the abundance and diversity of native plants in every area possible. These areas include private and public lands such as grasslands, wetlands, woodlands, farms, ranches, parks, yards, and urban areas.

This new reality requires a more thorough understanding of native plant restoration and production than what currently exists for native plants in the NGP. Therefore, the Native Plant Initiative (NPI) at South Dakota State University (SDSU) was formed to highlight and elevate work on plants native to the NGP. Current research at NPI falls into three categories: plant material development and production; wildland management and restoration; and using native plants in professional and private landscaping. Undergraduate and graduate research is being supported by NPI. Outreach is conducted through SDSU Extension, stakeholder newsletters, social media, demonstration plots, and native plant sales.

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Improving the Mapping of Disturbance Response Groups to Inform Management Strategies

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Contributed Oral Presentation

Abstract

Disturbance Response Group's (DRGs) stratify landscapes by grouping ecological sites based on their responses to natural or anthropogenic disturbances. DRGs allow managers to organize, scale up, and evaluate information collected on the ground thus creating expectations of how sites with similar characteristics will respond to disturbance and management. While the importance and utility of these concepts is well understood, the location and spatial extent of DRGs is not. Uncertainty of DRG location and extent make it challenging to evaluate trends or risks of a given area, making it difficult to define and organize adaptive management concerns or opportunities on a landscape scale. Presented here is a method for refining currently utilized techniques in ecological site and DRG mapping as well as the ecological implications of these techniques. Computer machine learning is utilized to generate spatial mapping of DRG's, and is compared to NRCS soil survey mapping, which is currently utilized by pubic land management agencies. The machine learning technique was found to enhance accuracy by 14% versus the conventional soil mapping, providing a more accurate way to conceptualize and manage plant communities at landscape scale. Further, it is observed that predictor variables used in machine learning can supplement our knowledge of ecological process information on sites, and aid researchers and land managers in understanding the various plant community responses to disturbance.

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New annual forage production scenario tool

Marketa Podebradska

University of Nebraska-Lincoln, Lincoln, USA

Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

What can I expect this year for forage production and what are the extremes I should plan for? Livestock producers need an estimate of total annual forage production or its possible range early in the growing season. This tool provides scenarios of possible end-of season forage production, based on winter and spring weather and a range of possible summer temperature and precipitation combinations (based on historical observations). These scenarios summarize the amount of annual forage production if the summer is, for example, cool and dry, warm and wet, or has a normal temperature and precipitation. Users access the annual production scenarios at a specific location early in the growing season (June). Users can also use the information to do a post-season assessment in September.

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Use of Herbicide, Prescribed Burns, Interseeding, and Grazing as Tools in an Adaptively Managed Grassland Restoration

Monica Polgar[1], Breanna Kobiela[1], Edward DeKeyser[1], Miranda Meehan[1], Jace Stallman[2]

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Contributed Oral Presentation

Abstract

Native grasslands within the Northern Great Plains are facing detrimental homogenization due to invasions by Kentucky bluegrass (Poa pratensis) and smooth brome (Bromus inermis). To evaluate management methods capable of decreasing the competitive advantages of Kentucky bluegrass and smooth brome, while also improving site biodiversity and production, a randomized complete block design study was conducted to evaluate the effects of interseeding, spring burning, and glyphosate applications. The experimental design consisted of five treatments (sized 40 x 100 m installed within six blocks across 12.1 ha); 1) control (no treatment applications), 2) native species interseeding, 3) spring burn prior to native species interseeding, 4) glyphosate application prior to native species interseeding, and 5) spring burn plus glyphosate applications prior to native species interseeding. Following treatment applications in 2010, half the treatments were grazed from 2011 to 2013, until grazing was deemed to have no significant impact on seedling growth, and the full study site was opened to rotational grazing. An additional prescribed burn was applied across all treatments during the spring of 2020, in an adaptive effort to further control both target invasive species. In 2020 and 2021, biomass samples were collected through clipping eight 0.25 m^2 quadrats per treatment to assess influences on native species biomass, diversity, and richness, as well as Kentucky bluegrass and smooth brome biomass production. Analysis of variance (ANOVA) indicated between 2020 and 2021, there was a decrease in total biomass and native warm-season biomass, however this may be attributed to a severe drought present during the 2021 sampling period and not the additional prescribed burn. The spring burn plus glyphosate application prior to native species interseeding significantly decreased Kentucky bluegrass and smooth brome biomass production in comparison to the other treatments. Research efforts will continue to evaluate management implications for future grassland restoration projects.

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Using Grazing Management as a Restoration Tool in Prairie Streams

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[1]North Dakota State University, Fargo, USA. [2]USDA ARS, Ames, USA

Contributed Oral Presentation

Abstract

A major threat facing riparian systems is the potential for entrenchment and incision of stream channels. Using theory based on riparian complex state-and-transitions model concepts for prairie streams, an experiment was created to assess the potential for riparian grazing to facilitate stream succession towards a more stable state. Treatments included grazing exclusion (GE), rotational grazing (RG), and high intensity short duration (HISD) grazing. Cross-sections were collected from 13 reaches, across three streams in Southeastern North Dakota, with baseline data collected in August 2020 and in August 2021 following initial treatments. Geomorphic characteristics across stream reaches were categorized based on the Rosgen Stream Classification System (E, C, B), entrenchment ration (ER), bank height ratio (BHR), width-to-depth ratio (WDR), meander-width ratio (MWR), sinuosity, slope, and channel material size (D^{50}). Plant community components (PCC) and vegetation cover within greenline plant communities were assessed using Global Positioning System (GPS) and Line Point Intercept, respectively. Results from multivariate analysis of variance (MANOVA) analyzing the connection between stream geomorphic characteristics, produced no significant differences. Analysis of variance (ANOVA) produced only one significant change across geomorphic characteristics and plant community characteristics between years. There was a significant difference in percent change of ER between the HISD treatments, with the RG reaches having a higher ER. A similar, though not significant trend was observed for MWR. This is not surprising since both are metrics of floodplain accessibility. No significant differences were observed in vegetation, bare ground, soil surface, or basal cover. The results indicate a single season of rotational or high intensity short duration grazing within an adaptively monitored system may have longer term use opportunities towards restoring prairie streams. Grazing treatments and monitoring will continue in the future to evaluate influences treatments many have on stream geomorphic parameters and PCC over a longer period.

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Grazing treatment influences recovery of mesic grassland from drought: an assessment using UAV-enabled remote sensing

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Poster

Abstract

Drought is frequent on grasslands, often creating patches with reduced coverage of living (green) vegetation that, in turn, influence the trajectory of vegetation recovery following drought. Limiting the extent and sizes of low-cover patches thus should be a target of adaptive management on grazed grasslands, but quantifying patch sizes requires pasture (paddock)-level measurements at small spatial resolution (grain). We used airborne (unmanned aerial vehicle; UAV) remote sensing to measure green plant cover at a spatial grain of 8 cm ground sampling distance. From these measurements, we quantified the aerial extent and patch sizes of mesic grassland in central Texas, USA in which green plant cover was eliminated during drought in each of two grazing treatments (rotational, continuous). Remote measurements of the normalized difference vegetation index (NDVI), indicative of plant biomass, then were used to compare post-drought recovery of vegetation in patches that lacked vs. retained green plant cover during drought (not green vs. green). Seasonal drought eliminated green plant cover from 5-12% of grassland area. Across grazing treatments, 43% of the not-green area during drought occurred in large (>30 m^2) patches. NDVI recovered quickly from drought. Within two years, seasonal mean values of NDVI were similar or greater in previously not-green than green patches. Vegetation in previously not-green patches recovered rapidly because of a marked increase in relative abundances of early-season annual species. Recovery in NDVI was reduced in large compared to small (<1 m^2) patches that lacked green cover during drought and in the continuous vs. rotational grazing treatment. Our results imply that managers can facilitate drought recovery in mesic grassland by 1) adaptively managing grazing to reduce patch sizes of grassland that suffer complete loss of green cover, and 2) eliminating grazing pressure for several consecutive months annually following drought.

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The effect of arbuscular mycorrhizal fungi (AMF) inoculum to ameliorate competition on three keystone *Artemisia* species

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Contributed Oral Presentation

Abstract

Rangeland plant species from the genus *Artemisia* provide multiple goods and services in the semi-arid ecosystem of the Sagebrush Steppe in North America. The growth, survival and establishment of these species are influenced by competition with invasive plant species. Evidence suggests that the association with Arbuscular Mycorrhizal fungi (AMF) might provide stress amelioration by increasing nutrient uptake and water relations. Because of this, we tested the effect of applying a commercial AMF inoculum to ameliorate stress from competition with *Taeniatherum caput-medusae* and drought of the plant species *Artemisia tridentata ssp. wyomingensis*, *Artemisia arbuscula* and *Artemisia nova*. Stress amelioration was measured as an increase in biomass production and nutrient acquisition. We hypothesized that the commercial AMF inoculum would ameliorate stress on the *Artemisia*. We found that AMF colonization was strongly influenced by the two types of stress. Plants grown at high moisture without competition produced more biomass. The commercial AMF inoculation did not provide evidence of biomass increases. However, colonization from field soils resulted in a statistically significant increase on P concentration for *A. tridentata ssp. wyomingensis* from 0.36% to 0.49% and from 0.40% to 0.93% on *A. nova* when both were subjected to drought. However, *T. caput-medusae* increased in average its P uptake from 0.057% to 0.098% when inoculated with the commercial AMF. Questions remain about the biological implications from the results, and more research is needed. Understanding how AMF influence growth responses of important sagebrush steppe plant species may provide an insight into how they respond to soil microbial communities and use that knowledge for restoration programs.

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Determining if the Timing of Defoliation Alters the Seed Production and Viability of Medusahead Plants

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Poster

Abstract

The invasive annual grass medusahead threatens all rangelands throughout the western United States, degrading wildlife habitat and forage quality. Common management practices to control annual grasses and forbs is to reduce seed production through defoliation, by either grazing or mowing, just prior to seed emergence. However, due to the large size and rough topography of many rangeland pastures in the western U.S., it is not possible to achieve the necessary levels of defoliation while plants are in the desired phenological stages. This research examines the effectiveness of three defoliation treatments at different times (November, March, and May) throughout the 2019-2020 and 2020-2021 growing season to reduce medusahead seed production. Treatments were repeated in the same plots in both years. Following treatments, we collected seed production data for each of the three treatments and a control (non-defoliated) in July of 2020 and 2021. Seed production differed across all treatments between 2020 and 2021, as 2020 received well above average precipitation (53 mm above the 30-year normal) and 2021 was a dry year (28 mm below normal). The November and March defoliations did not differ from the control in either year (8,800 – 10,600 seeds m^{-1} in 2020 and 3,600 – 5,000 seeds m^{-1} in 2021). In both 2020 and 2021 the May defoliation decreased seed production compared to the November and March defoliations and the control (2,000 seeds m^{-1} in 2020 and 1,000 seeds m^{-1} in 2021). Our results to this point show that November and March defoliations do not reduce medusahead seed production compared to the control. However, it does confirm that defoliations later in the growing season (May) can effectively reduce seed production.

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Managing Medusahead Using Dormant Season Grazing in the Northern Great Basin

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Contributed Oral Presentation

Abstract

The invasive annual grass medusahead (*Taeniatherum caput-medusae*) threatens many rangelands throughout the western US, from the Columbia Plateau to the California Annual Grasslands and the Great Basin. Dominating secondary succession in the sagebrush steppe, medusahead can degrade the habitat of sagebrush steppe obligates such as the greater sage-grouse and pronghorn antelope. We conducted research that explores the potential of dormant season grazing as an applied management strategy to reduce the negative impacts of medusahead while promoting recovery of perennial vegetation at the landscape-scale. In particular, we assessed the following four grazing treatments from 2018 – 2020: traditional grazing (May – October), dormant season grazing (October – February), traditional+dormant season grazing (May – February), and no grazing. After two years of grazing treatments, biomass, density, cover, and fuel continuity did not differ between treatments ($p > 0.05$). However, biomass measurements were significantly different between years which is likely due to greater than normal precipitation in 2019 and 2020. Between 2018-2019, annual grass biomass increased by 81% (666 – 1,212 kg ha^{-1}) and perennial grass biomass increased by 165% (118 – 313 kg ha^{-1}). Litter biomass decreased by approximately 15% in every year since 2018 (2,374, 2,012, and 1,678 kg ha^{-1} in 2018 – 2020). There were no significant differences in cover or density of annual and perennial grasses between treatments and years. Our results indicate that two years may not be adequate time for dormant season grazing treatments to be effective in reducing the abundance of medusahead, and that after two years of treatments, dormant season grazing did not have a detrimental effect on perennial vegetation. This work is an example of an ongoing, long-term, landscape scale study developed through a collaborative process.

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Landscape changes and ecosystem services trends in central grasslands of northern Mexico

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Poster

Abstract

Grasslands are the most important ecosystem type in northern Mexico. Identifying the state of an ecosystem and changes in its condition can help detect critical transitions, especially in degraded areas. Restoration of degraded vegetation can improve the quality of ecosystem services, enhance human well-being, and prevent loss of ecosystem services. These efforts are important to promote sustainable regional development. In this work, we analyzed quantitatively, during 2000-2020, landscape trends in the central grassland areas of northern Mexico with the assistance of remote sensing tools. For that, the Normalized Difference Vegetation Index (NDVI) and the Habitat Quality index from the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model were used. Based on the results from the NDVI, the condition of vegetation decreased over the last 20 years. The impact of vegetation changes during the evaluation period was detected with the NDVI while the impacts of landscape changes were detected with the Habitat Quality index. Both, NDVI and the habitat quality showed a downward trend with a strong correlation coefficient. The results of this study confirmed the hypothesis that the analysis of landscape patterns and spectral indices reflect the status of the ecosystems, which can be used as information to alert about the critical conditions of some grasslands.

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ASSESSING RANGE-WIDE POPULATION PERFORMANCE OF GREATER SAGE-GROUSE USING A TARGETED ANNUAL WARNING SYSTEM

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Contributed Oral Presentation

Abstract

When local perturbations are absent, greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) populations exhibit long-term oscillations in abundance, which are driven by large-scale climatic patterns. Concurrent to long-term oscillations is short-term “noise”, which is governed by environmental and demographic stochasticity. Multi-scale spatiotemporal fluctuations in abundance make population performance assessments difficult, especially when additional information regarding metapopulation structure is absent. By incorporating metapopulation structure into a hierarchical population monitoring framework developed for sage-grouse across their range within the United States, we were able to identify moments of aberrant decline at lek sites (i.e., traditional breeding grounds), as well as local populations defined as lek clusters, which are likely attributed to disturbances on the landscape rather than environmental stochasticity or intrinsic factors across broader regions. We defined aberrant decline as a negative trend at a relatively small spatial scale that is also declining at a rate below the estimated trend at a much broader scale. Multi-year assessments of aberrant decline accounted for environmental and demographic stochasticity, as well as observation error, and identified populations exhibiting strong evidence of climatically corrected negative trends. Post hoc analyses that simulated management intervention at the local scale used metapopulation stability as a target for identifying optimal management intervention thresholds. Using this modeling framework, we can leverage annual lek count data to immediately inform when and where increased monitoring or direct management intervention may be needed to reverse negative trends.

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Improving Fire Resiliency and Building Community through Development of a Prescribed Burn Association

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

California's Central Coast Prescribed Burn Association (CCPBA) is training community members in skills needed to safely conduct prescribed burns. We also offer educational programs on home hardening and defensible space for landowners at the wildland-urban interface (WUI). Through the PBA, we are reducing fire fuel loads, making our communities safer, improving livestock forage, enhancing conservation values, and facilitating new relationships and opportunities in our community.

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Impact of Cattle Grazing on Greenhouse Gas and Particulate Matter Emissions from California Grassland Wildfires

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

Between 2010 and 2020, an average of 36,037 hectares of grassland burned in wildfires in California each year, emitting greenhouse gasses (GHG) and particulate matter (PM). These emissions impact climate and human health. Cattle grazing removes herbaceous fuel through the consumption of forage; however, ruminant digestion also emits GHG. The purpose of this study was to examine the GHG and PM impact of livestock grazing in grasslands that go on to burn. We used Monte Carlo simulation to determine whether forage consumed by livestock led to reductions in grassland wildfire emissions, and whether these reductions outweighed the emissions from digestion of that forage.

We estimate that between 2010 and 2020, an average of 11,590 metric tons (MT) of herbaceous fuel were removed by cattle annually from grasslands that went on to burn in California. This resulted in annual wildfire emissions reductions ranging between 0.001 and 0.025 million metric tons (MMT) of CO_2-equivalents (CO_2e), and between 11 and 314 MT of $PM_{2.5}$ -- after accounting for emissions from cattle grazing. These reductions are modest compared to total GHG and PM emissions from wildfires in California.

We also evaluated the difference in emissions that would occur if burned grasslands in the state's Central and Northern Coastal Regions were instead shrublands. In these regions, removing livestock grazing can lead to encroachment of shrubs into grasslands. If the grasslands that burned in these regions in 2020 had instead been shrublands, we estimate between 0.35 to 0.90 MMT more CO_2e, and 3,674 to 8,448 MT more $PM_{2.5}$ would have been emitted by wildfires compared to emissions from grazed grasslands, depending on shrub type. Importantly, the effect of shrub encroachment on radiative forcing associated with GHG is complex and more research is required to determine the long-term effect of grazing on global warming in this system.

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Can livestock foraging kinetics inform animal response to rangeland forage conditions?

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Technologies are now available to continuously monitor livestock foraging behaviors, but whether such measurements can inform management decisions remains unclear. Empirical studies in extensive rangelands are needed to quantify relationships between short-term foraging behaviors (e.g., minutes to days) and longer-term measures of animal performance. To gauge whether commercially available on-animal sensor devices can provide meaningful information for management, we conducted studies of a solar-powered GPS collar and a jaw movement recorder. In the solar-powered GPS collar evaluation, we examined whether four daily metrics of foraging behavior (grazing bout duration, grazing time per day, grazing velocity, and turn angle while grazing) are related to weight gain by yearling steers grazing semi-arid rangeland. Study paddocks varied in forage quantity and encompassed a wide range of forage conditions. A model based on only two daily metrics of foraging behavior, grazing bout duration and grazing velocity, explained 62% of the variation in animal weight gain.

Additionally, we validated a halter-based jaw movement recorder that uses a noseband sensor to measure jaw movements. Our validation included hourly grazing time (n = 36 h) and 10-minute measurements of bite rate (n = 564 grazing bouts) in paddocks dominated by shortgrass (*Bouteloua sp.*) or midgrass (*Pascopyrum, Hesperostipa sp.*). Compared to visual observations for hourly grazing time (overall Spearman's Rank Correlation: r_s = 0.95) and 10-minute grazing bouts (r_s = 0.80), the correlation between visual observation and halter-based measurements was 7% and 28% lower in lawn-like prostrate shortgrass than vertically-oriented midgrass swards, respectively. Metrics of foraging behavior vary substantially in response to varying foraging conditions in space and time and can effectively serve as indicators of variation in cattle behavior and performance. Further implementation of studies addressing continuous monitoring of livestock foraging will aid our ability to intensify animal agriculture and meet production and conservation goals sustainably.

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Digital Soil Mapping Driven by Ecological Site Concepts

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

The National Cooperative Soil Survey employs a diverse range of digital soil mapping (DSM) methods that combine field data and quantitative models to predict soil types or properties across a geospatial extent. One varying component among DSM projects is the design of the classes that represent soil type and become the output of the model. The Challis National Forest project utilized ecological site occurrence to group (or stratify) soils that exist together spatially, interpret similarly, and express analogous plant communities. This project applied Random Forests with recursive elimination and cross-validation to 1.6 million acres in Central Idaho. Training data from field observations were stratified by landform, then grouped by abiotic properties, including soil moisture, depth to restrictive features, chemical properties, rock fragments, slope, and texture. Climate and lithology models were independently validated and included as covariates, among other standard terrain and spectral derivatives. Initial results showed soil classes can be accurately modeled by ecological site groupings, climate, and lithology within landform stratifications. However, limited field observations from remote and rugged terrain create class imbalance and constrain model performance. Further refinement of classes is needed to achieve accuracy standards across all classes and is the focus of future work.

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FuelCast: Projecting forage yield in the growing season

Matt Reeves

USDA, USFS, RMRS, Missoula, USA

Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

Fuelcast.net gives advanced insight to the forage situation this year for western rangelands and pastures answering the question: *What can I expect this year for forage production?* The Fuelcast application begins making projections of rangeland forage and fuels four months ahead of the peak of green in your area. Estimates of rangeland production are driven by daily precipitation and drought information, and weekly remote sensing data. The Fuelcast system uses 38 years of annual production estimates to provide forward looking projections in the current growing season. The tool evaluates conditions up to 2 years in the past, which can influence the amount of production in the given year. Products include projected yield, projected yield compared with the long-term average, standing dead vegetation, and yield of annual grasses such as cheatgrass, red brome and desert annuals.

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What forage conditions can I expect this Year?

Matthew Reeves

USDA, USFS, Rocky Mountain Research Station, Missoula, USA

Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

Fuelcast.net gives you advanced insight to the forage situation this year for western rangelands and pastures answering the question: What can I expect this year for forage production? The Fuelcast is a deployed artificial intelligence application that begins making projections of rangeland forage and fuels four months ahead of the peak of green in your area. Estimates of rangeland production are driven by daily precipitation and drought information, and weekly remote sensing data from the Moderate Resolution Imaging Spectroradiometer (MODIS). The Fuelcast system uses this information and relates it to 38 years of annual production estimates from the Rangeland Production Monitoring Service (RPMS) enabling forward looking projections in the current growing season. Importantly the machine learning process allows the system to evaluate conditions up to 2 years in the past which can influence the amount of production seen in the given year depending on the type of vegetation being evaluated. In this session we will work together to discover how to access, interpret, and leverage this information to aid your management decisions, such as: should I sell? Should I buy hay? As a Federal land range management specialist should I send letters of pre-notice to permittees? In addition, we review past performance and provide evidence where the tool excels and where it needs more research.

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Leveraging AIM methodology and data to examine post-management responses across a mesquite encroachment gradient

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

Aided by numerous factors including extensive livestock grazing and drought, woody species such as honey mesquite (*Prosopis glandulosa* Torr.) have progressively encroached into historically grass-dominated ecosystems in the southwestern United States. This transition from grassland to mesquite shrubland causes concomitant reduction in native grass and forb species, increased soil erosion and redistribution of ecosystem resources, and ultimately decreases the ecological and economic services provided by these lands. Though mesquite may be effectively removed or reduced by control measures, the recovery of desirable herbaceous plant species could be dependent on degradation severity prior to management, and after a threshold is crossed, difficult to achieve even with active intervention. Further still, herbicide application reduces foliage that would otherwise shelter the soil surface from wind shear stress, potentially exacerbating soil erosion. To examine this, we established twenty sets of paired herbicide-treated and untreated 5-ha plots across a gradient of relatively low to high mesquite encroachment on the Jornada Experimental Range in southern New Mexico. Vegetation data following AIM methodology and UAV imagery were collected prior to and immediately following herbicide application in 2021 and will be collected semi-annually to monitor long-term plant community responses. Regional AIM data collected on comparable ecological sites will be used to estimate changes in aeolian sediment transport following the removal of mesquite foliage by herbicide. We expect these data will help landowners and managers determine when to invest resources into mesquite management given estimates of aeolian sediment flux and plant community recovery (or lack thereof) across a range of initial mesquite encroachment severity.

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Evaluating noxious weed control and vegetative community response: a four-level monitoring protocol.

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Poster

Abstract

Monitoring the outcome of noxious weed control and the response of the co-existing vegetation is often overlooked. However, interest in monitoring has recently increased, driven most notably by variable control and cost over the long-term, along with a greater need for environmental and fiscal sustainability. Land managers want monitoring methods they can use that are not too cumbersome to perform and provide an improved understanding of the effectiveness of their control actions and if, consequently, their desired vegetation increases. For larger land areas with many noxious weed species, monitoring information can also be used to adapt and maximize the efficiency of integrated weed management programs and prioritize species. We developed a monitoring protocol to help land managers, landowners, and others to determine the effective of their weed control measures on the target weed(s) and co-existing vegetation. The protocol has four levels that range in degree of complexity from Level 1 - for people with limited plant identification skills (estimate abundance of target noxious weed(s)) to Level 4 - for people with advanced plant identification skills (estimate abundance of target noxious weed(s) and all other species). The protocol includes information and examples of how to collect data and perform basic statistical analysis in Excel. The protocol was tested by land managers with a wide range of field sampling and data analysis skills, and improvements were made. Further evaluation of the protocol will be performed over a wide variety of rangeland habitats. Initial tests suggest the four levels provide the desired spectrum of complexity needed for a diversity of land managers and will provide sufficient statistical power to determine change in the plant community.

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The Art of Ranching

Jacie Rex

Colorado State University, Fort Collins, USA

Wilmer- (Ignite) Seeing the Southwestern Rangelands through the History, Art, and Culture

Abstract

The Art of Ranching Project: The Art of Ranching project at began in the summer of 2021 as a collaborative endeavor between CSU Extension and the Public Lands History Center. The project works to 1) recover the voices of ranchers and those who work on ranchlands in areas subsumed by tourism, second-home ownership, and development, and 2) facilitate intergenerational knowledge transfer by using 4H students to collect oral histories with Centennial and family ranches.

6

Changes in Meadow Phenology in Response to Grazing Management at Multiple Scales of Measurement

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Contributed Oral Presentation

Abstract

Riparian and ground-water dependent ecosystems found in the Great Basin of North America are heavily utilized by livestock and wildlife throughout the year. Due to this constant pressure, grazing can be a major influence on many groundwater dependent resources. It is important for land managers to understand how intensity and timing of grazing affect the temporal availability of these commodities (i.e., biodiversity, water filtration, forage, habitat). Shifts in forage or water availability could potentially be harmful for fauna that rely on them at specific times of the year. Seven meadow communities, each consisting of three distinct vegetative communities, were grazed at three intensities to determine the relationship between grazing management and phenological timing of vegetation. The agreement of on-the-ground measurements, near-surface digital cameras (phenocams), and satellite-based indices of greenness was examined for a three-year period (2019–2021) over these grazing and vegetative community gradients. Field determined phenology, phenocam Green Chromatic Coordinate (GCC), and Landsat Normalized Difference Vegetation Index (NDVI) were all highly correlated and the relationship did not change across the treatments. Timing of growth varied in these ecosystems depending on yearly precipitation and vegetative type. Communities dominated by mesic sedges had growing seasons which stopped earlier in the year. Heavier grazing regimes, however, did not equate to significant changes in growing season. Ultimately, shifts in phenology occurred and were successfully monitored at various spatial and temporal scales.

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Trends Analysis of Rangeland Condition Monitoring Assessment and Projection (RCMAP) Fractional Component Time-Series (1985-2020)

Matthew Rigge, Hua Shi, Kory Postma, Brett Bunde

USGS EROS, Sioux Falls, USA

Contributed Oral Presentation

Abstract

Rangeland ecosystems in the western United States are vulnerable to climate change, fire, and anthropogenic disturbances, yet available geospatial data for assessing trends in land condition, fire risk, and invasive species are often inadequate. The Rangeland Condition, Monitoring, Assessment, and Projection (RCMAP) product quantifies the percent cover of rangeland components, associated error, and component cover trends across the western U.S. using Landsat imagery from 1985-2020. Yearly cover maps were trained on unchanged portions of each year in the time series and post-processing models were applied to ensure accurate post-burn trajectories and eliminate noise and illogical change in the predictions. The current generation of RCMAP dataset has been extended through 2020 and has been improved with more training data, regional-scale Landsat composites, and enhanced change detection. We assess the temporal patterns in each component with a linear model and structural change method, typically applied to raw spectral values from satellite imagery, to find break points in the cover value time series using an 8-year temporal moving window. The linear and structural change methods generally agreed on gross patterns of change, but the latter found more change. The structural change model provides more robust statistics on the substantial portion of pixels with non-monotonic trends, while also detrending some interannual signal that may be superfluous from a long-term perspective. While break point density within one year of fire and vegetation treatments was ~10x and ~4x that of unburned areas, respectively, break point detection in the correct year of fire was only moderately accurate. Climate response was more robust, with strong spatiotemporal relationships between break point density and year over year aridity index change. Data provide spatially, temporally, and thematically (i.e., multi-component) detailed information on rangeland condition change and attribute change events to specific component(s).

1

Conservation of Landscapes Depends on the Integrity of the Family Ranch -

Roy Roath

Colorado State, Fort Collins, USA

**Other

Abstract

Conservation of Landscapes Depends on the Integrity of the Family Ranch - The Difficulties of Expanding Ranches to be Competitive in Current Day Environment

Todays' environmental ranchers must change with the times to remain viable. Ranches that are not making money won't/can't invest overt amounts of money in resource conservation. The expenses for ranch operations are high and the total revenue stream is often low. Ranchers must increase revenue stream (expand the operation) or find a way to subsidize the ranch. The reality is that ranchers must expand their base operation to be competitive. This is exacerbated by the desire add additional generations on the ranch. The complexity is added to the dilemma in that the price agricultural land is increasing rapidly to the point where the average ranch supported by products of the land can no longer afford to purchase land to expand their operation. In recent sales in the west, grazing land purchases have exceeded $1000/acre; far beyond the capacity of livestock or the current land base mortgage value to pay that price. Even if, the ranch uses their current equity to float the loan for new property they are less well off than before the purchase.

This proposed workshop will address the situation of local ranchers and explore the options that may be available to them. The approach is through a panel of local ranchers who have long experience in ranching and who are looking for solutions to the dilemma outlines above. The participants are Dr. Roy Roath Extension Range Specialist, semi-retired, and ranch raised, (facilitator); Kelly and Randy Bader (speaker) ranchers from southeastern Colorado, Dean Wang, (speaker)rancher and banker from Eastern Montana, Montana GLC board member; and John Welch,(speaker) rancher and semi-retired general manager of the Spade Ranches in the Texas panhandle.

5

Fire management alters the thermal landscape and provides multi-scale thermal options for a terrestrial turtle facing a changing climate

Ellen Robertson[1], Evan Tanner[2], Dwayne Elmore[1], Samuel Fuhlendorf[1], Jonathan Mays[3], Jennifer Knutson[1], John Weir[1], Scott Loss[1]

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Contributed Oral Presentation

Abstract

As effects of climate change intensify, there is a growing need to understand thermal properties of landscapes and their influence on wildlife. A key thermal property of landscapes is vegetation structure and composition. Management approaches can alter vegetation and consequently the thermal landscape, potentially resulting in underappreciated consequences for wildlife thermoregulation. Consideration of spatial scale can clarify how management overlaid onto existing vegetation patterns affects thermal properties of landscapes relevant to wildlife. We examined effects of temperature, fire management, and vegetation structure on multi-level, multi-scale habitat selection of an ectothermic vertebrate (the turtle Terrapene carolina triunguis) in the Great Plains of the central United States by linking time-since-fire data from experimental burn plots to turtle telemetry locations and thermal and vegetation height data. Within three 60 ha experimental landscapes, each containing six 10 ha sub-blocks that are periodically burned, we found that turtles select time-since-fire gradients differently depending on maximum daily ambient temperature. At moderate temperatures, turtles selected sub-blocks with recent (<1 year) time-since-fire, but during relatively hot and cool conditions, they selected sub-blocks with later (2-3 year) time-since-fire that provided thermal buffering compared with recently burned sub-blocks. Within 10 ha sub-blocks, turtles selected locations with taller vegetation characterized by cooler ambient temperatures. Thermal performance curves revealed that turtle activity declined as temperatures exceeded ~24–29°C, and on ‘heat-days’ (>= 29°C) 73% of turtles were inactive compared with 37% on non-heat days, emphasizing that thermal extremes may lead to opportunity costs (i.e., foregone benefits that turtles could otherwise accrue if active). Our results indicate that management approaches that promote a mosaic of vegetation heights, like spatio-temporally dynamic fire, can provide thermal refuges at multiple spatial scales and thus be an actionable way to provide wildlife with multiple thermal options in the context of ongoing and future climate change.

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Building climate resilience across California’s working rangelands

Leslie Roche[1], Grace Woodmansee[2], Daniel Macon[3], Tracy Schohr[4], Kate Munden-Dixon[5]

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

California’s landscape includes 34 million acres of rangelands supporting diverse ecological and socioeconomic resources; these lands include some of the world’s major biodiversity hotspots, encompass watersheds for nearly all of the State’s surface waters, and support a >$3B annual livestock ranching industry. Climate change and weather extremes specifically threaten California’s rangelands, which are largely rainfall-dependent and, therefore, greatly vulnerable to extreme hazards like drought. In fact, the impact of drought on the rangeland economy is the most devastating climate-linked event for the ranching community. Other challenges for ranching in the Nation’s most populous state include wildfire, invasive species, and land-use change—which all interact to create novel ecosystem conditions. Here, we’ll draw on more than 10 years of survey and interview data to highlight lessons learned from the California ranching community, including both multi-generation and first-generation producers, around responding to transformational changes that have threatened ecosystems and livelihoods.

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Decision support software for wildfire restoration within greater sage-grouse habitat in the Great Basin

Cali Roth[1], Peter Coates[1], Mark Ricca[2]

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Contributed Oral Presentation

Abstract

Unprecedented conservation efforts for sagebrush (Artemisia spp.) ecosystems across the American West have been catalyzed by risks from escalated wildfire activity that reduce habitat for sagebrush obligate species such as the greater sage-grouse (Centrocercus urophasianus). However, post-fire restoration is challenged by spatial variation in ecosystem processes influencing resilience to disturbance and resistance to invasive species, and spatiotemporal lags between slower sagebrush recovery processes and faster demographic response of sage-grouse to loss of habitat needed during critical life stages. Decision-support frameworks that account for these factors can help managers strategically apply restoration efforts by predicting short and long-term ecological benefits of actions. Using a multi-stage modeling approach, we extended and improved a spatially explicit decision support tool that optimizes post-wildfire restoration. We quantify restoration success by the ecosystem's resilience to disturbance (i.e., wildfire) and resistance to invasion, as well as the effectiveness of restoration relative to sage-grouse habitat suitability. This tool: 1) simulates post-fire landscape and habitat loss; 2) quantifies spatial variation in vegetation recovery like sagebrush community type, dominance, and annual grass invasion based on passive, sagebrush seeding and sagebrush seedling transplanting; and 3) incorporates predicted surfaces derived from models of sage-grouse selection, use, and survival to calculate improvements in post-restoration habitat suitability. The tool is fully automated within a web-based application and provides a user-friendly interface. The outputs include pre- and post-restoration seasonal habitat suitability surfaces for sage-grouse and ranks proposed restoration sites by cost-effectiveness. Findings are preliminary and provided for timely best science.

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Interactive effects of predators, habitat, and livestock presence on sage-grouse demography in Wyoming

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Contributed Oral Presentation

Abstract

Over the last century, greater sage-grouse (*Centrocercus urophasianus*, hereafter sage-grouse) distribution and abundance in western North America have significantly declined. Habitat loss and degradation are the predominant factors attributed to these declines, but predation in some contexts may also contribute. Livestock grazing has been identified as an influence on habitat potential, yet very little is known about the interactive effects of livestock management (e.g., grazing strategies), ecosystem processes (e.g., food web dynamics), and vegetative characteristics (e.g., forage, cover) on sage-grouse vital rates. During 2019–2021, we conducted a study in Bighorn Basin, Wyoming to investigate these interactions. We hypothesize that presence of cattle influences both avian and mammalian predators with more avian predators near some livestock and fewer mammalian predators. Subsequently, we hypothesize that lower sage-grouse predator abundance near livestock operations explains observed patterns of higher sage-grouse nest success. As part of our ongoing study, we will present initial findings of potential benefits and threats of cattle operations on sage-grouse nest survival. We will present an evaluation of nest success across multiple study sites with different grazing strategies, in addition to predator, livestock, and landscape-level covariates. This study will provide a better understanding of sage-grouse population dynamics associated with the presence of livestock. Understanding how livestock may or may not influence sage-grouse is essential to allow management agencies to make decisions on best management practices.

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An online toolkit for grassland conservation

William Rutherford[1], Steven Archer[1], Anne Gondor[1,2], Sheila Merrigan[1,2], Elise Gornish[1]

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Contributed Oral Presentation

Abstract

Shrub proliferation in grasslands jeopardizes the provision of numerous ecosystem services and may necessitate 'brush management' activities. There is little consensus on the ecological site responses and biophysical variables relevant for planning and guiding the decisions regarding the type (mechanical, herbicidal, cultural) and timing of brush treatments. Collaborating with *The Rangelands Partnership*, we sought to bring together outreach and research in the construction of a practical, user-driven, web-based 'toolkit' for determining options and opportunities for managing undesirable woody plants. We will review the nine recently created brush management decision-making and informational resource webpages in the *Rangelands Gateway* (https://rangelandsgateway.org/). Additionally, we will overview a prototypic, web-based geospatial decision support application currently in development for the proactive management of shrub encroachment. The application leverages existing knowledge to make timely management decisions without the necessity for extensive, expensive, and time-consuming field campaigns. The new web-app, developed using a southeastern Arizona case-study of Major Land Resource Areas 40 (Southeastern Arizona Basin and Range) with AZ 40.1 (Upper Sonoran Desert), combines existing, freely available data products (e.g., land cover, climate, soil, and ecological sites) with a new raster product demonstrating a site's risk for shrub encroachment. Using the Santa Rita Experimental Range (AZ) as our test location, upwards of 45% (~ 9,600 hectares or 24,000 acres) has a moderate to high risk for increased shrub cover. The toolkit aims to broaden existing brush management online resources while providing easily accessible decision support tools and research/management information for our stakeholders, while providing a framework for land managers and Extension educators to guide and enhance future toolkit functionality, relevance, and usability. The web-based toolkit expands the online presence of land grant university Extension, while promoting sustainable rangeland ecosystem management.

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A National Approach to Identify Soil Groups, Ecological Sites, and Resource Concerns

Shawn Salley

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

Ecological Site concepts provide a nationally consistent classification and information system for defining ecological land units for management. The ecological site classification partitions landscape into soil groups that share similar range of biophysical properties (soil, climate, and potential vegetation) and lead to similar responses to management and activities and disturbance processes. As Ecological Sites were often developed at fine thematic resolutions, challenges remain to nationally evaluate their efficacy and consistency. Leveraging soils and ecological data from the National Soil Information System (NASIS) and the Ecosystem Dynamics Interpretive Tool (EDIT), we developed rule-based classification algorithms to group soil properties to Ecological Site units for the continental U.S. and to characterize the ecological dynamics for those soil groups.

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Efficacy of manipulating reproduction of common ravens to conserve sensitive prey species: three case studies

Corina Sanchez[1,2], Brianne Brussee[2], Peter Coates[2], Kerry Holcomb[3], Seth Harju[4], Timothy Shields[5], Mercy Vaughn[6], Brian Prochazka[2], Steven Mathews[2], Steffen Cornell[7], Chad Olsen[4], David Delehanty[1]

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Contributed Oral Presentation

Abstract

Expansion of human enterprise across western North America has resulted in an increase in availability of anthropogenic resource subsidies for generalist species. This has led to increases in generalists' population numbers across landscapes that were previously less suitable for their current demographic rates. Of particular concern are growing populations of common ravens (*Corvus corax;* hereafter, ravens) because predation by ravens is linked to population declines of sensitive species. Ecosystem managers seek options for mitigating the adverse effects of raven predation where unsustainable predator-prey conflicts exist. We present three case studies examining how manipulating reproductive success of ravens influences demographic rates of two sensitive prey species. Two case studies examine impacts of removing raven nests or oiling raven eggs on nest survival of greater sage-grouse (*Centrocercus urophasianus*) within Wyoming and the Great Basin of California and Nevada, respectively. The third case study uses Mojave desert tortoise (*Gopherus agassizii*) decoys to examine effects of oiling raven eggs on depredation rates of juvenile desert tortoises in the Mojave Desert in California. Initial years from all three case studies were consistent in finding improved vital rates associated with the application of strategies for reducing reproductive success of ravens. Specifically, removal of raven nests resulted in increased nest survival of greater sage-grouse within treatment areas where predation by ravens was the primary cause of nest failure. In addition, nest survival of greater sage-grouse and survival of desert juvenile tortoise decoys was higher following a treatment of oiling the eggs of ravens in their nests at 2 sites within the Great Basin and 4 sites in the Mojave Desert in California. Our findings indicate that these management options are important tools for managing ravens, especially in areas where breeding ravens have negative impacts on sensitive prey species. Findings are preliminary and provided for timely best science.

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Predicting Soil Carbon/Health Using Remote Sensing

Eric Sant, Gregg Simonds

Open Range Consulting, Park City, USA

Contributed Oral Presentation

Abstract

Rangeland managers have many tools which can positively or adversely affect soil health by either mining the soil of water and carbon or storing water and carbon into it. Unfortunately, there are no viable metrics to assess soil health over large landscapes. Consequently, there is not a way to know how well these different tools work and their effect on soil health. Current methods are very expensive and have a limited spatial scope that do not describe landscapes. Using remote sensing to look at specific soil properties offers a potential solution to the quandary of promoting the effectiveness of rangeland management but not having the ability to assess the results of management tools. This presentation will explore some real-world trials where remote sensing was used to assess soil health in rangeland and urban settings.

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Developing quantitative ecological state keys to assess structural and functional ecosystem changes using standard monitoring datasets

Jeremy Schallner[1], Rachel Burke[2], Alexandra Heller[1], Sarah McCord[1], Brandon Edwards[1,3], Laura Burkett[1], Nicholas Webb[1]

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Salley- (Ignite) Ecological Sites: Emerging Research and Applications

Abstract

Ecological Site Descriptions (ESDs) and State-and-Transition Models (STMs) are tools frequently used by land managers to better understand management options across differing land potential and to assess rangeland condition including setting management goals and benchmarks. When ESDs and STMs include quantitative, standardized indicators of ecosystem structure and function, they facilitate land health assessments and management by enabling establishment of measurable and achievable benchmarks that can be tied to readily available monitoring data and indicators such as ground cover and soil erosion. Here, we present our efforts to develop quantitative ecological state keys from STMs for existing ecological sites in the northern Chihuahuan Desert, New Mexico, USA. The quantitative keys enabled us to classify monitoring plots collected on public and private rangelands (e.g., BLM AIM, NRCS NRI) to ecological state. We then interpret differences in ecological states as they relate to quantitative measured and modelled indicators of ecosystem structure and function which can inform our understanding of drivers of state transitions, and where conservation practices and restoration options are most appropriate. This approach provides a framework for relating quantitative indicators (e.g., wind and water erosion rates, plant species cover for wildlife habitat) to ecological state that can be included in existing and future ESDs, STMs, and other management tools. Coupling monitoring data with ecological state concepts will improve land management by explicitly including within-state indicator ranges and threshold responses of indicators to state changes in the decision-making process. This will enable managers to prioritize valuable ecosystem services, assess the success of management actions, avoid undesired state changes, and identify target areas for restoration or application of conservation practices.

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Multi-scale grassland loss restricts a generalist species safe operating space

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[1]University of Nebraska, Lincoln, USA. [2]Oklahoma State University, Stillwater, USA

Contributed Oral Presentation

Abstract

Grasslands worldwide have been under substantial stress over the past few decades, yet we are still battling some of the biggest threats to the grassland biome e.g. land use change since the beginning of the Industrial Revolution. Today, our ability to track global landscape changes have improved substantially with the advancement in remotely sensed monitoring products such as the Rangeland Analysis Platform. In North American rangelands, woody plant encroachment is the biggest threat grassland conservation this century. This study utilizes newly developed screening technology to identify early warning signals of grasslands in transition to woodlands using bobwhite as a generalist indicator of a landscape in transition. Our objectives are two-fold: 1) quantify cross-scale behavior of alternative grassy woody regimes/states in and two wildlife management areas (WMAs) (Packsaddle and Beaver) in Oklahoma, USA and 2) what are the patterns of bobwhite habitat selection that correspond with complex signals of cross-scale system behavior across these two wildlife management areas? Our results suggest the Great Plains biome is experiencing transitions across multiple scales i.e., from patch to biome. and that this has spill-over effects into wildlife management areas reducing suitable habitat, especially for Packsaddle WMA at this moment. Here, bobwhite specifically avoid areas undergoing significant transition. However, in Beaver WMA, the entire WMA is currently considered usable space. However, the incoming wave of undesired transitions is fast approaching, and management can be proactive to maintain core areas in Beaver WMA.

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PhenoMap: Monitoring seasonal conditions on rangelands

Charlie Schrader-Patton[1], Jackie Ott[2], Nancy Grulke[3]

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Haigh-Bringing Ranchers and Researchers Together to Create the Ultimate Ranch Drought Plan Toolbox (Workshop)

Abstract

Tracking seasonal changes in rangeland productivity – the timing and amount of forage -- has become difficult with increasingly unpredictable occurrence, duration, and intensity of drought conditions. Remote sensing provides a weekly "check-in" on forage production and development. By using MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data, the NDVI (Normalized Differential Vegetation Index) of grassland areas as small as 15 acres can be calculated on short time scales. NDVI is a proven proxy for vegetation "greenness". The web-based mapping tool **PhenoMap** uses NDVI data to provide **weekly assessments of vegetation greenness,** or phenology**,** across the coterminous United States. Weekly NDVI is closely tied to leaf stage development of the dominant grasses and therefore a good indicator of grass development. PhenoMap can provide land managers a method of closely monitoring rangeland vegetation as drought conditions develop and subside during the growing season as well as provide a historical context of how current grass development compares the mean value for the same week in the past. In addition to NDVI data for the past 4 weeks, PhenoMap also contains the current Standardized Precipitation Index (SPI), Soil moisture layers (SMAP), the US Drought Monitor, NWS Quantitative Precipitation Estimates and USA-NPN Growing Degree-Day data. PhenoMap does not require software purchase or installation; it is open to all users and can also be used on mobile devices.

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Soil seed banks across a grassland to shrubland gradient in the Northern Chihuahuan Desert, U.S.A.

Ryan Schroeder[1], Molly Reichenborn[1], Erik Lehnhoff[2], Dave Thompson[2], Akasha Faist[1]

[1]Department of Animal and Range Sciences, New Mexico State University, Las Cruces, USA.
[2]Entomology, Plant Pathology, and Weed Science Department, New Mexico State University, Las Cruces, USA

Poster

Abstract

Soil seed banks – living seeds in the soil profile and on the soil surface – represent primary sources of regenerative potential and buffering capacity against disturbance and degradation in dryland ecosystems. An emerging conceptual framework suggests that soil seed banks also degrade during observed aboveground vegetation state transitions to degraded alternate states. An on-going study across an ecological state gradient on the Jornada Experimental Range provides a timely opportunity to empirically test this conceptual framework. During the 2020 field season, 408 soil seed bank samples were collected across 17 sandy and shallow-sandy ecological sites, including desirable primary black grama (*Bouteloua eriopoda*) grasslands, mesquite-encroached shrub-invaded grasslands, and alternate state mesquite (*Prosopis glandulosa*) shrublands. Paired shrub-island and interspace seed bank samples were collected to a depth of 5 cm alongside aboveground vegetation community data. The germinable soil seed bank composition was quantified in the greenhouse from February 2021 to December 2021. Preliminary results show that seed bank densities and microsite distribution differed along a degradation gradient. Across this grass to shrub gradient, seed bank densities ranged from approximately 800 seeds m^{-2} in primary grassland states where densities were evenly distributed between shrub-islands and interspaces, to 1200 to 1700 seeds m^{-2} in shrub-invaded grasslands where seed densities tended to be greater in interspaces than shrub-islands, and 800 to 1300 seeds m^{-2} in alternate state shrublands where seed densities were concentrated under shrub-islands. These results support the notion that soil seed banks change along ecological state gradients and may be a useful indicator of state transitions (and potential trajectories) for ecosystem restoration and management.

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Co-production for management-science collaborations in rangelands: Lessons learned from the Collaborative Adaptive Rangeland management (CARM) research project

Terri Schulz[1], Nicole Kaplan[2]

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Wilcox-Strengthening Collaborations Between Researchers and Stakeholders: Linking Data and Management in Rangelands

Abstract

The Collaborative Adaptive Rangeland Management (CARM) project is a ten-year, ranch-level, participatory effort to explore how community-engaged research can increase co-production of knowledge/information to achieve multiple conservation and ranching outcomes. An eleven-member stakeholder group has a shared management responsibility in setting objectives, determining metrics to monitor, and determining vegetation/animal behavior triggers for livestock movement between paddocks in a rotation sequence. The stakeholder group is comprised of 3 non-governmental conservation organization representatives (Environmental Defense Fund, Bird Conservancy of the Rockies, and The Nature Conservancy), 4 state and federal agency representatives (USDA-Forest Service, USDA-Natural Resources Conservation Service, Colorado State University Extension, and State of Colorado Land Board) and 4 ranchers from a local grazing association.

Wildlife habitat, vegetation community, livestock production, and social learning objectives were co-developed in a collaborative process, along with governance and decision-making. This process relies on mutual trust as attaining multiple objectives consistently within and across years is challenging because of complex ecosystem interactions involving soils, ecological sites, weather, and climate. Over a dozen large data sets - including forage quality, precipitation, soil moisture, animal weight gain, vegetation structure, bare ground, plant density of key species - are produced to help inform stakeholders' decision-making within- and between grazing seasons. Throughout this research project, many lessons have been learned regarding enhanced two-way communications, effectively translating and displaying research data, valuing divergent ideas and opinions, increasing understanding of different perspectives, and reducing perceived disagreement among disparate groups and objectives in the shortgrass steppe rangeland ecosystem.

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Technology to Support Land Manager Decision-Making – Using LandPKS to Monitor Forage Utilization

Terri Schulz[1], Tegan May[1], George Peacock[2], Jason Karl[3], Jeff Herrick[4]

[1]The Nature Conservancy, Boulder, USA. [2]LandPKS, Boulder, USA. [3]University of Idaho, Moscow, USA. [4]USDA ARS, Boulder, USA

Poster

Abstract

A Forage Utilization module was developed and is now available to ranchers through LandPKS. Existing modules of LandPKS can assist land managers in knowing the potential forage production of their land by determining the soil and thus the ecological site for a given location. The associated Ecological Site Description (ESD) tells a manager what they are managing for and utilization will help managers know how to achieve their goals.

The app has two ways to quantify utilization. If looking at the entire community, the Landscape Appearance Method is appropriate. If evaluating key species, such as one or more forage species whose use serves as an indicator of the grazing use of associated species, the Key Species Method is appropriate. Both methods provide the ability to estimate utilization for herbaceous and browse species. We will highlight the methods as well as the training guidance currently available through the app and website.

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Why pastoralists need to be central to the global food and climate debate

Ian Scoones

PASTRES, Institute of Development Studies, University of Sussex, Brighton, United Kingdom

Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

In global discussions around food systems and climate, livestock are often painted as the villain. The dominant narrative is that livestock production must be reduced and diets must shift away from meat and milk. This is a stance being promoted by international agencies, campaign groups, celebrities, corporates and governments alike. Caveats are applied, but policy and media messages tend to simplify. While there is no doubt that some livestock production in some places contributes significantly to climate change, this is not universally the case. This talk focuses on extensive livestock production systems, including mobile pastoralism, that make use of rangelands on over half of the world's surface, involving many millions of people. Through examining the framing of scientific assessments and investigating the assumptions behind the standard calculations of greenhouse gas emissions, a systematic bias against extensive, mobile pastoralism is revealed. The talk identifies ten biases in conventional scientific assessments based on life-cycle analyses and argues that a wider 'systems approach' to assessing emissions is required, rooted in pastoralists' own knowledge. Current framings lump all livestock systems together, failing to discriminate between highly contrasting material conditions of production. A political economy of science and policy processes around climate and food that fails to understand pastoral contexts and perspectives can lead to policy responses that are unjust and discriminatory. Instead, pastoralists and other extensive livestock producers making livelihoods on the world's rangelands can show a way forward for improving both livelihoods and environments in ways not currently part of the global debate on the future of food and the climate.

See also, https://pastres.org/livestock-report/

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Rangeland recovery and control of *Ventenata dubia* with indaziflam and imazapic over five years

Lilly L Sencenbaugh, Jane Mangold, Lisa J Rew

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

The non-native annual grass *Ventenata dubia* is becoming more abundant in northwestern rangelands and effective herbicide treatments are needed. Herbicide treatments should be monitored long-term for both their effectiveness in removing the undesired species and the response of desired native vegetation. The herbicides indaziflam and imazapic have been recommended for use on *V. dubia* in rangelands; indaziflam has soil residual control for up to three years, while imazapic has shorter residual control. For five years after a single application, we studied the response of *V. dubia* and the desired community. In 2016 nine herbicide treatments including indaziflam, imazapic, and a combination of the two were applied post-emergent to a *V. dubia* infested pasture located outside of Springhill, MT. Percent cover of each species was estimated yearly from 2017-2021. In the first year *V. dubia* cover decreased the most in the indaziflam and imazapic combination treatment, followed by the imazapic treatment; the indaziflam treatment had the least control. Five years later (2021) there was almost no *V. dubia* present in the indaziflam treatments, while in the imazapic treatment, the *V. dubia* cover was lower than 2017, but it was still present. All treatments were successful at reducing the target species, but the indaziflam treatments were the most successful after five years. The community richness was not impacted by the herbicide treatments, and abundance of the dominant perennial grass increased. Indaziflam or imazapic may be useful tools for the reduction of *V. dubia* in rangelands without decreasing native richness while increasing forage, however indaziflam showed longer term residual control. This research highlights the importance of long-term monitoring of both target species control and desired species resilience following herbicide application.

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Spring Phenology Drives Range Shifts in a Migratory Arctic Ungulate with Key Implications for the Future

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Contributed Oral Presentation

Abstract

Annual variation in phenology can have profound effects on the behavior of animals. As climate change advances spring phenology in ecosystems around the globe, it is becoming increasingly important to understand how animals respond to variation in the timing of seasonal events and how their responses may shift in the future. We investigated the influence of spring phenology on the behavior of migratory, barren-ground caribou (*Rangifer tarandus*), a species that has evolved to cope with short Arctic summers. Specifically, we examined the effect of spring snowmelt and vegetation growth on the current and potential future space-use patterns of the Porcupine Caribou Herd (PCH), which exhibits large, inter-annual shifts in their calving and post-calving distributions across the U.S.-Canadian border. We quantified PCH selection for snowmelt and vegetation phenology using machine learning models, determined how selection resulted in annual shifts in space-use, and then projected future distributions based on climate-driven phenology models. Caribou exhibited strong, scale-dependent selection for both snowmelt and vegetation growth. During the calving season, caribou selected areas at finer scales where the snow had melted and vegetation was greening, but within broader landscapes that were still brown or snow covered. During the post-calving season, they selected vegetation with intermediate biomass expected to have high forage quality. Annual variation in spring phenology predicted major shifts in PCH space-use. In years with early spring phenology, PCH predominately used habitat in Alaska, while in years with late phenology, they spent more time in Yukon. Future climate conditions were projected to advance spring phenology, shifting PCH calving and post-calving distributions further west into Alaska. Our results demonstrate that caribou selection for habitat in specific phenological stages drive dramatic shifts in annual space-use patterns, and will likely affect future distributions, underscoring the importance of maintaining sufficient suitable habitat to allow for behavioral plasticity.

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Quantitative assessment of range use effects on fire behavior

Matthew Shapero[1], Lenya Quinn-Davidson[2], Roxanne Foss[3], Jeff Stackhouse[2], Luke Macaulay[4], Stephanie Larson[5]

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

In a landscape of increasing fire potential in the wildland-urban interface, land managers and livestock operators need more than the existing anecdotal evidence to confidently apply necessary stocking rates for fire hazard reduction. This study examines the intersection between grazing (grassland biomass measurements) and fire behavior (severity and rate of spread) utilizing prescribed fire as a wildfire surrogate. The desired outcome of this research is to improve the way we manage our working rangelands to intentionally reduce fire hazards and improve ecological resilience by quantifying the impact of grazing intensity on fire behavior metrics.

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COVER CROP CONSIDERATIONS FOR RANGELAND RESTORATION

Brianna Slothower[1,2], Anthony Falk[3,1], Sandra Rideout-Hanzak[1,2], Dustin Golembiewski[1,2], Emily Bishop[1,2], David Wester[1,2]

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Contributed Oral Presentation

Abstract

A cover crop is a crop grown to protect the soil surface from damage. These crops have been used primarily in agriculture, but have also been recently included as a management tool in native grass restoration. A previous study seeded an annual grass cover crop alongside a native grass mix after the installation of a petroleum pipeline; two years post-restoration, plots seeded with a cover crop + native grasses had lower invasive grass biomass than plots seeded only with native grasses As an extension to this project, we designed a cover crop + native grass experiment at another pipeline site. We want to know how (1) seeding date and (2) two different cover crop treatments affect native grass and invasive grass establishment over time. We measured seedling density in 0.5 m^2 quadrats 3 and 12 months after seeding. Native grass density was highest in early native grass seeding despite limited rainfall. Invasive grass density was highest in the control, but was not different in treatments that were seeded with native grasses, regardless of time of year. Lastly, the legume cover crop treatments yielded the highest native grass density after 3 months following seeding, but after a year, native grass density was not different among treatments.

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Eastern red cedar (Juniperus virginiana L.) tree growth dynamics in South Dakota

Alexander Smart, Nolan Litterer, Lan Xu

South Dakota State University, Brookings, USA

Poster

Abstract

Eastern red cedar (*Juniperus Virginiana L*.), a native coniferous tree to the eastern United States, has been rapidly expanding into the Northern Great Plains region threatening biodiversity and forage production for grazing livestock operations. We were interested in understanding the growth dynamics of eastern red cedar trees along a temperature (north-south) and precipitation (east-west) gradient in South Dakota to guide management decisions. We collected growth related dynamics (tree height, canopy area, tree trunk basal diameter, tree ring (age), and tree ring growth rate at six locations in South Dakota. At each location 40 trees were destructively harvested from four height classes (50-100 cm, 100-150 cm, 150-200 cm, and 200-250 cm). Tree height was strongly linearly related to tree rings (age) at all locations. Trees in the southern counties were taller with age compared with the trees located in the central and northern locations of South Dakota. Tree ring growth rate and tree trunk basal diameter was linearly related to tree age, while tree canopy area was curvilinear related to tree age. It appears that trees in southern locations of South Dakota grew faster (height, canopy area, basal diameter) than in central and northern locations. The implications are such that tree canopy closure will occur more quickly in the southern regions of South Dakota than in central and northern regions. The locations in western South Dakota received less annual precipitation than the locations in eastern South Dakota and the trees in the western locations were generally slower growing in all parameters. This information, combined with tree recruitment data, will be helpful to build forecast models of eastern red cedar tree expansion in South Dakota.

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HOW CHAINING DECADENT STANDS OF SAGE BRUSH CAN INCREASE FORAGE PRODUCTION

Dallen Smith[1], Taylor Payne[2]

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Smith-Options for Improving Forage Production on Western Rangeland for Sustainability

Abstract

Chaining has been used for almost 80 years to increase forage production on land that has become dominated by juniper or sagebrush. The practice of chaining can be used to prepare seedbeds in shrub rangeland. In this case study, we will introduce you to the equipment used and the procedures followed by the Willis family to triple forage production in a drought year on an upland site dominated by Mountain Big Sagebrush. Chaining and reseeding increased forage yields of control from 55 pounds per acre to 176 pounds per acre which is an increase of 121 pounds per acre.

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Wildfire Fuels Monitoring Using Remote Sensing

Wayne Smith, Eric Sant, Gregg Simonds

Open Range Consulting, Park City, USA

Poster

Abstract

Fine fuels allow wildfire to spread across the interspace of the sagebrush landscape. Monitoring the buildup of fine fuels is critical to mitigating wildfire. Fine fuels can be defined as Residual Dry Matter (RDM). RDM is composed of standing dead and decomposing herbaceous plant material. RDM has been a standard method of measuring the impact of grazing on rangelands, now it is being used to measure fuel and there by the potential for a wildfire. Open Range Consulting (ORC) has developed a method of measuring RDM using remote sensing. This method maps RDM at a high resolution across a pasture, allotment, or whatever scale a project is on. ORC can measure RDM through a season and for previous years. This technique can cheaply and accurately measure RDM across the vast sagebrush landscapes. Using RDM as a measure of fine fuels allows a land manager to evaluate the landscape to see where RDM is accumulating and provide opportunity for mitigation measure to be put into place.

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Encroachment and Management of Western Juniper

Laura Snell[1], David Lile[2]

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Poster

Abstract

Western juniper (Juniperus occidentalis) has invaded over three million acres of sagebrush rangelands in northeastern California becoming the dominant vegetation over the past 100 to 140 years. While juniper is a native species and old-growth sites in the 1000 year old range are not uncommon, juniper was largely contained to fire safe locations, such as rocky shallow soils that naturally lacked understory vegetation to carry fire. Juniper is a very well adapted and competitive species. Over time, it will outcompete understory vegetation for limited soil moisture, sunlight, and space. Although juniper can be milled for flooring or cabinets and used for firewood, it does not have a high commercial value. The first step to juniper control is conducting a pre-treatment site assessment and selecting a site. Factors such as soils, aspect, precipitation, juniper dominance, and understory plant community will be discussed. The next step is selecting your treatment techniques which could include a combination of mechanical, chemical, hand, and fire. After treatments are completed, post treatment management including rangeland restoration, seeding, and grazing is important. The last step is future follow up treatments and management. Controlling juniper provides forage and habitat for livestock and wildlife by restoring a more productive and diverse understory grass and shrub plant communities. Restoring these invaded rangeland ecosystems also improves hydrologic function and subsurface flow in an already arid environment. Special attention is being given to Juniper encroached landscapes through species management strategies such as the Sage Grouse Initiative and water management regulations such as the Sustainable Groundwater Management Act in California. This focus has provided supplemental income for juniper removal projects and provided resources for landscape scale treatment opportunities.

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IDENTIFYING AND PRIORITIZING HABITAT RESTORATION FOR LESSER PRAIRIE-CHICKENS ON RANGELANDS IN THE MIXED-GRASS PRAIRIE

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Contributed Oral Presentation

Abstract

Collaboration between agencies and private landowners has been an integral part to conserving grassland habitat for lesser prairie-chickens (LPCH) in the southern Great Plains. However, recent efforts aimed at increasing the quantity and quality of LPCH habitat within the mixed-grass prairie ecoregion has resulted in very little change in population size suggesting a potential disconnect between current self-sustaining subpopulations and potentially suitable habitat for LPCHs. As such, providing tools to rangeland managers to better prioritize habitat restoration and identify habitat suitable for LPCHs at both the regional and ranch scale is crucial for the long-term persistence of the species. Our objectives were to 1) develop a highly conservative, spatially explicit habitat suitability model using ensemble approaches to combine predictions from multiple modeling techniques for areas currently occupied by LPCHs in the mixed-grass prairie ecoregion, 2) identify areas of unoccupied habitat potentially suitable for LPCH reintroductions, and 3) prioritize areas for habitat restoration based on proximity to existing subpopulations and potential for increased connectivity. We developed habitat suitability models using regression approaches and Random Forest models to compare landscape-level habitat conditions within 5 km of known lek locations and paired random points. Predictions from all models were then ensembled into one model to provide highly conservative estimates of habitat suitability. Finally, to further prioritize areas for habitat restoration, we used a least cost path analysis to identify potential corridors connecting current subpopulations to potentially suitable, unoccupied habitat. Our final ensembled habitat suitability model should assist future reintroductions and guide rangeland managers in prioritizing specific areas for habitat restoration by conservatively identifying habitat conditions that predict the presence of LPCH leks in the mixed-grass prairie ecoregion.

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Evaluation of current rangeland conditions and trends on non-Federal rangeland community types (K.E. Spaeth)

Kenneth Spaeth

USDA-NRCS, Weatherford, USA

Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

Evaluation of current rangeland conditions and trends on non-Federal rangeland community types (K.E. Spaeth)

The USDA-NRCS in cooperation with Iowa State University's Center for Survey Statistics and Methodology, Ames, Iowa, USA, has conducted large-scale resource inventories for >65 years to assess US natural resources on non-federal lands. On rangeland, the inventory process has evolved from qualitative assessments in the early 1980s to robust quantitative field methods that have been used since 2003 to the present. The NRI rangeland on-site study is scientifically based, using a randomized statistical methodology where each point has a calculated expansion factor which represents the number of hectares for the sample point on the landscape. The full field methodology includes foliar and ground cover estimates by species using line-point intercept; production determination by species; plant height measurements by species; field soil stability test; identification of resource concerns; disturbances, and conservation needs; rangeland health assessment; full plant census; and photographs taken at random points on the landscape. In this paper, a summary analysis of pertinent NRI data relevant to rangeland conditions and trends is presented for several key rangeland types in Omernick level II ecoregions, I will specifically examine how this information can be used to identify the impact of conservation practices with regard to existing trends and projected changes in climate, as well as potential transformational change that will require new responses.

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Rangelands through Murals and Other Public Works of Art

Taylor Spence

Independent Artist and Historian, Albuquerque, USA

Wilmer- (Ignite) Seeing the Southwestern Rangelands through the History, Art, and Culture

Abstract

Contributing to the development of a love of the land and a sense of belonging and ownership, white North American settlers commissioned public art works and murals that enshrined rangelands, open spaces, and the control and domination of those spaces starting in the 1930s. How many of those public images persist? What do these images represent now in an era when different groups are challenging settler dominion of Western lands? How can we broaden the meaning of a love of the land to include more ways of loving and belonging? My contribution to this panel explores some of these questions through public art about Western rangelands.

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Sustainable Southwest Beef: Evaluating innovations from pasture to plate

Sheri Spiegal[1], Andres Cibils[2], Jean Steiner[2], Rick Estell[1], Brandon Bestelmeyer[1], Matt McIntosh[1], Stephanie Bestelmeyer[3], Skye Aney[1], Emile Elias[4], Glenn Duff[5]

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

Consumers and producers worldwide are paying attention to the environmental and social impacts of the beef industry, demonstrating preferences for beef produced with high standards of animal welfare, environmental quality, and well-being of agricultural communities. At the same time, major pressures such as climate change impacts, market variation, and disease complicate prospects for achieving the environmental, social, and economic targets that result in sustainable beef production systems. Climate impacts are especially pronounced in the Southwestern US: as temperatures rise and rainfall becomes more erratic, forage production is decreasing and ranching input costs are increasing. Also, this region is dependent on other regions for finishing its ranch-raised cattle – and ultimately for marketing the beef from the cattle originating in the Southwest. A team of 25 organizations led by New Mexico State University and funded by the National Institute of Food and Agriculture is exploring the performance of three management strategies with promise to improve sustainability outcomes in these conditions: heritage cattle genetics, digital ranching, and alternative finishing options include grass-finishing on southwestern rangeland and recycling the feedlot manure produced by cattle that originate on southwestern ranches. We will introduce our integrated research/extension/education approach and describe how we are using a supply chain perspective to understand and communicate the tradeoffs of the three strategies under investigation, from pasture to plate. We will also provide context for the other talks and discussions in the symposium and make sure the attendees are well prepared to enjoy and learn with the SRM community in the session.

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Patch-burn grazing increased structural heterogeneity in southwestern North Dakota rangelands

Jonathan Spiess[1,2], Devan McGranahan[3], Benjamin Geaumont[4]

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Poster

Abstract

Persistent land use change throughout the North American Great Plains increases the need to maintain and improve ecosystem service delivery from remaining rangelands to meet production and conservation goals. In this study, we investigated the efficacy of patch-burn grazing to increase structural heterogeneity on semi-arid post-Conservation Reserve Program grasslands in southwestern North Dakota. We surveyed plant community composition and structural characteristics in patch-burn grazing pastures during the 2017 – 2020 summer grazing seasons. Three pastures were stocked with cow-calf pairs and three stocked with sheep. We also surveyed structural characteristics on units with conventional management (hay or idle) for active and post-CRP enrolled grasslands during summers 2018 – 2020. We tested for vegetative and structural differences between patches with varying time since fire and between grazer type on patch-burn pastures using mixed-effect models and ordination. We used variance partitioning to determine if structural contrast on patch-burn pastures increased over the study period and if structural contrast was higher on patch-burn grazing pastures relative to conventional management. Time since fire was significant for all structural characteristics with recently burned patches being different from other patches. There were no structural differences between cattle and sheep pastures, but forb and legume cover were lower in sheep pastures. Structural contrast on patch-burn pastures increased over the study and was greater than conventional management. Increased structural heterogeneity is important for supporting a broad suite of rangeland wildlife and can also stabilize forage production. This study supports the expectation that patch-burn grazing with moderate stocking rates will increase structural contrast regardless of grazer type, but practitioners should consider which suites of species that management may benefit.

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Using fire to maintain coastal rangelands of California

JEFFERY STACKHOUSE[1], Lenya Quinn-Davidson[1], Josh Davy[2]

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Larson-How to Build Rangeland Resiliency through Grazing & Prescribed Fire

Abstract

Currently, woody encroachment is one of the largest contributors to losses of rangelands in the west. Different regions face different species and rates of encroachment, but arguably, all types of encroachment create ecological impacts. Along California and Oregon's coastlines, one of the mid-successional species is *Baccharis pilularis* (coyote brush), followed by transition from brush to nonmerchantable trees in regions with adequate rainfall. This shift takes highly productive rangelands out of livestock production and reduces ranch profits. *Baccharis* control is particularly challenging because of its ability to aggressively resprout, requiring expensive mechanical removal, herbicide application, or repetitive prescribed fire. We monitored the efficiency and cost of three mechanical treatments, four common herbicides with differing timing and application methods, and three single entry prescribed fires on their ability to control *Baccharis*. Managers wanting to reduce *Baccharis* encroachment should consider a multi-pronged approach of costly (~$340/acre) mechanical treatments with a dozer when and where necessary, mid-cost (~$68/acre) herbicide treatment of glyphosate at 10% v/v drizzle application in the fall where accessible, and utilize the cheaper (~$15/acre) prescribed fire option on any sites where burns can be conducted safely with moderate to high fire intensity. Unfortunately, permit requirements and limited weather windows reduce the availability of prescribed fire as a tool in California, but the economics of fire make it worth the effort to accomplish successful projects at the ownership scale.

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A web interface for exploring and setting benchmarks for land management

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Poster

Abstract

Land managers make their decisions informed by the best available data. Data require interpretation in order to be applied to management decisions, however. One method for interpreting quantitative data is the application of quantitative benchmarks. Benchmarks are values or ranges of values for a given measured indicator of landscape function which can be used to classify the data into management categories such as “meeting” and “not meeting” objectives or “unsuitable,” “marginal,” and “suitable” habitat. Importantly, benchmarks can be tied to covariates like soils, landforms, or ecological sites, which then enables the application of benchmarks as a layer of interpretation. This practice is already widespread with applications like the Sage-Grouse Habitat Assessment Framework which uses benchmarks tied to season of use to classify measured indicator values according to habitat suitability classes. However, most potential use cases for benchmarks start with the difficult determination of the benchmark values for each classification category.

In order to empower land managers to set their benchmarks, we have created a web application, the Benchmark Exploration Tool. This tool allows users to upload their own monitoring data or download data from the Landscape Data Commons and visualize them as histograms. Users are able to set quantiles to plot in the generated figures in order to better intuit the distribution of their data. Users can also set and apply benchmarks, based on policy, local knowledge of ecosystem structure and function, or other sources. This allows users to see how different benchmark values might affect their interpretation of the data. All figures and tables produced by the tool can be downloaded for use in reports or other documentation.

With this tool, land managers can better understand their data and establish data-driven benchmarks for their management efforts.

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Livestock Mortality Composting to Mitigate Livestock Predator Interactions

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Poster

Abstract

When a large animal dies on your farm or ranch, there are often few options for disposal. In California, there are limited legal options especially as rendering facilities have closed, regulatory burden has increased, and predators have increased in numbers. Livestock Mortality Composting could be a viable solution. Composting of mammalian tissue is legal in most states and recommended for on-farm disposal of livestock mortalities but is currently illegal in California. Instead, many ranches have used "bone piles" to dispose of livestock mortalities. This option has been shown to attract large predators such as wolves, mountain lions, bears and others making it a hazard for livestock operations and increased livestock-predator interactions. Removing these bone piles is the number one attractant removal recommended by Oregon Department of Fish and Wildlife. Mammalian tissue composting is also a viable option for waste from on-farm animal processing especially as this practice has become more popular the last few years. After navigating the regulatory oversight of multiple local and state agencies, a livestock mortality composting site was approved for research at the Intermountain Research and Extension Center in Tulelake, CA. This site has composted four adult cows and demonstrated the effectiveness and safety of this process. Results on temperature and as well wildlife interactions at the compost pile verse nearby bone piles are presented. A best management practices document is currently being written to provide an on-farm livestock mortality composting exemption. This exemption could be carried out at the local, regional, or state level although permanent changes to this policy will most likely need a legislative change.

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Rangeland compost amendments improve productivity and methane uptake

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Contributed Oral Presentation

Abstract

Grasslands store 12% of the world's carbon stock and may be a more reliable source of sequestration than forested lands in the face of increasing fire, drought, and heat with climate change. Land management strategies to sequester soil carbon on working lands may be an important solution to climate change, but more research is needed to understand how the effects of management such as organic amendments differ across diverse landscapes in the dryland southwest. Thus, we added compost to five ranches across New Mexico that range in annual precipitation from 250mm to 425mm. We assessed the effect compost amount (0, ¼, ½, and 1”; two ranches), type (food waste, manure waste, or biosolids; two ranches), and exposure time (6m to 3y; one ranch) on aboveground biomass and gas fluxes in dry rangelands. We measured plant aboveground and belowground productivity and recorded carbon dioxide (CO2) and methane (CH_4) in the monsoon season of 2021. Overall, we found that compost generally increased aboveground biomass and CO2 emissions but reduced CH_4 emissions or even increased CH_4 uptake compared to controls. We found that aboveground biomass and CO2 emissions increased with 1” of compost added (~60% for each, $P < 0.05$, $P = 0.11$, respectively) but CH_4 emissions were always at least 2x lower ($P < 0.01$), and even ¼” of compost had beneficial effects. There were not strong differences in biomass or fluxes with different types of compost over short (< 6 month) time scales, and also not strong differences with compost that had been in place up to 3y (though the site was extremely dry when monitored). Our results suggest that compost amendments may be valuable for forage production, stimulation of the decomposition process in the soil, and importantly, uptake of methane, a potent greenhouse gas.

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The effect of various rates of compost addition on aggregate stability and infiltration rate

Eva Stricker, Janet Garcia

Quivira, Albuquerque, USA

Poster

Abstract

Some dry rangelands have been degraded due to past management practices and face challenges in restoration in light of changing climate. Active restoration may be required to build productivity and resilience of grasslands in order to support the people, livestock, and wildlife that rely on these regions. Compost applications have shown promise on rangelands in California, but little is known about the effectiveness of compost for improving soil health and water relationship in dry, monsoon-driven environments such as the Chihuahuan Desert and southern Great Plains grasslands. Additionally, for compost to be used at larger scales, we must optimize applications to meet producer's goals and constraints. Thus, we measured and compared aggregate stability using a dip test and infiltration rate of the second inch across three different compost applications of 0.25", 0.5" and 1" (n=3) at Sol Ranch in Wagon Mound, NM and Polk's Folly Farm in Cedar Crest, NM. Each application rate was spread onto two replicate plots and a no-compost control was included in comparisons. At Sol Ranch, as compost amount increased from control to 1", aggregate stability increased 30%; At Polk's, there was not a change in aggregate stability with compost addition (interaction compost x site $P < 0.05$). Infiltration rate decreased at both sites by at least 5 minutes from control to 1" addition (compost $P < 0.05$). Our results show that compost addition can increase soil health and reduce water runoff and soil surface evaporation with the largest amount of compost application having the biggest effect. This research offers reproducible methods to improve upon the rangeland outcomes of past land management practices and help adapt these rangelands to a changing climate.

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The Prairie Project: Learning about Woody Brush Encroachment Outside the Classroom, College Station, USA

Erika Sullivan, Morgan Treadwell, Laura Goodman, Ben Wu, Erin Ingram, Maria Macik, Jenny Keshwani

The Prairie Project, College Station, USA

Poster

Abstract

Over the past hundred years in the Southwestern Great Plains a takeover of woody plants has been occurring. This woody plant encroachment has been disrupting the hydrology, biodiversity, production, and overall nutrient cycling of rangelands. However, new tools and techniques such as prescribed burning, patch-burn grazing, and pyric herbivory have been developed to help remove and prevent these woody invaders from spreading. In addition, new technology applications such as the Rangeland Analysis Platform (RAP) have been created to help assist in the managing/monitoring of America's rangelands. The Prairie Project strives to use this current knowledge on woody plant removal/monitoring and apply it into the hands-on, in-field classrooms of 4H and FFA students. A protocol has been created that will allow for students to use RAP to analyze the effects of (prescribed fire, patch-burn grazing, and multi-species grazing) on the four different plant types (grasses, forbs, shrubs, trees) found on rangelands. Students will actively participate and engage with Demonstration Ranches that have employed multi-species grazing, prescribed burning, and patch-burn grazing to manage woody brush encroachment. Students will be given full access to these ranches, including virtually, with identifiable pasture treatments relying on the RAP during the first year and in-field assessments the following year. Students will actively determine changes in percent cover of (grasses, forbs, shrubs, trees, bare ground) on pastures with history of prescribed fire, no fire, pyric herbivory, traditional rest rotations following fire, and multi-species grazing, and single-species grazing. More importantly, students will become familiar with each unique Demonstration Ranch and the philosophies of each owner/operator. This relationship will be evaluated as students progress through the Prairie Project as informed agents of change based on action research.

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Innovations in Mechanical Equipment for Habitat Enhancement in Utah

Daniel Summers, Kevin Gunnell, Ron Larsen, Jesse Newton, Melissa Landeen

Utah Division of Wildlife Resources, Ephraim, USA

Poster

Abstract

Utah's Watershed Restoration Initiative (WRI) is a partnership based program in Utah to improve high priority watersheds throughout the state. One contribution from the Utah Division of Wildlife Resources (DWR) is to provide specialized mechanical equipment to partners to improve the restoration and enhancement of important habitats. DWR has modified or improved various mechanical implements to help improve restoration outcomes. A few examples include: a dozer mounted mechanical scalper to establish browse in grass dominated rangelands; tractor mounted scalper; modified broadcasters; large chains and chain harrows for seedbed preparation; modifying rangeland drills for different purposes; wheel packer imprinters, and other equipment improvements. All of this equipment is available to partners within WRI. Feedback from project managers allow our skilled personnel to continue to adapt and improve the equipment.

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A new perspective and approach to ecosystem restoration: a seed enhancement technology guide and case study

Lauren Svejcar[1], Vanessa Brown[2], Alison Ritchie[2], Kirk Davies[1], Tony Svejcar[3]

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Contributed Oral Presentation

Abstract

Restoration efforts in dryland systems are often limited by a complex range of environmental variables and chronically low establishment of seeded native species. Methods for restoring large tracts of degraded drylands in the western United States and southwestern Australia have not advanced substantially since the early 1900s despite continuous efforts to improve success. Historic agricultural practices used in large scale restoration efforts are often unsuccessful. A multidisciplinary approach towards problem resolution is necessary for future advancements in restoration applications and methods. Specifically, agricultural technologies such as seed enhancements should be applied to native restoration approaches. Seed enhancement technologies, such as activated carbon coating and extruded pelleting, are novel in the restoration context. However, their use is increasingly recognized as an opportunity to overcome current limitations to restoration efforts. At this early juncture in the development of seed enhancement technologies within restoration, we reflect on the need to tailor current agricultural technologies in light of the differences between agricultural and restoration contexts and re-conceptualize our approach to seed enhancement technologies. In this talk we provide a guide for the development of seed enhancement technologies in ecological restoration.

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Avian Predator Occupancy and Diet at Communication Sites in Sage-Grouse Habitat

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Contributed Oral Presentation

Abstract

Habitat fragmentation resulting from anthropogenic features can pose a threat to Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter, Sage-Grouse). Studies have shown that Sage-Grouse avoid tall structures, and both transmission lines and communication towers have been linked to Sage-Grouse nest failure, lek abandonment, and extirpation. These unnatural features provide nesting and perching substrates for ravens and other avian predators of Sage-Grouse and their nests.

We designed a field study to assess how the design, arrangement, and location of communication towers influence nesting and perching of avian predators within Sage-Grouse habitat. In the 2021 pilot season, we conducted 449 visits to 285 communication sites located in 60 sage-grouse habitat clusters across Oregon, Idaho, Nevada, and Wyoming. Site visits consisted of a point count survey, measurements of available nesting substrate, inventory of avian predator nests, and collection of genetic materials for dietary analysis.

Naïve occupancy of avian predators observed during point count surveys at communication sites and the surrounding landscape was 71.8%. We discovered predator nests at 29/285 (10.2%) communication sites. Pilot data suggests avian predators preferentially nest on large, wind-blocking antenna types, and areas of the tower structure with dense steel lattice. Whenever possible, we collected all fecal materials, pellets, and prey remains found under avian predator nests at communication sites and on other tall structures within the 60 Sage-Grouse habitat clusters (sampling units) surveyed. We are currently in the process of extracting, amplifying, and sequencing mitochondrial RNA of the prey species present in the ~800 samples collected.

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Diet botanical and chemical composition of cattle grazing under short duration and deferred rotational grazing management systems on puna rangelands

Raúl Tácuna, Enrique Flores

National Agrarian University La Molina, Lima, Peru

Poster

Abstract

Grassland researchers have postulated that one of main the disadvantages of deferred grazing is that the quality of the diet is lower than other grazing systems because the animals encounter overmature grass when they enter the paddock. The objective of this study was to compare the composition of the diet under this system with one of short duration for four years. The experimental design was completely randomized 2 x 2 factorial, where the treatments resulted from the combination of two grazing systems: short duration (SD) and deferred rotational (DR), and two seasons (wet and dry). The results showed that there was an effect of the grazing system on the botanical composition of the diet between SD vs DR. Grasses were the main component of the diet (79.9 vs 86.5%, P <0.01), followed by grass-like plants (11.0 vs 7.3%, P = 0.02) and forbs (9.0 vs 6.2%, P = 0.04), respectively. The animals preferred leaves (67.8 vs 78.3%, P = 0.01) over stems (26.3 vs 15.4%, P <0.01) and flowers (5.9 vs 6.4%, P = 0.59) and green (74.4 vs 78.3%, P = 0.05) over dead (25.6 vs 21.7%, P = 0.05). Diet quality was similar between SD vs DR systems, in vitro dry matter digestibility (41.5 vs 40.0%, P = 0.25), neutral detergent fiber (76.6 vs 78.5%, P = 0.20) and crude protein (9.6 vs 8.9%, P = 0.39). There were no interactions between grazing systems and the season, but the diets were of lower quality during the dry season. It is recommended to investigate the role of forage allowance and grazing pressure in the nutritional response in grazing systems.

Keywords: native plants, short duration, deferred rotational, composition and quality of diet.

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Range condition and health under seasonal continuous, short duration and deferred rotational grazing on Andean rangeland

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Poster

Abstract

Grazing systems are a low cost, investment and risk tool to improve the ecological status of native grasslands. The purpose of this study was to evaluate the variation of the ecological condition and health status of a puna tussock, dominated by *Festuca humilior*, managed under three grazing systems: seasonal continuous (SC), short duration (SD) and deferred rotational (DR), for a period of four years. The experimental design was a completely randomized 3 x 4 factorial with covariance. The results showed that grazing systems improved the condition of the rangeland SC: 39.1%, SD: 53.1% and DR: 58.3%. The systems also improved the health status and its attributes biotic integrity, site stability and hydrologic function respectively, SC (2.4, 2.2 and 2.5), SD (1.7, 1.8 and 1.7), DR (1.6, 1.6 and 1.5). The improvement in the hydrologic function was reflected in higher rates of infiltration and soil moisture SC (0.19 cm/min and 25.8%), SD (0.25 cm/min and 30.1%) and DR (0.35 cm/min and 38.7%). The best ecological response obtained with deferred rotational grazing was associated with a greater accumulation of biomass, soil protection and reproduction of key plants. While in short duration grazing was probably due to a better control over pressure, forage allowance and grazing density, key variables in grazing management.

Keywords: native plants, short duration, deferred rotational, condition, health status.

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Ranch Economics of Targeted Grazing for Wildfire Control

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Contributed Oral Presentation

Abstract

Targeted grazing in the Great Basin has been used to reduce cheatgrass fuel loads to enhance wildfire control. In this project, we evaluate the economic impact of targeted grazing on cow-calf ranches across southeast Oregon, northeast Nevada, and southwest Idaho when practices such as fencing, water hauling, and herding are necessary for producers to accomplish desired grazing outcomes. Large and small representative ranch models were developed for Major Land Resource Areas 23, 24, and 25 where applicable. Typical targeted grazing cost were obtained from producer focus groups in each state and introduced into ranch economic models. Targeted grazing periods begin one month before typical BLM turnout in the spring and again in the fall after typical public land grazing ends. In each year, targeted grazing would occur when the previous growing season (September to March and April to August) had more than 25% of median precipitation based on PRISM historical data. Hence, targeted grazing could occur in the spring, fall, or both depending upon precipitation. In both seasons, targeted grazing continues until the desired AUMs are removed. One hundred precipitation data sets were randomly generated using Excel to mimic the actual number of drought years in the spring and fall. The model is a 40-year recursive linear programming model using 100 cattle price sets and the 100 precipitation sets. Results are averaged over the 10,000 runs and compared to the scenarios with no targeted grazing and targeted grazing based on the actual precipitation data set. Results show changes in cattle herd size, hay sales, and the economic impacts to the public ranch operation for 2 ranch sizes in each of the 3 MLRA's by state.

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Assessing the Impacts of Mid-Contract Management on Lesser Prairie-Chicken use of Conservation Reserve Program Lands

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Contributed Oral Presentation

Abstract

The lesser prairie-chicken (Tympanuchus pallidicinctus; hereafter "LPC") is a declining species of North American prairie grouse that has benefited in recent decades from the enrollment of the Conservation Reserve Program (CRP) in the Southern Great Plains. Despite the potential of CRP to influence LPC conservation, empirical evidence of how individuals and populations function in relation to spatially explicit CRP cover is lacking. Moreover, temporally explicit events such as mid-contract management associated with CRP contracts may have impacts on the use of these lands by the LPC. In this study, we sought to determine how mid-contract management (i.e., prescribed-grazing) of CRP influenced movement patterns of LPCs. From April to January 2014-2015, we captured and fitted GPS transmitters to LPCs on a lek located within CRP in Beaver County, Oklahoma. Prescribed grazing (30 cow/calf pairs on 122 ha) associated with mid-contract management was implemented on 2 July 2014 and lasted 84 days. We found similar relationships across treatment (experiencing prescribed grazing) and control groups with regards to the interaction between the proportion of the step length in CRP and whether or not the step length ended in CRP. Step lengths did not differ across grazing periods (pre-, during, or post-) when a movement ended in CRP for the treatment group whereas there were differences for the control group. Our results suggest that the mid-contract management associated with individuals in our study did not influence LPC movement patterns during this practice. This potentially highlights that managers and conservation scientists should think about habitat quantity rather than quality or composition in human-influenced matrices within the LPC distribution. However, our sample size is limited and future research should explore how the timing and variation in specific mid-contract management practices may change these relationships.

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Modeling sagebrush recovery across the Western United States using three decades of remote sensing products

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Contributed Oral Presentation

Abstract

Ecosystems dominated by sagebrush (*Artemisia* spp.) extend over much of the Western United States and increasingly face various threats from disturbances such as fire and exotic annual grass invasion. Effective management is needed to counter these trends, but understanding the conditions that determine when, where, and at what rate, sagebrush recovery will occur is a pressing research need for prioritizing and implementing restoration efforts across this vast landscape. We developed a framework for modeling and predicting sagebrush recovery across the sagebrush biome (1985–2020) by taking advantage of multiple datasets covering large extents, including vegetation estimates derived from remote sensing (Rangeland Condition, Monitoring, Assessment, and Projection), restoration practices (Land Treatment Digital Library, Conservation Efforts Database, Utah Watershed Restoration Initiative, Oregon Watershed Restoration Inventory), fire (Landsat Burned Area), and soil moisture. When combined, these datasets yielded analysis-ready data at an unprecedented extent, including from >700 wildfires (nearly 2 million ha) and >270 other disturbances (nearly 80,000 ha). We assessed the influence of environmental factors (e.g., soil moisture), disturbance type (e.g., wildfire, brush removal), and restoration treatment (e.g., aerial seeding, herbicide application) on trends in sagebrush cover. Our results will facilitate stewardship of the sagebrush biome and hosted species by providing a variety of spatially explicit predictions and projections of sagebrush recovery, thereby informing regional planning and on-the-ground restoration efforts. These analyses also will support on-going efforts, including economic cost-effectiveness analyses, studies of sage-grouse (*Centrocercus urophasianus*) responses to post-fire restoration, and restoration prioritization tools that optimize management efforts targeted at wildlife species of conservation concern.

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Economic Impacts of Removing Federal Grazing Used by Cow-Calf Ranches in Wyoming, Idaho, and Oregon

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Contributed Oral Presentation

Abstract

Questions have arisen in the past about the economic impact of removing federal grazing from public land ranches. We have built ranch models for the primary Major Land Resource Areas (MLRA) in Wyoming, Idaho, and Oregon to estimate how the ranch would be affected by the loss of the federal grazing permits. Ranch models were based on recursive linear programming models where the ranch operated for 40 years with 100 different cattle price sets. The results from those models show the impact on ranch sales from changes in herd sizes and hay sales. The ranch models were constrained to find the profit maximizing number of cattle sales. Results from the ranch models are then aggregated to the state level using USDA Forest Service and USDI Bureau of Land Management grazing AUM information allocated to MLRAs in each state. The change in sales is then used as input into a 2019 IMPLAN economic impact model for each state. The IMPLAN model is adjusted to include a specific beef cattle sector and a specific hay sector. Results from IMPLAN show the change in economic output in each state, change in employment, and labor income. This includes the direct impact on the ranches, indirect impacts from the loss of purchases by the ranch from other regional businesses, and induced impacts from the loss of household purchases by ranch and support sector employees from other regional businesses.

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Aiding native plant community recovery with seed restoration treatments in semi-arid climates

Erin Teichroew, Colter Mumford, Lisa J. Rew

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Poster

Abstract

Plant communities are often slow to recover after invasive species control, which may be due to depleted seedbanks. However, seeding to increase desired species is expensive and often not successful. We conducted a study to evaluate if: 1) different seeding methods (broadcast and seed pellets at 20.2 kg/ha) and timing (fall and spring) improved seeding success, and 2) seedling recruitment increased along a native grass cover gradient. Three seeding treatments (fall broadcast (2020), spring broadcast, and spring pellets (2021)) were compared along a native grass gradient after application of imazapic (fall 2017-2018; 0.42 kg/ha ai) to reduce B. tectorum cover. Complete species counts and basal cover estimates were collected to analyze changes in biodiversity. Seeding method did not have any effect on richness, evenness, or alpha diversity. Seedling recruitment was very low and did not differ along the native grass gradient. Bromus tectorum cover was associated with higher alpha diversity due to increased evenness with no difference in richness and did not differ along the native grass gradient.

The seed pellets remained largely intact over the summer, possibly due to drought which inspired a greenhouse study to determine the amount of precipitation required for the seed pellets to break apart. We compared different sized pellets (1.5, 2, 2.5 cm) with different rates of watering (0, 2.5, 5, 10, 15, 30 mm) which correlate with mean storm totals for winter and spring in southwestern Montana. Each pot received its prescribed rate of water daily until the pellets broke apart. This information will help inform the optimal size of pellets for restoration projects based on mean storm totals.

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Understanding cheatgrass distribution and response to climate change using soil moisture and germination modeling

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Contributed Oral Presentation

Abstract

Cheatgrass continues to threaten western rangelands by converting shrublands to exotic annual grasslands. Currently, cheatgrass has expanded to fill over 30% of the Great Basin and is likely to continue expanding. Typically, cheatgrass distribution is determined using satellite imagery to build spatially extensive maps. However, these models often require a combination of wet/dry years to make a distribution map, tell us little about the drivers of cheatgrass distribution, and cannot be used to explain/predict interannual variation in cheatgrass abundance. Being an annual grass, cheatgrass is highly dependent on soil conditions to germinate and grow. Combining soil moisture and germination models could create a more mechanistic model to predict annual cheatgrass abundance and distribution. Using a soil moisture model (SHAW), we predicted hourly temperature and water potential of soils at 2600 field sites across the sagebrush steppe. We then applied germination curves to modeled soil conditions to explain field observations of cheatgrass cover in a linear model. Our model successfully predicted cheatgrass presence at 72% of field sites in our test dataset (850 sites), a similar accuracy to modern remote sensing approaches. The model however, explained little variance in cheatgrass cover (15%) underperforming remote sensing approaches (~30%). We hindcasted our model to understand if favorable conditions for cheatgrass are becoming more prevalent, but found that changes in climatic soil conditions 1983-2018 had little effect on cheatgrass range expansion. Using a germination/soil model was an effective method to accurately identify locations where cheatgrass can grow. Using only microclimate variables, our model predicts cheatgrass distribution as well as common NDVI approaches that are post-hoc analysis of satellite images. Our results support the idea that expansion of cheatgrass in the West is likely not driven by climate factors, but rather driven by propagule pressure, disturbance, and seed availability.

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Plant Community Composition Changes Following Twolined Spittlebug (*Prosapia bicincta*) Infestations in Hawaii Rangelands

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Poster

Abstract

Twolined spittlebug (TLSB), *Prosapia bicincta*, (Hemiptera: Cercopidae) was first detected in Kailua-Kona, Hawaii in September of 2016 where it had damaged over 2,000 acres of rangeland. In 2017 four locations were selected for long-term, monthly monitoring of TLSB activity, population dynamics, and changes in plant community composition. Two of the monitoring sites were at the center of the initial infestation while the other two were located outside the northern and southern boundaries of the known distribution of the pest to estimate rate of spread. At each location a series of 100-m long transects was established along elevational gradients between 500 and 1850 m. Along each transect ten sample points were systematically established every 10 m alternating from left to right of the transect line. A 0.25-m^2 ring was placed at each sample point to record vegetative cover by species, percent live and dead grass by species, vegetation height by functional group, and TLSB nymph abundance and host associations, and adult presence. The monthly surveys revealed TLSB expanded its range from the initial 2,000-acre infestation to over 176,000 acres in approximately eight generations. In highly infested areas, TLSB resulted in nearly 100% die back of key range grasses including Kikuyu (*Pennisetum clandestinum*) and pangola (*Digitaria eriantha*) grasses when nymph densities exceed 50/m^2. The loss of these important forages provided entry for the establishment of invasive plants including Pamakani (*Eupatorium adenophorum*), wild blackberry (*Rubus* spp.), fireweed (*Senecio madagascariensis*), Hilograss (*Paspalum conjugatum*), and other weeds. Each season the pest was active between March and October with two population peaks before entering diapause over the winter. Peak nymph densities often reached over 150 nymphs/m^2 resulting in complete loss in grass cover and subsequent replacement by unpalatable weeds. The establishment and spread of TLSB has devastating impacts on the ecosystem services Hawaii rangelands provide.

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Strengthening RREA Through Enhanced Connections: A Web-based Conference Series

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Poster

Abstract

The Renewable Resources Extension Act (RREA) was passed by Congress “to provide for an expanded and comprehensive Extension program for forest and rangeland renewable resources” with a funding level of $30,000,000. Since 2002, RREA appropriations have been maintained at $4,060,000, well below the authorized limit set in 1978. While small, RREA funding is integral to renewable resource extension programing within land-grant institutions. Many forestry and range Extension professionals have developed innovative and effective programs to address RREA strategic issues. However, their successes are not generally known outside of their land-grant universities. Until now, few opportunities existed for increased awareness of these programs. This web-based conference series provided opportunities for Extension professionals to: 1) strengthen and create new networks; 2) develop regional and national collaborations addressing RREA strategic issues, and 3) learn innovative approaches for stakeholder education. The purpose was to increase capacity among Extension professionals through a cross-pollination of ideas, approaches, technology use, and methodologies that would lead to more informed, better-served stakeholders and a stronger RREA program. The RREA webinar series included nine sessions organized around critical issues identified in the 2018-2022 strategic plan that featured innovative programing tools or approaches. In total, the webinars featured 26 professionals across 14 land-grant institutions. Each session was presented live, recorded, and uploaded to a website for future access and review. A discussion thread was started for each session to allow speakers and participants to continue engagement. Across all nine webinars there were 1069 registrations and 649 participants with 59% of participants working in Extension. Post-webinar surveys revealed that 53.6% gained information and planned to adopt what they learned, 23.8% learned something new and 11.6% wanted to learn more. More than 96% of respondents indicated that what they learned was somewhat to very likely to enhance their existing Extension programing.

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Potential and Challenges for Remotely Detecting Livestock Welfare Concerns

Colin Tobin[1], Derek Bailey[2], Mark Trotter[3], Kelsey Nelson[2], Cory Oltjen[2], Caroline Wade[2]

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Long-term models predict increases in population, which will result in greater demand of food and fiber. Increasing meat production has historically impacted animal welfare. The Farm Animal Welfare Council created the "Five Freedoms" to guide development of standards and management practices to minimize welfare concerns for livestock. Although created for confined livestock systems, the Freedoms can be utilized for the caretaking of rangeland livestock. Monitoring livestock well-being on rangelands through visual observation is labor intensive, expensive and often impractical. Remote monitoring technologies can identify livestock welfare concerns associated with each of the Five Freedoms. Real and near-real time technologies that combine global positions systems, accelerometers and other sensors have the potential to provide producers notification of changes in livestock behavior that can occur during onsets of disease, parturition, or infrastructure failure while on rangelands. However, many challenges still exist with these technologies, especially for rangeland livestock. Variability among sensors, individual animals, and atmospheric conditions could cause false alerts which may frustrate ranchers. The cost, durability and reliability of the sensors as well as the ease of use and interpretation of data could potentially prohibit many producers from adopting remote sensor technologies. Additional research is needed to develop algorithms to predict normal behavior as well as the deviations in behavior that occur when illness and other factors adversely affect animal welfare.

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Effects of long-term ungulate herbivory on soil constituents associated with C3 and C4 perennial grasses in the Edwards Plateau region of Texas.

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Poster

Abstract

Soil is the matrix for plant life and is thus a keystone resource in terrestrial ecosystems. Carbon and nitrogen are essential elements of organic molecules involved in life processes. Savannas provide grazing for domestic livestock and ungulate wildlife and are increasingly recognized as among the most at-risk ecosystems globally. Soil characteristics in a given ecosystem vary spatially with respect to plant species and distribution. There is a need to better understand spatial dynamics of soil carbon and nitrogen in grazed savanna ecosystems. In the summer of 2019, we evaluated nitrate nitrogen (NO3N), organic matter (OM), and organic carbon (OC) in clay loam soils at the Texas A&M Sonora Research Station. The objective of the study was to determine the effects of depth (1 cm vs 2 cm), landscape position (under *Bouteloua curtipendula* [C4] vs *Nassella leucotricha* [C3] canopy) and long-term grazing history (no ungulate herbivory, wildlife herbivory only, and moderate livestock and wildlife herbivory) on these parameters. At each point (n = 60 samples total), soil (~500g) was collected from near the base of a grass plant and later analyzed in a laboratory. Differences in NO3N, OM, and OC were determined by analysis of variance procedures. NO3N (ppm), OM (%), and OC (%) averaged 1.97 ± 0.25, 8.41 ± 0.42, and 4.78 ± 0.24, respectively. Long-term grazing history and landscape position were significant ($P < 0.01$) predictors of all soil constituents measured. Samples with no ungulate herbivory were consistently lowest, while samples under C3 canopy were consistently highest. Both OC and OM tended ($P < 0.1$) to be greatest at 1 cm vs 2 cm depth. Long-term exclusion of large herbivores has not increased soil constituents associated with native perennial grasses in this study. Management that affects distribution of C3 and C4 grasses will affect soil constituents.

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Portable near infrared reflectance spectroscopy as a tool to determine rangeland soil composition.

Douglas Tolleson[1], William Fox[2], Forrest Cobb[3], Edward Osei[4], Jesse Wood[5], Jason Brooks[5], Roel Lopez[6]

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Poster

Abstract

Emerging ecosystem goods and services markets have the potential to reward rangeland managers for maintaining or improving attributes such as soil carbon and organic matter. Rapid, accurate, and cost-effective assessment of soil chemical properties will facilitate their application in both research and management. An experiment was conducted to determine the ability of portable near infrared spectroscopy (NIRS) to quantify percent organic matter (OM) and carbon (OC) on rangeland soils in the Permian Basin of Texas. Two sites on the same soil type (Kinco – Fine Sandy Loam), one chemically treated in 2020 to kill Honey Mesquite (*Prosopis glandulosa*) and one non-treated, were selected. Within each site, 12 points were located adjacent to a mesquite shrub or, in an interspace. At each point, soil samples (~500g) were collected at the surface or ~30 cm deep. Soils were stored in plastic Whirl-Pak® bags and transported to a laboratory for analysis after spectra (400-2500 nm) were collected using an ASD FieldSpec® with contact probe directly through the Whirl-Pak® bag. Calibrations were developed using multiple partial least squares regression. Multiple coefficient of determination (RSQ) was 0.62 for both OM and OC ($P < 0.05$). Slope was also 0.62 for both OM and OC. Standard error of calibration was 0.07 for OM and 0.04 for OC. Principal component and linear discriminant analyses yielded correct identifications ($P < 0.05$) in 9/12 treated and 8/12 non-treated samples; 10/12 mesquite shrub and 8/12 interspace samples. Although statistically significant, portable NIRS calibrations for OM and OC were not strongly predictive. Larger and more diverse data sets will be required to develop portable NIRS calibrations capable of predicting important chemical properties in rangeland soils under different land management regimes.

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The short-term effects of woody plant management practices and landscape position on rangeland soil organic carbon.

Douglas Tolleson[1], William Fox[2], Forrest Cobb[3], Edward Osei[4], Jesse Wood[5], Jason Brooks[5], Roel Lopez[6]

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Poster

Abstract

Rangelands have varying ability to sequester carbon. Rangelands comprise 50% of Earth's surface. Emerging carbon markets, in an effort to monetize ecosystem goods and services, are creating opportunities and challenges for rangeland managers. Timely and accurate quantification of soil carbon is needed to inform managers and enable transparent commodity trading. Woody plant treatments are often applied in rangeland restoration efforts. In fall of 2021 we evaluated soil organic matter (OM) and carbon (OC) with the objective of determining the effects of chemical woody plant treatments in the Permian Basin of Texas. Two sites on the same soil type (Kinco – Fine Sandy Loam), one chemically treated (T) in 2020 to kill Honey Mesquite (*Prosopis glandulosa*) and one non-treated (N) were selected. Within each site, 12 points were located adjacent to a mesquite shrub or, in an interspace. At each point, soil samples (~500g) were collected at the surface or ~30 cm deep. Soils were stored in plastic Whirl-Pak® bags and transported to a laboratory for analysis. Differences in OM and OC were determined by analysis of variance procedures. Standardized precipitation index was -0.15 in 2019, -0.97 in 2020 and 0.9 through October for 2021. Percent OM was numerically greater but not statistically different ($P > 0.1$) in N (0.48 ± 0.3) and T (0.42 ± 0.03) sites, under shrubs (0.28 ± 0.02) and in interspaces (0.24 ± 0.02), as well as at 30 cm (0.27 ± 0.02) compared to the surface (0.25 ± 0.02). Similar results were obtained for OC ($P > 0.1$): N (0.28 ± 0.2) vs T (0.24 ± 0.02) sites; under shrubs (0.28 ± 0.02) vs interspaces (0.24 ± 0.02); and at 30 cm (0.27 ± 0.02) vs the surface (0.25 ± 0.02). Longer term data will be required to inform soil carbon management trends on these sites.

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Comparison of residual effects of Ivermectin as a parasiticide on soil nutrient cycling, plant biomass and dung beetle abundance in different seasons

Shiva Torabian, Joshua Leffler, Lora Perkins

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Poster

Abstract

Rangelands cover more than 40 percent of the earth's terrestrial area and are critical for livestock production. Hence, knowledge of the key ecosystem processes contributing to healthy rangelands is important for global food security. Nutrient cycling in rangelands is closely linked to the decomposition of dung, facilitated by dung beetles with subsequent movement of nutrients into soil and uptake by plants. Additionally, abiotic factors such as temperature, and soil moisture impact activity of dung beetles and decomposition. Any change in these variables can disrupt nutrient cycling and forage production. Increasing use of anthropogenic chemicals in livestock production can alter key controls on decomposition. For example, parasiticides in animal dung can affect the abundance of dung beetles; but the magnitude of the effect of parasiticides may depend on seasons which change activity and abundance of dung beetles. Therefore, our goal is to examine the effect of ivermectin, the most commonly used parasiticide, in cattle dung on nutrient cycling in soil and dung, and plant biomass in a grassland during spring and summer. In this study, cattle dung with zero, low (2 mg kg^{-1} dung), and high (10 mg kg^{-1} dung) concentration of ivermectin were placed in a grassland in western South Dakota in July 2019 and May 2021. We monitored the N content of dung, soil, the abundance of dung beetles, and plant biomass for 63 days. The results indicate that residual ivermectin in dung may not affect N content of dung and soil in spring when dung beetles were less abundant. In the summer, when dung beetles are more abundant, ivermectin decreased soil inorganic N. However, the impact of ivermectin on plant biomass was less than hypothesized both in spring and summer.

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The Prairie Project: Learning to Do and Doing to Learn

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Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Two of the main objectives of the extension component of the Prairie Project are (1) develop agents of change and future range managers who can facilitate the efforts of owners/operators in adopting pyric herbivory and multi-species grazing and (2) promote peer-to-peer learning and foster mentorship of all ages in the learning process as well as the development of online and social media resources—such as short videos, podcasts, student documentaries, virtual field trips, and media productions—to support all activities and reach broader audiences and adoption of pyric herbivory and mixed-species grazing. All intensive extension activities were facilitated by both education and extension colleagues to effectively connect to real-world rangeland management. Four demonstration ranches were identified in Texas, Oklahoma, and Nebraska. These ranches routinely implement multi-species grazing and pyric herbivory at a variety of scales to combat woody brush encroachment. Both web-based (Rangeland Analysis Platform) and real-time data from demonstration ranches were developed to forge connections with ranch managers and 4H/FFA students through ranch tours, workshops, and field days throughout 2020 and 2021. Coupling demonstration ranches and building collaboration between members of the ranch manager cohorts and 4H/FFA cohorts has enabled monitoring research for building evidence-based demonstrations while providing high-impact learning through life-relevant research experiences for the next generation of ranch managers and professionals. Reaching diverse and broader audiences through social media campaigns on three platforms, development of two websites, and numerous TV segments, and podcasts has generated much interest on multi-species grazing and pyric herbivory. From January 2020 - September 2021 the project website received 812,331 total reaches, 984,506 total impressions, and 63,504 total engagements. Our Facebook social media campaign has reached over 596,000 people with just 57 posts and our Prairie Project Twitter page has yielded 42,456 impressions averaging 832 screen counts for each of the 51 posts.

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Detection of animal illness using machine learning

Ly Ly Trieu[1], Derek W. Bailey[1], Huiping Cao[1], Tran Cao Son[1], David R. Scobie[2], Mark G. Trotter[3], David E Hume[4], B. Lee Sutherland[2], Colin T. Tobin[5]

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Poster

Abstract

Management of livestock well-being is important and time consuming. Livestock monitoring becomes even more challenging when animals are kept in large groups or in extensive pastures because of the time and effort required to find and observe them. Our research focuses on applying different technologies to remotely detect when an animal becomes ill. Our first approach used machine learning (ML) classification of accelerometer data to successfully identify the onset of perennial ryegrass staggers (staggers). Staggers is a neurotoxic condition that is caused by consumption of *Epichloë* endophyte infected ryegrass (*Lolium perenne*) which produce toxins that can adversely affect sheep. Symptoms include head shaking, changes in gait, stiffness and falling. The study was conducted at Lincoln, New Zealand for 17 days in late March and early April 2017. ML analyses of accelerometer data showed clear changes in behavior of affected sheep from the beginning to the end of the study. The results show that ML is a good tool for developing algorithms to remotely detect the onset of staggers from accelerometer data because it simultaneously evaluates variable patterns from different metrics (features). Our next approach to remotely detect illness is to apply a combination of change-point detection algorithms, knowledge-based approaches, and real-time monitoring of livestock behavior remotely with accelerometers. These techniques can be used in combination with ML. In our first study, ML and change-point detection could be used to notify managers that sheep should be moved from an endophyte-infected paddock to a paddock without endophyte toxins. Although more research is needed, we believe that these state-of-the-art techniques will improve animal well-being.

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Building capacity through water partnerships to help the Navajo Nation thrive

Crystal Tulley-Cordova

Navajo Nation, Window Rock, USA

Padilla-Building Resilience in Indigenous Natural Resources

Abstract

Domestic water haulers, public drinking water systems, irrigators, dryland farmers, ranchers, wildlife, and forests are vulnerable to drought in the Navajo Nation. Spanning more than 27,000 square miles across the Four Corners region in the southwestern United States of America, the Navajo Nation is the largest land-based and populated tribal nation. Water is a critical resource that has provided the foundation of existence for the Navajo people. With ongoing climate change impacts, water challenges have increased. The living Navajo philosophy of water is life has sustained the people for many generations. Innovative tools, methods, and partnerships have helped the Navajo Nation work toward a sustainable water future.

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Are undergraduate range and wildlife students better equipped than their agricultural peers in managing a complex agro-ecological conflict? Initial results from a dynamic role-playing simulation

Benjamin Turner, Lane Michna, Kristyn Stewart

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Poster

Abstract

Ecosystem management problems in systems with both agricultural and natural environments (e.g., land conservation, watershed health, human-wildlife conflict) can be perplexing for many students due to the feedback-driven dynamics across natural and social spheres. Much research has found deficiencies in students' abilities to reason about such complexity because their mental models tend to be simple, visual, or lack the interrelated characteristics needed to understand nonlinear change over time. To test how well students' disciplinary education prepares them for complex problem-solving situations, we designed a role-playing simulation capable of evaluating student performance in a complex system. The simulation involves three stakeholder groups: irrigators, indigenous communities, and conservation NGOs, who must manage surface water allocations in an arid watershed over a 30-year period. The goal is to achieve above financial breakeven in the agricultural sector without collapsing a wildlife population dependent on the river source. Undergraduate students representing 2 departments, wildlife and range management (n = 20 students) and agricultural science (n = 12 students), played the game independently. Annual allocation decisions were recorded in real-time with the simulation. After gameplay, all students completed a questionnaire asking each to describe their strategic intentions behind the decisions they made. Results indicated that students prioritized low-leverage strategies in their respective domain (conservation or agriculture) and did not adequately explore strategies outside their domain that would yield higher leverage and therefore success. Further game play will allow testing alternative pedagogical interventions aimed at improving student reasoning and therefore performance in complex problem-solving situations.

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A New Conservation Movement to Address Biome-Scale Threats in Great Plains Grasslands

Dirac Twidwell

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

A 'Call to Action' has emerged in the Great Plains to scale-up conservation on private lands and meet the sustainability targets needed to sustain agriculture and wildlife from biome-scale threats. Following the release of new science showing rangeland loss from woody encroachment now matches losses associated with agricultural conversion, a multi-state, areawide planning initiative was held in 2020 that resulted in the first biome-scale framework focused on fostering transformational change and preventing further losses to wildlife and rancher livelihoods. The backbone of this framework is new spatially-explicit guidance showing how to reduce risk and vulnerability and halt geographic expansion of woody plants into rangeland ecosystems. One year later, multiple states have launched Great Plains Grassland Initiatives, committing over 8 million acres of private landholdings to defend some of the last remaining and iconic grassland core areas from woody encroachment. In this paper, I provide an overview of this new conservation movement and showcase early examples of conservation success resulting from the scaling-up of collaborative, private lands conservation efforts.

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Ecoregion-scale restoration with fire fosters a suite of rangeland conservation outcomes

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Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Woody plant encroachment is a global phenomenon that threatens the productivity, diversity, and profitability of rangeland ecosystems. In the Great Plains of North America, decades of scientific research have documented the consequences of woody encroachment. Natural disasters, collapses in rural livelihoods on working rangelands, the depletion of grassland flora and fauna, increased risk of endangered species, heightened disease risk, and even impacts to social programs like school funding have all been linked to the transition of grasslands to *Juniperus virginiana* dominance. However, scientific research showing restoration of these and other ecosystem services are exceedingly rare – particularly at large scales. Here, we present a series of investigations that quantify conservation outcomes following ecoregion-scale restoration of fire in the Loess Canyons, a 135,00-ha ecoregion in Nebraska, which has halted woody plant expansion and stabilized the formerly grassland-dominated region. Conservation outcomes include: (1) ecoregion-scale increases in population abundance of the previously endangered American burying beetle, (2) ecoregion-scale increases in grassland bird richness, (3) restoration of plant species richness following collapse from *Juniperus* encroachment, (4) 2,900 pounds acre^{-1} more forage production (2,700% higher than before restoration), (5) reduced wildfire danger potential. These results provide some of the first evidence that fire, operating at critical scales and to increase landscape heterogeneity, can restore a series of conservation outcomes that have been depleted due to woody encroachment.

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Impact of nonrenewable energy development on dust emission potential in the Uinta-Piceance Basin, USA

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Poster

Abstract

Anthropogenic land use is a primary external driver of dust emissions from drylands. While dust contributions of different land use types are beginning to be understood, those of nonrenewable energy development remain understudied. Infrastructure for energy development creates expansive networks of well pads and access roads, which are small, discrete, but high-intensity landscape disturbances. Removal of vegetation and other nonerodable surface elements during well pad and road construction decreases surface roughness, a first-order control on wind erosion, at the site level. Surface roughness controls the potential for dust emission by reducing wind friction velocity at the soil surface to below that which is required for erosion to occur. Within the Upper Colorado River drainage, where dust is understood to have far-reaching impacts on hydrology and ecosystem functioning, the Uinta-Piceance Basin contains over 19,000 well pads and 34,000 miles of access roads. The total area of energy development infrastructure in the Uinta-Piceance Basin increased by 23.74% from 2000 to 2016 and similar growth is expected to continue in the future. To determine landscape-scale impacts of energy development on surface roughness in the Uinta-Piceance Basin from 2000 to 2016, we assessed change in a new albedo-based metric of surface wind friction velocity using time series decomposition. The surface wind friction velocity was calculated using MODIS daily albedo (500-m) and ERA-5 wind speeds (10-km). We then estimated the dust emission response to energy development from estimates based on the modeled surface wind friction velocity and a generalized threshold surface wind friction velocity. Preliminary results suggest that energy development affects landscape-scale surface roughness and potential for dust emission in the context of certain edaphic, geomorphic, and climatic conditions. This research will contribute to our understanding of the landscape impact and dust contribution of a major land use in the western US.

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Land Health Community of Practice: BLM Districts Come Together to Tackle Shared Challenges

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Contributed Oral Presentation

Abstract

The Land Health Community of Practice (CoP) provides a silo-busting forum for BLM staff in eastern Oregon to compare notes on the Land Health Assessment and Evaluation process, a federal framework that is central to assessing landscape condition, identifying necessary management actions, and renewing grazing permits on BLM-administered rangelands.

At its most simple, the Land Health process involves three steps: 1) *assessing* available information to understand current conditions, 2) *evaluating* whether current conditions meet regionally specified Land Health Standards, and 3) *determining* the causal factors involved wherever Standards are not being met. In practice, however, the Land Health process requires the integration of numerous lines of evidence, and often involves high social scrutiny along with wicked natural resource challenges. Coupled with staffing challenges, the steep reality of navigating and completing Land Health Evaluations has contributed to a significant backlog of unprocessed grazing permits. In the face of these complexities, the Land Health CoP brings together BLM specialists from different districts and disciplines to unpack new approaches and efficiencies—such as the use of remote-sensing data. Ultimately, the intent behind the CoP is to work towards a better understanding of Land Health—among BLM districts and for external audiences—by improving the clarity and consistency of Land Health documents.

Led by the CoP's facilitator and BLM State Office convener, this presentation will cover some of the content areas and achievements that the CoP has collaboratively advanced since its launch in 2020. We will also explore broader lessons learned, such as the value of structured peer-to-peer learning opportunities for land managers tasked with navigating social and ecological complexity. The intended audience for this presentation is agency personnel who might be interested in addressing similar challenges in their own geographies as well as anyone who works closely with the BLM in rangelands.

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Digital Ranching as Aspirational System for Resilient Ranching on Southwestern US Rangelands

Santiago Utsumi[1], Shelemia Nyamuryekung'e[1], Matthew McIntosh[1], Andres Cibils[1], Richard Estell[2], Sheri Spiegal[2], Glenn Duff[1], Huiping Cao[1], Laura Boucheron[1], Huiying Chen[1], Trung Le[1], Zachary Winkler[1], Sajidur Rahman[1], Qixu Gong[1], Andrew Cox[1], Craig Gifford[1], Marcus Krohn[1], John Ragosta[1], Vinícius Gouvêa[1,3], Carolina Brandani[1], Anthony Waterhouse[4], John Holland[4], Emily Elias[2], Skye Aney[2], Brandon Bestelmeyer[2], Jean Steiner[5]

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Spiegal-From Desert Pasture to Dinner Plate: Evaluating the Sustainability of Supply Chains for Beef Cattle Coming from Ranches of the Southwest

Abstract

The Sustainable Southwest Beef Project led by New Mexico State University is strategically partnering with ranchers, researchers, extension specialist, educators and industry stakeholders to pioneer a Digital Ranching Platform for improving sustainability outcomes on ranches of the Southwestern US. The goals of the platform are to improve the operational efficiency of managing beef production systems for profitability, climate-resilience, and adaptive capacity. Ultimately, end-users will implement near real-time tracking and scouting of livestock across large pastures, rapid assessments of animal welfare, remote monitoring of rain gauge tipping buckets and tracking of water levels in cattle drinking troughs dispersed across the ranch. Another module is providing unobtrusive scoring of cattle body condition using support vector machine classifiers feeding on video imagery collected by automated infrared depth cameras. Methodologically, our approach fuses traditional statistics and smart analytics with novel dashboard tools to rapidly provide management indicators computed from streams of real-time data which are concurrently collected, logged and transmitted through a network of high throughput sensors, gateways routers and cloud computing services. The IoT infrastructure includes field sensors and accelerometer and GPS sensors on animals, and operates on a Long Range Wide Area Network (LoRa WAN) using solar or grid power and Ethernet, WiFi backhaul, or GSM communication. Our software engineering and IT team is developing a unified web-based server and dashboard application that facilitates the aggregation, visualization and retrieval of computed data, and configurations of sensors. Current analytics seek to enhance the harmonization (i.e. common feature representation) and curation of data using preprocessing, cleansing and normalization steps prior to implementing machine learning variants for classification and predictions objectives. Pilot case studies suggest several advantages of the system along with areas for potential improvement of existing sensors, network infrastructure and engineering, which may enhance future applications of the system on cooperating commercial ranches.

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Digital Tools for Sustainable Ranching on Southwestern US Rangelands

Santiago Utsumi[1], Shelemia Nyamuryekung'e[1], Matthew McIntosh[2], Andres Cibils[1], Richard Estell[2], Sheri Spiegal[2], Glenn Duff[1], Huiping Cao[1], Laura Boucheron[1], Huiying Chen[1], Trung Le[1], Zachary Winkler[1], Sajidur Rahman[1], Qixu Gong[1], Andrew Cox[1], Craig Gifford[1], John Ragosta[1], Marcus Krohn[1], Vinícius Gouvêa[1], Carolina Brandani[1], Anthony Waterhouse[3], John Holland[3], Emily Elias[2], Skye Aney[2], Brandon Bestelmeyer[2], Jean Steiner[4]

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

The Sustainable Southwest Beef Project is partnering with ranchers and stakeholders to develop a Digital Ranching Platform aimed at informing decision making of ranch-level management tasks and climate -resilient livestock systems. This aspirational management approach fuses traditional statistical and advanced data science with visualization dashboards to inform key indicators of animal welfare and ranch resources. The system collects large streams of real-time data, which is logged and transmitted through a network of high throughput sensors, gateways and cloud computing services. Internet of Things infrastructure includes field sensors and high throughput GPS sensors, and accelerometers mounted on animals, operating on a Long Range Wide Area Network (LoRaWAN) solar or grid powered and Ethernet, WiFi backhaul, or GSM communication. Software engineering and IT project components are focused on unifying a web-based dashboard and server application for visualization and retrieval of computed data and configuration of field devices and sensors. Utilities include improvements of operational efficiencies through near- to real-time tracking and scouting of livestock, rapid animal welfare assessments, remote monitoring of rain gauge tipping buckets and tracking of water level in cattle drinking troughs. Procedures seek to facilitate the harmonization (i.e. common feature representation) and curation of varying streams of data (i.e. erroneous sensor data and missing data points) prior to implementing machine learning for advance classification and prediction objectives. Future analytics will aim to merge patterns of animal data with insights on animal activity budgets, early warnings of breeding status, and faulty animal health or grazing performance. Unobtrusive scoring of cattle body condition is being collected using machine learning classifiers via high throughput video imagery of infrared depth cameras. Pilot case studies suggested important utilities of the system and have reveled several areas for improvement of existing sensor and network infrastructure and applications, which will be discussed in this symposium.

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Comparing Daily Distance Traveled Between Cattle Grazing in Continuous and Virtual Fence Rotation

Logan Vandermark, Jameson Brennan, Krista Ehlert, Hector Menendez III

South Dakota State University, Brookings, USA

Poster

Abstract

Commercially available virtual fence (VF) systems are a novel technology that provides a fence boundary without the need for a physical infrastructure, like t-posts and barbed wire. VF has tremendous potential for improving utilization and natural resource management on extensive rangeland systems in the United States. Preliminary research has sought to evaluate the effectiveness of VF technology; however, the impact on animal behavior from precision management technology on a rangeland beef production setting has yet to be quantified. A study was conducted in 2021 at the South Dakota State University Cottonwood Field Station in southwest South Dakota within a Mixed Grass Prairie ecosystem to compare daily distance traveled between steers within a continuous graze and a VF rotational system. Yearling steers (n=127) were outfitted with VenceTM VF collars from June to August in six pastures, three under VF rotation and three under a continuous grazing system. Animals within the virtual fence system were trained for 1 week on virtual fence boundaries and rotated within virtual paddocks based on forage abundance at approximately three-week intervals. VF collars were set to record GPS fixes at 5-minute intervals, data was transmitted through LoRa communication and uploaded to an online server. Distance between successive accurate GPS fixes were calculated daily for each steer using Program R. Differences in daily distance traveled between grazing systems were compared using a mixed model ANOVA (P-value 0.05). Comparing daily distance traveled between grazing systems (VF rotational vs continuous) could provide producers the ability to calculate energetic efficiency of the herd traveling, with the potential to maximize net energy for growth (NEgr).

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Small Ruminant Spatial Distribution in Queensland Australia

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Contributed Oral Presentation

Abstract

Small ruminant landscape distribution and grazing management are becoming a more important issue as the sheep and goat industry in Australia continues to grow. The objective of this study is to evaluate spatial movement patterns of Merino sheep, Dorper sheep, and rangeland goats in Queensland, Australia. We assessed both goats and Dorper sheep in the same pasture at one property and Merino sheep at another property. Positions were recorded at 10-minute intervals with GPS collars over the course of several months. Dependent variables were daily distance travelled, distance to water, and percent activity. Dorper sheep traveled an average of 5.6 km/d with a maximum of 11 km of travel each day. Merino sheep travelled an average distance of 7.2 km/day with a maximum of 17.7 km. Goats traveled an average of 5.6 km with a maximum of only 9.1 km/day. Throughout the entire study both goats and Dorper sheep were an average of 0.8 km from water, with a maximum distance from water of 2.4 km for Dorper sheep and 1.9 km for goats. Merino sheep were on average 1 km from water and their maximum distance to water was also 2.4 km. Goats and both breeds of sheep were active for about 45% of the day. A hotspot analysis of the GPS tracking data showed a higher concentration of sheep and goats near water sources. As the maximum daily temperature increased, sheep and goats remained closer to water ($P < 0.05$). The maximum distance Dorper sheep traveled from water decreased as minimum daily temperature increased ($P = 0.02$). Understanding small ruminant distribution in extensive rangeland pastures helps managers to determine optimal places to develop new water sources and implement new grazing management pastures to improve efficacy and sustainability of land use and production.

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Remote Monitoring of Livestock Reservoirs

John Walker

Texas A&M AgriLife Research, San Angelo, TX, USA

Poster

Abstract

The most important nutrient for grazing livestock is water. Livestock are mostly water (50 – 80%), and while an animal may lose most of its fat and about half of its protein during starvation and survive, a 10% loss of body water can be fatal. Though rarely reported, livestock die from lack of water due to a water delivery system's failure every year. To help avoid these losses, livestock producers spend hours checking water systems. My goal was to compare the efficacy and cost of different systems to monitor livestock water remotely. Three systems for monitoring the water level in a concrete reservoir from which water was gravity distributed by pipeline to troughs were compared. The three systems were a SpyPoint game camera, an AguaCheck pressure transducer, and an Informational Data Technologies (IDT) pressure transducer, water flow meter, and cutoff valve. The SpyPoint camera and Agua Check pressure transducer use cellular networks to transmit data. The IDT system uses a satellite. All systems performed satisfactorily. Purchase cost and annual communications subscription cost, respectively, for the systems were: SpyPoint $400, $0; AguaCheck $780, $240; and IDT $1,800, $90. All systems would pay for themselves the first year for a person living on the ranch and making one 10-mile roundtrip per week to check their reservoir. The IDT water flow meter was much more sensitive to system failures, i.e., broken float valve, than measuring water height in a reservoir with either a pressure transducer or visually with a photograph. Cost is not the deciding factor for selecting a system. The best system for ranch will depend on the availability of cellular connections and the operator's technological ability. The AguaCheck is simplest to install and operate and the IDT most difficult, but it also provides more information and flexibility.

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Trees or Goats, Your Choice

John Walker

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Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Let's be honest most rangeland managers prefer to raise cattle. Even in west central Texas, the region with the greatest number of goats in the U.S. 91% of the animal unit equivalents are cattle and only 4% are goats. Extension livestock budgets for the same region show that for the past 10 years the returns to profit on an animal unit equivalent basis, goats were profitable 90% of the years, while cow-calf operations were only profitable only 60% of the years. Furthermore, over the same time frame, goats had a 40% higher gross margin than cattle. In addition to the economic advantages of goats they are an effective management tool for managing encroaching woody plants, especially juniper species, which are rapidly expanding in the Great Plains. Goats are most effective in controlling juniper using targeted grazing on seedlings in the winter. When combined with other control measures targeted grazing with goat can greatly increase treatment life. Goats can be especially useful when combined with prescribed fire because in years with limited fine fuels for effective fire goats can still be used to help control seedling establishment. When used in multispecies grazing with cattle, goats can increase carrying capacity and produce an additional revenue stream without affecting cattle production. With all these advantages, why is the use of goats to increase ranch revenue and help control wood plant encroachment so limited? In addition to historical prejudices against small ruminants, the increased labor and management, the most limiting resource on most ranches, required to incorporate an additional enterprise into the operation limits adoption. Or perhaps it is because, as Asa Jones wrote almost 50 years ago in the Cattleman magazine: "Ranching is not a business it is a disease," and ranchers have a cow addiction.

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Perceptions of social-ecological threats by livestock producers in the American West: Interlinked challenges to rangeland resilience

Kathryn Walsh[1], Dan Ferguson[2], Christina Greene[2], Mitchel McClaran[2], Michael Crimmins[2], Hailey Wilmer[3]

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Contributed Oral Presentation

Abstract

Rangeland managers in the U.S. West face a variety of existing and emerging social and ecological challenges. Although social-ecological systems research in rangeland contexts has burgeoned, less is known about how ranchers themselves perceive interlinked challenges and implement strategies to build or maintain resilience. We conducted focus groups with 52 livestock producers in seven locations across the American West in 2019 to examine how ranchers characterize social-ecological challenges and have been responding to change. Across the seven locations, our analysis yielded four dimensions of change that participants identified as affecting the future viability of ranching: changing ecological conditions, changing economic conditions, changing ranching communities, and changing rangeland users and uses. Ranchers described having the greatest adaptive capacity to address ecological changes, but less capacity to address changes to the economy, ranching communities, and rangeland land-use. To summarize our research findings, we developed an interactive Story Map, which we shared with study participants during five follow-up focus groups conducted in 2021 with 14 livestock producers and 5 extension personnel to garner their feedback. The Story Map is now a publicly accessible resource that demonstrates, from the perspectives of participating ranchers, layers of interlinked environmental and social processes that are changing over time and are challenging the future of ranching. Additional research is needed to further understand: (1) the role of individual agency (i.e., the ability to act independently and make your own choices) in ranchers' perceptions of and responses to interconnected social-ecological changes; and (2) best practices for repeated stakeholder engagement during long-term research projects.

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Forage nutrient composition responses to three different grazing systems

Megan Wanchuk[1], Devan McGranahan[2], Kevin Sedivec[1,3], Kendall Swanson[4], Marisol Berti[5], Micayla Lakey[6], Torre Hovick[1], Ryan Limb[1]

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Poster

Abstract

Nutrient composition of forage on rangelands is influenced by several factors including precipitation, maturity, and disturbances like fire and grazing. Understanding how different grazing management practices influence forage nutrient composition helps determine whether nutrient requirements of livestock are met or if supplementation is needed to sustain livestock performance. Data were collected on mixed-grass rangeland at Central Grasslands Research Extension Center in south-central North Dakota during the 2017 to 2020 grazing seasons. We clipped available forage biomass at monthly intervals from fixed points from May to October to evaluate spatial and temporal variability in forage nutritive composition. Grazing management types included patch burn grazing (PBG), season-long (SL) grazing, and a modified twice-over rest rotational (MTRR) systems. Points were stratified within dominant ecological sites. We determined crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL), and NDF digestibility (NDFD) using near-infrared spectroscopy (NIRS), which we also used to calculate net energy of maintenance (NE_m). As a comprehensive indicator of forage composition, we created a forage composition indicator (FCI) using the first axis of a principal component analysis, which explained 66% of variation. In PBG pastures, forage in recently burned patches had greater CP, NE_m, and NDFD, and lower ADF and NDF than patches with longer time since fire, SL and MTRR pastures. Recently burned patches also had the highest proportion of points that met the CP and NE_m requirements of the cattle grazing throughout the grazing season. Patch-burning has the potential to provide nutrient composition that meets requirements throughout the grazing season, mitigating costs associated with supplementation while maintaining livestock performance.

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Livestock performance under three different livestock grazing methods

Megan Wanchuk[1], Devan McGranahan[2], Kevin Sedivec[1,3], Kendall Swanson[4], Timothy Long[3], Torre Hovick[1], Ryan Limb[1]

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Contributed Oral Presentation

Abstract

Livestock performance has a direct impact on a producer's profitability, making it an important consideration when evaluating the sustainability of grazing management practices. Limited studies have compared cow and calf gains between conventional grazing management practices and conservation-based management like patch-burn grazing. In this study, we compare cow and calf weight gain on patch-burn grazing (PBG), season-long (SL) grazing and modified twice over rest rotational (MTRR) grazing management. Data were collected on experimental rangeland pastures at Central Grasslands Research Extension Center in south-central North Dakota during 2018, 2019 and 2020. We grouped cows into pastures in May based on age and weight. Cows in their first to third parity (calf number) were grouped in young age class pastures with all other cows grouped in old age class pastures. All replicates of each treatment received an equal balance of young and old age class cows. We weighed cows on two consecutive days and calves on one day prior to turnout. These weights were used to sort animals to maintain a consistent stocking rate and average cow weight across pastures. Two-day weights were collected for both cows and calves when removed from pastures. Average daily gain (ADG) was calculated by subtracting the average turnout weight from the average final weight, then dividing by the number of days grazed. Age class had an effect on calf ADG, but not cow ADG. Cow and calf ADG were lower in the MTRR compared to the PBG and SL treatments. Similar ADG was observed between PBG and SL for cows and calves across old and young age classes. However, PBG had the least variability in cow ADG across all years and cow age class. Producers can use PBG as a management practice to achieve conservation goals without sacrificing livestock production.

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Rush for the “wasteland”: revaluing pastoral land in the light of renewable energy

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Coppock-The International Year of Rangelands and Pastoralists (IYRP) 2026: Global Framework, Action Plans, and Knowledge Gaps

Abstract

Governments, international bodies and the general public hold many misperceptions about rangelands – especially in Africa – and one of the biggest is that they are “empty wastelands”. Until recently, governments and development planners largely ignored these areas considered marginal. Now, however, the growing global awareness of the climate crisis and the need to make a transition from fossil fuels to renewable energy with lower CO_2 emissions is bringing into the spotlight the vast areas where such “green” energy can be generated – from the “empty wastelands”.

Huge tracts acquired by investors for large-scale energy projects are being fenced off, preventing livestock access, fragmenting the grazing areas and blocking movement between them. This reduces pastoralists’ inherent ability to be resilient to climate change through herd mobility. Their traditional rights to use the land are usually ignored. Because most governments greatly underestimate the value of pastoralism in terms of food production and ecosystem services, pastoral land is greatly undervalued. As a result, pastoral communities have little leverage in negotiations over land use, even if compensation is paid.

This paper focuses on land acquisition in pastoral areas for investment in generating solar, wind and geothermal power. It explores possibilities of multifunctional land use that includes pastoralism. It identifies the type of research needed to help pastoralists gain evidence to negotiate sharing of land and benefits from renewable energy. It also explores how pastoralists are gaining legal support to claim community rights to their traditional land and thus strengthen their bargaining position. In the course of the energy transition, it is inevitable for the pastoralists and desirable for the globe that more “green” energy is generated. The challenge is to find how this can happen in ways that do not oust the pastoralists but rather support their efforts to live and thrive in the rangelands.

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Development of LoRaWAN communicating sensors for extensive livestock grazing in the Scottish mountains - opportunities for the science and practice of managing livestock and pastures in harsh environments

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

Precision farming technologies offer opportunities for extensive livestock systems but have major challenges. Obtaining meaningful real-time data from livestock, and from the resources they use such as water or supplementary feed, or from their local environment, all have potential to support animal performance and welfare, resource management and save valuable farmworker time. We have been investigating and developing these technologies linked to production systems in the mountainous areas of the UK, which often feature free-ranging sheep or cattle on unfenced hill pastures with infrequent human inspections, but the lessons learnt relate to rangeland systems worldwide.

For 5 years, a LoRaWAN network covering a large part of a hill research farm has been developed and evaluated. Environmental sensors measuring air temperature, soil temperature and moisture, rainfall and river level have been deployed across the farm. Animal collars on both cattle and sheep, based around GNSS location devices providing real-time location data, have also been used within this environment, providing information about animal behaviour and state. More recently an integrated platform system (WISP – Wearable Integrated Sensor Platform) with combined GNSS, motion sensor, and Bluetooth (BLE 5.0) proximity readers has been developed, tested and evaluated. These animal-worn, or fixed LoRaWAN communicating units, connecting through BLE to small wearable beacons (<10g) have been evaluated. They provide real-time data on 5-minute duty cycles communicating via LoRaWAN with data pushed to an ArcGIS Online (ESRI) database and dashboard. BLE proximity data has been evaluated as an alternative to GNSS, as a potentially more cost-effective but still practical method of collecting real-time location, activity and movement data, in addition to dam-offspring proximity data. LoRaWAN provides an ideal platform for getting data from the field into the hands of the end-user, but there are challenges in terms of gateway location, site topography and distance to sensor.

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Impacts of Communication Towers on Greater Sage-grouse Population Demographics

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Contributed Oral Presentation

Abstract

Communication infrastructure development, particularly tower structures, increase habitat fragmentation and provide additional nesting and perching substrates for avian predators throughout sagebrush ecosystems and have the potential to negatively impact sensitive species such as greater sage-grouse (*Centrocercus urophasianus*). However, previous research on impacts of tall structures on sage-grouse has largely focused on impacts of electrical transmission and distribution lines. Thus, the impacts of communication towers and associated infrastructure on sage-grouse populations is not well understood. We used a two-step approach to explore the impacts of communication towers on sage-grouse population demographics across a large portion of their range including Oregon, Wyoming, Nevada, and Idaho. First, we developed a Bayesian hierarchical state-space model (SSM) to obtain estimates of population growth and an index for annual abundance for each lek within the study area from 1986–2019. We then used these estimates as a response variable in a random forest regression analysis (RFRA) to explore how tower structures and other landcover features impacted population trends over multiple temporal (e.g., nadir-to-nadir population cycles) and spatial (1, 2, 4.8, 8, 12.5, and 20km) scales. Our models indicated that communication towers had adverse impacts to sage-grouse populations at broad spatial scales over time, while accounting for influences from other environmental covariates. These findings can be used to help guide tower modifications in relation to sage-grouse population centers to reduce or offset predicted adverse impacts. Furthermore, estimated parameters can be used in a quantitative decision support framework to help guide placement of newly developed towers within sagebrush ecosystems. These findings are preliminary, provided for timely science communication, and subject to change.

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Workflows for integrating soil erosion model estimates into the qualitative assessments of Interpreting Indicators of Rangeland Health

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

Soil erosion assessments of ecosystem attribute conditions enable land managers to identify environmental resource concerns and management needs for vulnerable landscapes. Qualitative land health assessments that incorporate soil erosion indicators have been used extensively and are widely applied across US rangelands. More recently, quantitative rangeland erosion models have been developed that provide land managers with estimates of wind or water-driven sediment movement using inputs of commonly measured ecosystem characteristics. These quantitative erosion model estimates can provide additional information that complements ongoing qualitative assessments to support management decisions. However, approaches for using quantitative model estimates to inform land health assessments have yet to be fully established. Here, we describe workflows for integrating quantitative erosion model estimates into the qualitative assessments of Interpreting Indicators of Rangeland Health (IIRH). One approach is to use model estimates during IIRH assessments to help identify whether evidence of soil erosion is expected by reviewing aggregated model estimates based on similar boundary conditions (e.g., wind regime and ecological site) or from similar, previously evaluated plots. Conversely, land managers may need to evaluate land health using previously completed qualitative assessments, in which case they can use model estimates as a complementary evaluation of risk and vulnerability to soil erosion. With either approach, integrating model estimates into IIRH assessments can provide additional information that will improve decision support tools for rangeland management.

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Identifying native species in sagebrush ecosystems that can maintain abundance in the face of invasion and fire

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Nafus- (Ignite) Applying Long-Term Monitoring Data to Rangeland Science: Perspectives from Early-Career Rangeland Scientists

Abstract

Restoring degraded ecosystems is a global priority but remains difficult. Invasive grass-fire cycles are among the most alarming agents to transform ecosystems and threaten biodiversity. In the Great Basin region of the United States, cheatgrass (*Bromus tectorum*) outcompetes native vegetation and alters fire regimes in ways that accelerate native community displacement. Identifying native species that can maintain or increase abundance with persistent invasion and fire can help set durable restoration targets.

We used AIM terrestrial data from 8163 plant surveys across the Great Basin in zero-inflated modeling to assess how cheatgrass abundance, fire, and their interactive effects related to the occurrence and abundance of 27 regionally common plant species. While fire and cheatgrass abundance had different impacts among focal species, fire often more strongly impacted species occurrence and abundance. The effects of fire were insensitive to how long ago a fire occurred (in the previous 30 years) suggesting very long-lived impacts of fire on native plant communities.

Our model identified several native forb and grass species that maintained or increased abundance in the face of cheatgrass and fire, suggesting they may be valuable in bridging degraded habitats to longer-recovery native shrubland communities. Native flora performed better than a non-native bunchgrass commonly seeded for revegetation. However, cheatgrass and fire negatively impacted most shrub species, notably keystone species *Artemisia tridentata* ssp. *wyomingensis*.

Our regional analysis confirmed the generally detrimental impact of fire, and to a lesser extent, cheatgrass, on the abundance of Great Basin native flora. We also identified several native herbaceous species as restoration candidates robust to an invasive grass-fire cycle. Our observational study is, to our knowledge, the first to examine regional sensitivity of widespread native plants in the face of these interacting threats and highlights the potential of monitoring data for strategic restoration in degraded ecosystems.

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An Explicit Estimate of US Carbon Stocks on Indigenous Lands in the CONUSA

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Poster

Abstract

We addressed two propositions of carbon dynamics in US Native American drylands. First, a key finding of a draft of the Second State of Carbon Cycle Report (SOCCR2) from the US Global Change Research Program stated that "... scientific data and peer-reviewed publications pertaining to carbon stocks and fluxes on indigenous (native) lands in North America were virtually nonexistent..." Second, a 2019 study presented in the journal Ecological Applications compared net primary productivity (NPP) of Tribal, Private, and Public lands within the United States drylands and concluded that Privately-owned land was more than twice as productive as Tribal and Publicly-owned lands and thus the most sustainable land ownership group. We addressed the first proposition by identifying and using existing carbon dynamics literature and related databases that implicitly addressed local to global carbon dynamics to explicitly show carbon dynamics on Tribal lands, particularly the 250-m pixel resolution Moderate Resolution Imaging Spectroradiometer (MODIS)-derived NPP dataset for 2001-2019. We addressed the second proposition by showing that land ownership is neither a valid experimental unit nor treatment at the landscape spatial scale as it shows no agency. However, a comparison between land-uses (treatments) rather than land ownership, within different ecoregions (experimental units) is a more robust experimental design at the landscape spatial scale. Consequently, in this study we measured and compared the NPP of cropland and rangeland within the three land ownership types that were stratified by ecoregions. We found that average annual NPP (MT C per square meter) is comparable across land ownership types with Tribal exceeding private and public in some ecoregions and demonstrate the average annual NPP and time series of total NPP by land ownership, land use, and ecoregion.

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Prairie Project on Zooniverse: Connecting Research and Education through Citizen Science

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Contributed Oral Presentation

Abstract

The Prairie Project aims to develop a sustainable agricultural system within the Great Plains by implementing a new management paradigm consisting of pyric herbivory and mixed-species grazing. Key to fulfilling a paradigm shift is effectively engaging land managers and professionals, future professional and decision makers, and the general public through education and extension outreach. Citizen science projects have become a common tool to bridge gaps between research and education. The Prairie Project was designed to optimize the synergies among research, education, and extension efforts, with a citizen science program engaging secondary and undergraduate students as well as the general public, at the research and demonstration ranches across the Great Plains and through crowdsourcing. As part of this effort, we have developed a citizen science project on the Zooniverse platform. Here, students and the general public engage in identifying animal species and their activities as captured on camera-trap photographs from one of our research ranches. This data is essential for us to study spatial and temporal distributions of livestock and wildlife among different vegetation communities with different burn statuses. Crowdsourcing the data categorization also presents educators with a robust platform for design and implementing high-impact learning activities in classrooms and extension programs. To achieve this goal we are developing learning activities for several age levels, and piloting the project in an introductory ecology course at Texas A&M University. This citizen science aspect of the project allows us to reach a greater number of the public from a larger diversity of backgrounds.

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The art of ranching with fire: social and ecological factors affecting the spread of pyrodiversity in ranching communities

Ryan Wilbur, Kristie Maczko, Derek Scasta

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Contributed Oral Presentation

Abstract

Rangeland ecosystems are not only shaped by ecological disturbances but are managed and maintained through intricate public decision-making processes. Prescribed fire is an integral component to rangeland ecosystems for reducing shrub encroachment and limiting hazardous fuels but it faces social hesitancies as a management practice. Ranching communities are an integral part of preserving and maintaining rangeland ecosystems and benefit from utilizing prescribed fire as a management tool for livestock production, but are reluctant due to safety, liability, knowledge gaps, weather and attitudinal barriers. Understanding geographical, ecological, and social perceptions of prescribed fire utility and efficacy in ranching communities is fundamental to improve rangeland ecosystems and increase prescribed fire application. This study aimed to understand the ecological and social factors affecting the application of prescribed fire by ranchers in the Southern Great Plains and Central Rocky Mountains.

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Herbivory promotes resistance of Wyoming big sagebrush under extreme drought

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Poster

Abstract

Drought frequency and intensity is likely to increase in grasslands throughout the 21st century, and are likely to co-occur with extreme herbivore pressure. Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) is an important plant species in the western US, and impacts of drought and herbivory will likely have cascading effects on the functions and services these ecosystems provide. Previous research suggests that Wyoming big sagebrush is relatively resistant to single year moderate droughts, but less is understood about responses to extreme multi-year drought, especially when combined with heavy browsing pressure. We conducted a fully factorial drought-by-browsing experiment in a sagebrush ecosystem within the Thunder Basin Ecoregion (Bill, Wyoming) where ambient and heavy browsing treatments were crossed with five levels of rainfall exclusion: ambient, -25%, -50%, -75%, and -99%. Here, we address the following hypotheses: First, extreme drought will reduce growth of Wyoming big sagebrush due to drying the deeper soil layers; second, extreme browsing will exacerbate drought effects on Wyoming big sagebrush individuals due to reductions in carbohydrate reserves used for regrowth after herbivory.

We found evidence for our first hypothesis, extreme drought treatments resulted in reductions in crown volume during the second year of the experiment. Interestingly though, drought effects on shoot growth were not apparent, so reduced sagebrush cover may be due to extreme drought limiting new shoot formation rather than reducing growth of existing shoots. Surprisingly, we found results opposite to our second hypothesis, extreme browsing reduced the effects of drought. We think this was likely due to reductions in transpiration water losses resulting from reduced active photosynthetic tissue in heavily browsed shrubs. These findings suggest that Wyoming big sagebrush may be more impacted than previously thought when droughts become multi-year and extreme, but that herbivory by wildlife may be a natural mechanism for resistance during these events.

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Climate Change and Its Effects on Inter-Specific Competition Between Native and Introduced Grasses Through Seed Germination

Tyler Williams, Brent Turnipseed, Lan Xu

South Dakota State University, Brookings, USA

Poster

Abstract

Climate change is occurring, whether or not it is anthropogenic or natural causing. Within the last century, the average global temperature rose 1ºC. Because climate change can be associated with rising and falling temperatures, it is crucial to understand how these changing temperatures will affect the competition between native and introduced grasses. The objective of this study is to examine how current and predicted temperatures, and habitats, may affect grass species germination. A total of three changing temperatures (15/25ºC, 15/30ºC, and 20/30ºC) and two constant temperatures (20/20ºC and 25/25ºC) were utilized to simulate current and increasing temperatures. Four grass species were divided into introduced (*Bromus inermis*, smooth bromegrass; *Phalaris arundinacea,* reed canarygrass) and native species (*Pascopyrum smithii,* western wheatgrass; *Calamagrostis canadensis*, bluejoint) from two different habitats. Western wheatgrass and smooth bromegrass represented the terrestrial habitat; reed canarygrass and bluejoint represented wetlands. The seeds underwent either one of two treatments, stratified or non-stratified. Each species had 50 reps of seeds with four replications for each variable. To promote germination, seeds were placed in a germination box with two layers of blotting paper, then placed in a germination chamber. Counts were conducted from 7-28 days. We found that the stratification and temperature treatments did not influence both introduced species, as no statistical difference across almost all temperatures. As for the native species, the stratification influenced the germination of the western wheatgrass across almost all temperatures, while bluejoint only had a statistical difference with constant temperatures. Three-fourths of the species drastically decreased in germination with constant temperatures. The only unaffected species, by all treatments, was smooth bromegrass. We can use this data to predict how introduced grasses may outcompete the native grasses and soon replace many species. If we do not find treatment to control these species, ecological and economic harm can occur.

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Ranching, Rangelands and Resilience: Moving from Buzzwords to Boundary Objects

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Brown-Transformational Climate Change on Rangeland Ecosystems

Abstract

In this presentation, we report on an interdisciplinary investigation of ranching and rangeland resilience in the western US. Resilience thinking has long informed range science. Despite its growing use as a climate adaptation “buzz word” resilience is a theoretically rich, pluralistic, and contested framework. It offers us a boundary object to see inter-related climate, ecological, socio-economic, and political processes across spatiotemporal scales. To demonstrate this, we report on two studies. First, a vegetation modeling study asks how climate change will impact forage production in different ecoregions. It predicts industry-altering changes in the Southern Plains and Southwestern regions by mid-century, suggesting adaptation is most urgent in these ecoregions. The second study, based on qualitative research in seven focal landscapes, captures ranchers’ views of resilience. Ranchers report some capacity to adapt to ecological change but less ability to deal with sociological, political, and land use dynamics occurring at scales outside the ranch gate under late capitalism. Together these studies offer lessons for future science and management. The drivers of the political ecology problems that constrain adaptations to predicted climate/ecological change are the same drivers of that climate change. We will need more than grazing management innovations at the ranch-scale to foster rangeland resilience. Range science has an opportunity to host conversations among multiple areas of knowledge and practice that construct new imaginaries for systems facing multifaceted change. However, these conversations face disciplinary, theoretical, and scalar barriers that must be overcome in order to fully see and address all relevant scales and drivers of resilience.

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Automated Estimation of Body Condition Score using Depth Images

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McIntosh-Precision Grazing: State of the Science and Opportunity for User Feedback on New Technologies

Abstract

In this study, we aim to estimate body condition scores of Criollo cows using Intel Realsense depth cameras and a variety of shape and texture descriptors. Fifty-five cows were sourced from the Jornada Experimental Range. The ages of these cattle ranged between three and fifteen years old. Body condition score was assessed by four experts, during which time the cows were recorded from an overhead position such that their backs were fully visible to the camera. Images were then extracted from the resulting video, and suboptimal images, such as images where the cow's full back were not visible, were discarded. The remaining images were then segmented using multiple rounds of Otsu thresholding and labeling. Fourier descriptors, kernel principal components, Hu moments, and Gray-Level Co-Occurrence Matrix features were then extracted, and used to train a support vector machine, using a radial basis function kernel. Future work includes exploring intra-cow body condition score variance, inter-breed body condition score behavior, and ranking individual feature effectiveness.

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Quantitative Change Analysis of Undisturbed (Native) Lands in Eastern South Dakota: 2012 – 2018.

Riley Wollschlager, Alexander Smart, Pete Bauman

South Dakota State University, Brookings, USA

Poster

Abstract

The actual rate of loss of native grassland and woodland in eastern South Dakota is unknown, and the landscape composition of the region continues to change. Agricultural and other land use practices create disturbances, resulting in further conversion of native grasslands and woodlands. Previous work by South Dakota State University quantified undisturbed (native) land up to 2012. The objective of our current study is to quantify the rate of conversion of undisturbed (native) land, that has no prior cropping history, between 2012-2018. Light Detecting and Ranging (LiDAR) imagery layered with FSA common land unit quantified potentially undisturbed land as of 2012. An analysis was then conducted utilizing South Dakota NRCS derived LiDAR imagery, which revisited polygons where LiDAR detected change (i.e., “LiDAR Removed Review”). Images containing lands detected by LiDAR were contrasted over National Agricultural Imagery Program (NAIP) imagery to assess change from 2012-2018. Change Analysis included an image layer containing previously mapped undisturbed acres (2012) for each county in eastern South Dakota, which was placed into ArcMap for each land parcel. Layered over the top of this was NAIP images with corresponding years: 2012, 2014, 2016, 2018. Conversion of native grassland or woodland detected with NAIP imagery from 2012-2018 was removed from the layer. Change Analysis combined with LiDAR Removed Review quantified undisturbed (native) lands as of 2018. Five pilot counties were randomly selected for Change Analysis and LiDAR Removed Review. Total acres in these five counties were 2,215,815, which 736,417 (33%) are considered potentially undisturbed (native). The total acres converted from undisturbed to disturbed between the five counties was 9,720 over this six-year period. Native habitats continue to see conversion across eastern South Dakota. At the current rate of conversion these five pilot counties lose on average 0.2% of native habitat per year.

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Legacy climate over prior seasons and years influences rangeland phenology and productivity

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Contributed Oral Presentation

Abstract

Many aspects of recurring plant developmental events – vegetation phenology – are measured by remote sensing. By consistently measuring the timing and magnitude of the growing season, it is possible to study the complex relationships among drivers of the seasonal cycle of vegetation, including legacy conditions. We studied the role of current and legacy climate, and contextual factors on the land surface phenology of the U.S. Northern Great Plains, a region with large expanses of rangelands covering wide climate gradients. Specifically, we used multiple annual and seasonal climate variables covering the current and past four years derived from PRISM climate reconstructions. We also included soils, disturbance, and within pixel land cover heterogeneity as additional independent variables that may interact with climate to control phenology. We assessed four phenological measures from the AVHRR satellite sensor, start of season, end of season, peak productivity, and season-long productivity, using variable selection techniques utilizing nested random forest models. We identified the top variables for the four phenological measures for pixels with predominantly grassland and shrubland land cover classes. We found that short- and long-term legacy climate modulated the impact of current-year climate on phenology. For example, in grasslands, increased precipitation over the prior four water years led to higher peak productivity in the current year. Likewise, for shrublands, start of season date was influenced by vapor pressure deficit over the prior four years and summer growing degree days from the prior year, while key antecedent factors for season-long productivity also included precipitation over the prior four water years. Vegetation phenology has cascading impacts across the ecosystem. Including legacy conditions and accounting for key drivers among biomes is important for predicting impacts to communities and risks to ecological services.

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Educating the voters and policy-makers of tomorrow to ensure the future of rangelands

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Wilcox-Saving Imperiled Grassland Biomes by Recoupling Fire and Grazing

Abstract

Two of the main objectives of the education component of the Prairie Project are (1) to develop agents of change in secondary and undergraduate institutions through faculty and curricular development and action research and (2) to develop next-generation land managers and professionals through intensive engagement of 4H/FFA groups in monitoring research on the effects of pyric herbivory and mixed-species grazing in the demonstration ranches. This presentation focuses on the former. The engagement of the secondary and undergraduate students, especially those from urban/suburban areas who are the majority of the voters and policy-makers of tomorrow, is essential for ensuring the sustainability of rangelands and of livestock production. We have organized two 2-year Educator Cohorts (2020-2022, 2021-2023) with 12 participants each from diverse secondary and higher education institutions. Each cohort started with an intensive summer workshop focused on current science of rangeland ecology and ecosystem services, pyric herbivory and multi-species grazing, as well as the current learning science and inclusive and high-impact pedagogy. It was followed by monthly cohort meetings focused on professional development in ecology and education, sharing and supporting participants' work, and community building, as well as regular individual consultations. Cohort 1 participants have developed a set of high-impact educational materials related to fire and grazing, implemented in their own classes, and conducted action research. They have started presenting their work and findings in professional and education conferences to engage a broader audience of educators and professionals. The Prairie Project is also designed to optimize the synergies among research, education, and extension efforts, with a citizen science program engaging the participants of the educator and 4H/FFA cohorts and the general public, at the research and demonstration ranches across the Great Plains and through crowdsourcing, such as a Zooniverse project based on game cam photos from our research projects.

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Interactive mapping and analysis of geospatial big data using geemap and Google Earth Engine

Qiusheng Wu

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Washington-Allen-The "How to" of Innovative Technologies for Monitoring & Assessment of Rangelands at Local to Global Scales

Abstract

Google Earth Engine (GEE) is a cloud computing platform with a multi-petabyte catalog of satellite imagery and geospatial datasets. It enables scientists, researchers, and developers to analyze and visualize changes on the Earth's surface. The geemap Python package provides GEE users with an intuitive interface to manipulate, analyze, and visualize geospatial big data interactively in a Jupyter-based environment. The topics will be covered in this workshop include: (1) introducing geemap and the Earth Engine Python API; (2) creating interactive maps; (3) searching GEE data catalog; (4) displaying GEE datasets; (5) classifying images using machine learning algorithms; (6) computing statistics and exporting results (7) producing publication-quality maps; (8) building and deploying interactive web apps, among others. This workshop is intended for scientific programmers, data scientists, geospatial analysts, and concerned citizens of Earth. The attendees are expected to have a basic understanding of Python and the Jupyter ecosystem. Familiarity with Earth science and geospatial datasets is useful but not required. More information about the geemap Python package can be found at https://geemap.org

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Monitoring grazing behavior and forage conditions on rangeland and the application of data in general management

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Wilcox-Strengthening Collaborations Between Researchers and Stakeholders: Linking Data and Management in Rangelands

Abstract

In rangeland livestock production systems, management strives to effectively utilize the forage resource base while obtaining optimal animal performance. Thus, monitoring pasture conditions and grazing distribution are central aspects of domestic livestock use on rangelands. Although the spatial component of herbivory is an essential aspect of domestic livestock ecosystems, it has remained challenging to interpret. Advances in remote sensing and activity sensors allow for improved pasture mapping and the ability to separate grazing locations from other activities. Limiting GPS observations to grazing locations allows for the determination of important foraging areas rather than general pasture distribution. Furthermore, the relative volume of grazing location distribution can identify core grazing areas (area within a pasture that contains 50% of grazing locations) within a management unit. Pairing grazing distribution maps to information gathered from remote sensing offers an opportunity to quantify space use related to habitat covariates in resource selection analysis. This allows for a more in-depth evaluation of grazing distribution and behavior response to management strategies and changing environmental conditions. However, GPS and remote sensing data, as well as results of resource selection analyses often require geospatial and/or statistical training to interpret and can be difficult to utilize in management. Thus, alternative methods of viewing data, participating in stakeholder meetings/field days, and incorporating extension specialists and social scientists in research may aid in the management application.

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Introduction to the UN International Year of Rangelands and Pastoralists

Engin YILMAZ

Yolda Initiative, Ankara, Turkey

Contributed Oral Presentation

Abstract

This presentation will provide information on why an IYRP was and is needed and what are its objectives; the milestones passed on the long road to the endorsement by the United Nations General Assembly; current status of the IYRP including the information on the role of the UN member States, UN agencies, organisations and communities; the roles within and structure of the global governance and management of the IYRP, the role and functions of Regional IYRP Support Groups; the objectives of the global and regional level action plans.

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Developing a State and Transition Model for Fescue Tussock Grasslands in the Central Puna of Peru

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Contributed Oral Presentation

Abstract

Peruvian Puna Grasslands, areas above 3800 meters, cover 15 million hectares and constitute the main forage source of more than 80% of the livestock population and thus are fundamental to national food security. Understanding the ecological processes of succession, changes in rangeland health indicators, and ecosystem services is essential for grassland management. State and transition models (STM) provide a logical framework, based on theoretical elements that allow the design of interventions to maintain or restore ecosystem. This model framework can help to identify management strategies to promote desired transitions and prevent unwanted ones. Our work proposes a state and transition model for Puna grasslands, based on historical data, field surveys and species responses to grazing gradients and other environmental factors. Once the model was developed, transition processes and restoration pathways were identified and validated through expert panels, workshops with rangeland managers, gradient analysis, and further field evaluations. The proposed model consists of a reference state dominated by an association of *Festuca humillior* and *F. dolichophylla* with *Calamagrostis vicunarum* as subdominant, which is altered by continuous intensive grazing to a state dominated by *C. vicunarum* followed by appearance of invasive species. This altered state can give rise to three other states characterized by the invasion and dominance of three invasive species: *Opuntia flocosa*, *Astragalus garbancillo* and *Aciachne pulvinate*. Formerly dominant tussock grasses can recover from invaded states via various restoration approaches. We conclude that STM are a useful tool to identify restoration pathways for Puna grasslands.

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Elephants mitigate the ecosystem effects of cattle

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Contributed Oral Presentation

Abstract

On rangelands worldwide, cattle interact with many other ecosystem components, most obviously with soils, plants, and other large herbivores. Since 1995, we have been manipulating the presence of cattle, mesoherbivores, and megaherbivores (elephants and giraffes) in a series of eighteen 4-ha plots at the Kenya Long-term Exclosure Experiment. We have demonstrated a wide array of cattle effects on this savanna rangeland, including their reduction of grass cover, wildlife use, and soil nitrogen and phosphorus pools, but their increase (at moderate stocking rates) of primary productivity and termite abundance. We demonstrate experimentally that the presence of mega-herbivores (elephants, mainly) reduces the magnitude of these cattle effects. Additional experimental evidence suggests that this may be at least partly because the elephants reduce the most desirable (N-rich) forage, causing cattle to slow their extraction of (low-N) grasses, while elephants simultaneously reduce tree cover.

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Implementing a System of Ecological Response Units to Monitor Rangeland Condition and Health in Pampa Galeras Vicuña Reserve

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Poster

Abstract

The Pampa Galeras Barbara D´Achille National Reserve covers an area of 22,232 ha of puna grasslands and has played a role in the recovery of vicuña (Vicugna vicugna) populations from their extinction. The reserve is made up of 6,500 ha of the rigid area where 4200 vicuñas graze and 14,732 ha of the buffer. The objective of this study was to implement a system of ecological response units (ERU) and from them to implement an evaluation and monitoring system of the condition and state of health in the ecosystem, based on biotic integrity, hydrological function, and site stability, which can serve as a model for other Protected Natural Areas (PNA) for the conservation of the vicuña. A total of 29 ERUs were delimited, combining fieldwork with spatial information systems. The results revealed that the rangeland health status is at risk. The evaluation of the condition of the grassland indicates notable differences between the rigid area (very poor 6.4, poor 85.3, and regular 8.3%) and the buffer area (very poor 8.7, poor 73.3 and regular 18%), which suggests the need to implement an evaluation and monitoring system, based on indicators of the health status and condition of rangelands, and thus lay the foundations for the implementation of an adaptive management plan, with the participation of the peasant communities that benefit from the vicuña products and the Peruvian national service of protected natural areas (SERNANP).

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Time-since-fire and livestock species influence butterfly populations in post-Conservation Reserve Program landscapes

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Contributed Oral Presentation

Abstract

Global pollinator declines represent a major threat to future food security. Habitat destruction and fragmentation in combination with mismanagement and pesticide use are all contributing factors. Conservation Reserve Program (CRP) plantings have been important in reestablishing perennial cover and can help support pollinators in regions where native grasslands have been lost. However, as recent contracts have expired, many landowners have decided not to reenroll in CRP and instead allocate the land for different uses. We evaluated the influence of grazing post-CRP landscapes with cattle or sheep within a patch-burn grazing framework on grassland butterfly communities. Specifically, we examined the effect of time-since-fire and livestock species (sheep or cattle) on butterfly abundance and diversity at the Hettinger Research Extension Center (HREC) in Hettinger, ND. We used line transect distance sampling (LTDS) across 72 transects in 6 pastures (3 sheep and 3 cattle-grazed). Surveys were repeated three times yearly (June-August) for five years (2017-2021). We observed 17,759 butterflies composed of 30 species across all sites, with cattle pastures boasting 1.6 times more individuals than sheep pastures. Selection ratios for the six most commonly observed butterfly species indicated differing patch preferences. Two species selected for the most recently burned areas, two species selected for least recently or never burned areas, and two species did not show preference. Species preferences differed by grazer type also, with more patches selected for in cattle-grazed pastures and more avoided in sheep-grazed pastures. Our results suggest that restoring natural disturbances to post-CRP fields can provide resources for grassland butterfly communities. Varying time-since-fire on different patches in post-CRP working landscapes appears to create butterfly diversity, since many species selected for different time-since-fire patches. This demonstrates converting post-CRP lands into working landscapes has the potential to provide conservation-friendly alternatives to row-crop implementation, decreasing fragmentation and improving biodiversity.