



Poster Abstracts



Poster Session Monday 1: Poster Pod 1, Poster 1

EXTENSION SURVEY OF WYOMING RANCHERS REVEALS INSIGHT FOR PREDATOR-LIVESTOCK INTERACTIONS

Barton Stam*¹, J. Derek Scasta², Jessica L. Windh²; ¹University of Wyoming Extension, Thermopolis, WY, ²University of Wyoming, Laramie, WY

ABSTRACT

Predator-livestock interactions are a major concern for both agriculture and conservation globally and Wyoming, USA provides an insightful state-level case study due to the presence of a suite of carnivores. Using survey data from 274 ranches in Wyoming, we used information theory to model how ranch attributes and large carnivores influenced the timing, duration, and severity of livestock predation. We then used constrained ordination to understand how 1) landscape, weather, and animal features influence predation and 2) how livestock behavior and nonlethal loss relate to ranch attributes and large carnivores. In addition, we rated the efficacy of predation mitigation strategies for foxes, dogs, coyotes, wolves, bobcats, and birds (buzzards, eagles, hawks, ravens). Timing, duration, and severity of livestock predation were generally not explained by ranch size or number of counties but were explained by livestock type, livestock parturition (either timing or duration), and documented large carnivore loss. When asked about mitigation efficacy, ranchers reported efficacy of mitigation varied by predator species, mitigation strategy, and lethality of strategies, but not livestock type. Ranchers perceive they were most effective at mitigating predation by foxes and coyotes, moderately effective at mitigating large carnivores, and the least effective at mitigating bird predation. Ranchers also reported that avian predators seem to be the most challenging predator type. The general perception was lethal mitigation strategies were more effective than non-lethal strategies, with guard animals showing the most potential among the non-lethal options. Understanding predator-livestock interactions relative to ranch and rangeland features, parturition, large carnivore exposure, and losses that extend beyond mortalities can assist in developing novel strategies to mitigate lethal and nonlethal losses. As predator-livestock conflicts continue effective mitigation strategies are needed to ensure profitable and sustainable livestock production.



Poster Session Monday 1: Poster Pod 1, Poster 2

WILD HORSES: VALUES AND ATTITUDES TOWARDS MANAGEMENT METHODS

Maria Fernandez-Gimenez, Elena Dosamantes*; Colorado State University, Fort Collins, CO

ABSTRACT: MS STUDENT

Since its creation, the Wild and Free Roaming Horse and Burro Act of 1971 has been a source of conflict and controversy on American rangelands. Studies in other regions and countries have found that divergent values of wild horses held by different groups influence similar conflicts. However, the role of values and their influence on attitudes towards wild horse management methods has not been studied in relation to conflicts over wild horse management in the western United States. We interviewed Bureau of Land Management (BLM) employees, BLM permittees, and wild horse advocates in northwestern Colorado to identify and describe values each group associates with wild horses and explore how these values are related to attitudes towards different wild horse management methods. With rising wild horse populations, paralleled by increasing conflict and media attention, this study contributes to understanding the role of values and attitudes in wild horse management controversies in the western United States.



Poster Session Monday 1: Poster Pod 1, Poster 3

EVALUATING KNOWLEDGE, ATTITUDES, AND PERCEPTIONS OF RANCHERS AND BLM MANAGERS OR SPECIALISTS

Calee L. Garn*, Debra Spielmaker, Eric Thacker, Kelsey L. Hall; Utah State University, Logan, UT

ABSTRACT

The Bureau of Land Management manages approximately 245 million acres in the United States, the majority of which are in the western half of the country. Numerous conflicts in Nevada, Oregon, Utah, and Arizona, since 2010 have resulted in fatality, armed militias, several incarcerations, and lawsuits facing the federal government. Following a preliminary needs assessment conducted in Box Elder County, Utah, and a comprehensive review of the literature, further research was needed to understand BLM professional and rancher perceptions regarding BLM policies and procedures. The study specifically looked at attitudes, perception and knowledge concerning the implementation of range improvement projects to potentially address conflicts and relationship issues between ranchers and BLM professionals. A needs assessment model was used to frame the research.

Two similar questionnaires, one for BLM professional and the other for permittees (ranchers) using federal land managed by the BLM, were developed by the researcher. The questionnaire was divided into four sections: participant characteristics; perceptions concerning BLM policies; knowledge questions related to BLM policies; and attitudes concerning federal land ownership and BLM policies. The rancher questionnaire was mailed to 182 ranchers and netted a 37.2% response rate. The BLM questionnaire was emailed to 15 BLM professionals in the Salt Lake Field office and netted an 84.6% response rate. Results were analyzed using descriptive and appropriate correlation statistics. Rancher interventions should include a) when to submit rangeland improvement projects, b) what could result in a temporary reduction in AUMs on a grazing allotment c) where to access online NEPA documents, and d) who makes final land management decisions for the BLM. BLM professionals' interventions could include the steps required for planning a juniper removal project, and when to submit a new waterline or fenceline request. Ranchers' background has minimal influence on their perception.



Poster Session Monday 1: Poster Pod 1, Poster 4

PUBLIC LAND GRAZING AND NEPA: A MULTIMEDIA EDUCATIONAL PROGRAM FOR ARIZONA COOPERATIVE EXTENSION AND BEYOND

Larry D. Howery¹, Barbara Hutchinson², Aaron M. Lien^{*2}, Julie Conley³, Cameron Burleson¹, William Gray¹, George Ruyle², Andrew Brischke⁴, Joshua Grace⁵, Ashley L. Hall⁶, Kim McCreynolds⁷, Jeff Schallau⁸, Priya Sundareshan¹; ¹The University of Arizona, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³Consultant, Yakima, WA, ⁴University of Arizona Cooperative Extension, Kingman, AZ, ⁵University of Arizona Cooperative Extension, St. Johns, AZ, ⁶University of Arizona Cooperative Extension, Globe, AZ, ⁷University of Arizona Cooperative Extension, Wilcox, AZ, ⁸University of Arizona Cooperative Extension, Prescott, AZ

ABSTRACT

Ten years ago, the Rangelands Partnership (RP), an initiative of 19 western land grant universities including the University of Arizona (UA), developed a series of webpages and educational resources on public land grazing issues, including NEPA. These resources were made available via the Global Rangelands/Rangelands West websites. Over the last decade, the ecological, economic, and social debates surrounding these issues have changed as has our understanding and management of public lands grazing. In response, our team is developing a new collection of online resources to provide up-to-date information to producers and the public. The new topic page features improved design and delivery of information using videos, images, figures, and other multimedia. This poster will describe the following completed and continuing tasks and activities including: 1) Conducting a comprehensive review of the current public lands topic on the Global Rangelands/Rangelands West websites, 2) Completing research for updating topics using current science communication approaches and tools, 3) Coordinating with web designers to develop a “site map” plan to link content into a “learning module” design, 4) Conducting video interviews with extension and agency personnel, and ranchers to demonstrate how public land laws and policies impact the livelihoods of those who manage livestock on public lands, 5) Carrying out peer review of new materials and resources by RP members and Arizona Cooperative Extension faculty (on-campus and in several Arizona counties) to ensure the content brings science to bear on real world problems, 6) Rigorously testing the new web design for utility and navigation, and 7) Announcing the availability of new resources through social media, newsletters, and conference activities. In addition to the poster, we will have laptops available to allow conference participants to explore the new website.



Poster Session Monday 1: Poster Pod 1, Poster 5

RE-INTERPRETATION OF ROBINSON ET AL. 2019: PATTERNS OF RANGELAND PRODUCTIVITY AND LAND OWNERSHIP: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT. ECOLOGICAL APPLICATIONS, 29(3), E01862

Robert Washington-Allen*¹, Ryan E. Emanuel²; ¹University of Nevada, Reno, Reno, NV, ²North Carolina State University, Raleigh, NC

ABSTRACT

In this Ecological Application's Communication, Robinson et al. (2019) compare the satellite derived net primary productivity (NPP) of US rangelands under tribal, private, and public land ownership. The authors conclude that privately owned rangelands were more than twice as productive for total and average NPP as tribal and public lands. The authors compared production at 3 spatial extents by these 3 land ownerships including the continental US, three regional administrative areas, e.g., the Western states, and by Bailey's Level II ecoregions. Bailey's ecoregions are homogenous low variance units that are stratified by precipitation, temperature, and topography and are thus appropriate replicates for studies at large spatial scales. Administrative extents, e.g., states or land ownership boundaries are characterized by inherent heterogeneity and high variance of landscapes at large spatial scales. Thus, Stoms & Hargrove (2000) have called administrative landscape comparisons: "Apples to Oranges" situations. Consequently, in this study ecoregions X land ownership is the only legitimate comparison. This changes the interpretation of the results where the authors show: Tribal NPP ~ Private NPP > Public NPP or tribal lands exhibit productivity similar to NPP on private lands. Additionally, this interpretation may change as Tribal lands actually have 3 types of ownerships 1) allotments held in trust by the US Government that will eventually become 2) privately owned allotments, and 3) government trust land or Tribal lands. Nonetheless, this is a surprising result as the forced removal of Native Americans to the reservation system suggests that the best most arable lands were not the lands allocated to these peoples.



Poster Session Monday 1: Poster Pod 1, Poster 6

WILDISH: MUSTANG OF THE AMERICAN WEST

Anna B. Coburn*¹, Alan Wartes², Corrie Knapp³; ¹Western Colorado University, ²Alan Wartes Media, ³University of Wyoming

ABSTRACT

I am developing a podcast series investigating the controversies and human stories surrounding wild horses and burros in the American West. I partnered with *ThinkRadio* and Alan Wartes Media. According to the Bureau of Land Management (BLM), wild horses and burros are grossly overpopulated in the West. A majority of herds reside in remote landscapes managed by BLM, and a smaller portion of herds roam United States Forest Service (USFS) lands and Native American lands, including the Navajo Nation. Drought, climate change impacts, and shared grazing between horses, burros, and livestock continue to degrade historic rangeland ecology. Management solutions are desperately needed, but stakeholders' ideas for solutions fluctuate across a large spectrum. Conflict is intense. To stakeholders, it is common knowledge that the general public knows no or very little information about wild horses and burros in the U.S. The goal of this project, increasing public awareness, will ameliorate this situation. I have traveled the West and collected genuine stakeholder interviews and stories. Our podcast series will be entertaining and informative: two hallmarks of impactful science communication. A high-quality podcast has never been done on this issue.



Poster Session Monday 1: Poster Pod 2, Poster 7

RANGE RESEEDING AND PASTORALISTS RESILIENCE TO CLIMATE VARIABILITY

Diana W. Githu^{*1}, Jeffrey S. Fehmi², Anna Josephson¹, Mitchel P. McClaran³; ¹University of Arizona, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³The University of Arizona, Tucson, AZ

ABSTRACT: MS STUDENT

Pastoralism supports livelihoods on less productive land across Africa and other parts of the world. The pastoral culture has social systems that support populations by ensuring that animals efficiently convert limited ecological resources into sustenance. Socio-economic changes, population increase and climate variability including frequent and prolonged droughts are shrinking grazing lands and making forage availability less predictable. This among other challenges are affecting the resilience of pastoralists. The objective of my research is to examine range reseeding as a sustainable rangeland management practice that enhances pastoralists' resilience by reducing their vulnerability to climate variability. The environmental and socio-economic benefits from range reseeding have the potential to improve pastoralists livelihoods by making them more food secure, prosperous and resilient. To determine pastoralists resilience, we evaluate dry season grazing and other tradable outputs created by range reseeding as proxies for resilience. Land size, herd size, fence types, inherited skill and affordability were identified as factors that affect range reseeding potential. Survey data was collected from 193 households representing two pastoral communities from Baringo, Kenya. Though still in its preliminary stages, the researcher has established that the diverse options of field utilization decrease over time. Fields reseeded within the last five years were used for more income generation activities than those that were reseeded over five years ago. This could be attributed to a number of reasons among them grazing management decisions, fence type and grass species characteristics. Those who used their fields for multiple uses year round or intensively pursued commercial production of tradeable outputs did not engage in other income generating activities like formal employment. This shows that reseeding associated benefits were capable of sustaining livelihoods. Investing in extension services to teach sustainable rangeland management practices to pastoralists may help improve their resilience to climate variability.



Poster Session Monday 1: Poster Pod 2, Poster 8

ADDRESSING BARRIERS TO PROACTIVE RESTORATION FOR AT-RISK SAGEBRUSH COMMUNITIES: A CAUSAL LAYERED ANALYSIS

Carmen Calzado*¹, Mark Brunson¹, Sofia Koutzoukis¹, Kari E. Veblen¹, Jacopo A. Baggio², David A. Pyke³; ¹Utah State University, Logan, UT, ²University of Central Florida, Orlando, FL, ³U.S. Geological Survey, Corvallis, OR

ABSTRACT: Ph. D STUDENT

Restoration success of degraded rangelands often depends on the location's resilience to disturbance and resistance to invasive annual grasses. Rather than try to restore sagebrush plant communities after they are degraded by exotic annual grasses, we are studying the feasibility of proactive restoration in communities at risk of crossing degradation thresholds. These communities may lack native perennial grasses and forbs, but they are not dominated by exotic annual grasses. When developing any new management tool, it is important to consider its management feasibility. Accordingly, we studied institutional factors within land management agencies that could affect the adoption and use of a specific proactive restoration approach: out-planting grass and forb seedlings into sagebrush stands before they are dominated by cheatgrass, *Bromus tectorum*. Rangeland managers from eight federal and state agencies across the Great Basin were contacted regarding their perceived feasibility of these practices, and under what conditions the practices might be incorporated in their vegetation management toolkit. Twelve in-depth interviews were conducted, and the responses were analyzed using the qualitative method of Causal Layered Analysis, an approach to assessing factors that determine alternative future scenarios. Preliminary results are presented. In the most superficial (litany) layer, cost, cost-effectiveness, and scale were prominent; the systemic causal layer (economic and political contexts) was framed by policy and bureaucracy limitations as well as technical barriers to implementation; in the worldview layer, lack of a proactive management tradition within agencies was identified as a principal barrier. Finally, in the deepest (myth/metaphor) layer, what appears as the central mythos is that human intervention (management) is necessary to protect ecosystem services disrupted as a result of human activity. Based on the different obstacles found at each level of analysis, we offer suggested ways to overcome the barriers detected.



Poster Session Monday 1: Poster Pod 2, Poster 9

IMPROVING DROUGHT PREPAREDNESS FOR UTAH RANGE LIVESTOCK SYSTEMS

D. Layne Coppock*; Utah State University, Logan, UT

ABSTRACT

Drought is a big challenge for Utah. Efforts to improve drought preparedness are important. This research provides a retrospective view of the past 20 years and then looks to the future. Research elements include: (1) analysis of drought-management tactics by ranchers using an innovation-adoption framework; (2) updating probabilities of drought years; and (3) gathering insights from Extension and federal range management professionals concerning drought issues. Research methods include social surveys, analysis of precipitation records 2000-2018, and key informant interviews. Statistics focused on logistic regression. A survey of 429 randomly selected ranch households revealed 3,133 non-adoption decisions concerning use of 14 commonly recommended drought-management tactics. About 44% of all non-adoption decisions indicated that the drought management tactic in question was incompatible with priority needs of the operation. Other reasons for non-adoption included complexity, high cost, and low observability of the tactic. Regression analyses indicated that adoption of some drought management tactics was positively associated with a person being more business oriented or having a pro-active attitude about crisis management. Adoption of other tactics was negatively associated with advancing producer age and pending retirements. Empirical analysis of drought records revealed that drought risk in Utah is now pronounced; the probability of one drought year is 0.53, while probabilities of two- or three-year droughts are 0.28 and 0.15, respectively. Range professionals expressed concerns that Utah ranchers: (1) are not as drought vigilant as they should be; (2) are highly variable in terms of risk management skills; and (3) most barely survived a one-year drought in 2018. Education—from new online platforms to classroom and individualized one-on-one delivery—is needed among all stakeholders to improve drought preparedness. Policy changes that enhance producer access to drought forage reserves on public lands are desirable, but unlikely to occur anytime soon.



Poster Session Monday 1: Poster Pod 2, Poster 10

THE GLOBAL EFFORT TO DESIGNATE A UN INTERNATIONAL YEAR OF RANGELANDS AND PASTORALISTS

Barbara Hutchinson*¹, Jim ORourke²; ¹University of Arizona, Tucson, AZ, ²Rancher, Chadron, NE

ABSTRACT

A growing worldwide network acknowledges that the condition and productivity of the world's rangelands and grasslands are critical to a sustainable future for people everywhere. Unhealthy and unproductive rangelands and grasslands destabilize countries, endanger national security, compromise economic productivity, and rob our youngest generation of opportunities for a prosperous future. To increase knowledge and understanding of these unique ecosystems and the people and animals who rely on them, an initiative to gain a United Nations-designated International Year of Rangelands and Pastoralists (IYRP) was introduced in 2016. This poster will document the status on this effort, provide the "whys" for an IYRP, and suggest how others can become involved. Specifically, numerous organizations have been working to gain an IYRP through a formalized Support Group. This Group, represented by international organizations such as SRM, NGOs, academia, and community groups, sustains the effort by actively engaging with colleagues and interested parties around the world. It has coordinated numerous meetings and events and has worked with members to gain the support of their respective governments for an IYRP. These activities are documented on the

website: <https://globalrangelands.org/international-year-rangelands-and-pastoralists-initiative>.

Most recently, the Government of Mongolia presented a formal request for an IYRP designation at an open session of the October 2018 FAO Committee on Agriculture (COAG) meeting. Subsequently, Mongolia, with the support of numerous internal ministries as well as more than 20 countries and organizations, successfully submitted a proposal for an IYRP to COAG in July 2019 requesting that the resolution be put on the agenda for the 2020 COAG Meeting - the necessary next step in the designation process. The proposal also must be endorsed at the 2021 FAO Conference and finally by the UN General Assembly. If these hurdles are successfully overcome, then an IYRP will likely be designated for 2027!



Poster Session Monday 1: Poster Pod 2, Poster 11

USING FIRST FOODS TO GUIDE ECOSYSTEM MANAGEMENT

Bryan A. Endress*¹, Eric J. Quaempts², Shawn Steinmetz³; ¹Oregon State University, La Grande, OR, ²Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR, ³Confederated Tribes of the Umatilla Indian Reservation, PENDLETON, OR

ABSTRACT

First Foods have sustained tribal people since time immemorial and the relationship between First Foods and the Tribes is essential to the ongoing culture of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The First Foods serve a fundamental role in the health, well-being, and cultural identity of the Tribes and are considered to constitute the minimum ecological products necessary to sustain CTUIR subsistence and cultural needs. Recently, the Department of Natural Resources of the CTUIR adopted a mission based on First Foods: “To protect, restore, and enhance the First Foods - water, salmon, deer, cous, and huckleberry - for the perpetual cultural, economic, and sovereign benefit of the CTUIR...” In order to assist in applying this mission to natural resource management decisions, the CTUIR created a vision statement: *Our vision for upland landscapes is to ensure healthy, resilient and dynamic upland ecosystems capable of providing First Foods that sustain the continuity of the Tribe’s culture.* The primary goals of this vision are to: 1) articulate CTUIR’s vision for upland resource management, 2) serve as the foundation for planning and managing upland ecosystems and resources, and 3) serve as a resource for non-Tribal land managers, policy makers, and other stakeholders to better understand the importance of First Foods and provide a framework to consider and incorporate First Foods concepts into their management activities within CTUIR’s ceded territory. The vision highlights desired ecological characteristics of upland ecosystems and provides a framework for planning, management and restoration efforts. We will present the CTUIR upland vision and identify key ecosystem attributes critical to the sustained natural production of culturally important resources across upland ecosystems within the CTUIR's ceded lands.



Poster Session Monday 1: Poster Pod 2, Poster 12

DROUGHT ADAPTATION FOR RANGELAND LIVESTOCK PRODUCERS: LESSONS FROM CALIFORNIA'S HISTORIC DROUGHT.

Grace E. Woodmansee*¹, Tracy Schohr², Daniel K. Macon³, Leslie Roche¹; ¹UC Davis, Davis, CA, ²UC Cooperative Extension, Quincy, CA, ³University of California Cooperative Extension, Auburn, CA

ABSTRACT: MS STUDENT

Rangelands represent the largest land use type across the western United States. While these landscapes have been historically shaped by patterns of low and variable precipitation, between 2012-2015 California experienced conditions that were warmer and drier than any period during the previous 1200 years. Evidence is rapidly mounting that these co-occurring periods of precipitation deficit and warm temperatures are likely to increase over the next century and will result in levels of drought intensity and duration rivaling those in the paleoclimate record. Because ranching and rangelands are fundamentally dependent on seasonal precipitation (as opposed to stored or ground water), these systems are among the first to experience impacts of drought. This threat poses an unmatched risk to California's \$4.2-billion-dollar rangeland livestock industry. Consequently, understanding how to adapt California rangeland livestock production to anthropogenic drought and enabling producers to sustain economic and environmental viability in the face of climate change represents one of the most serious research and extension challenges of our time. We conducted telephone interviews with 48 rangeland beef cattle, sheep, and goat operations to ascertain the impacts of California's 1200-year drought and to evaluate the strategies that these operations used to cope with drought conditions. These interviews provide a first look at the drought preparation and mitigation strategies that actually worked (and some that did not) for California ranchers. Using the Adaptive Decision Making framework as a guide, we will assess the management capacity of ranchers and how individual suites of adaptive strategies influence overall drought adaptation and ranch resilience. Specifically, we will assess the influence of multi-species grazing and land resource base on individual adaptive capacity. We will present preliminary results from this assessment.



Poster Session Monday 1: Poster Pod 3, Poster 13

MANAGEMENT OF HERBAGE ALLOWANCE LEADS TO DIVERSE RESULT OF STOCKING RATE, BUT IMPROVE ANIMAL PRODUCTIVITY

Martin Do Carmo*¹, Pablo M. Soca²; ¹Universidad de la Republica, Rocha, Uruguay,
²Universidad de la República, Paysandu, Uruguay

ABSTRACT: MS STUDENT

Management of herbage allowance (HA) is essential to improve animal productivity, but at year and farm scale it could be related to lower, equal or higher stocking rate. Based on experimental information of control of HA, with multiparous and primiparous cows where the mean HA were 5 and 3 kg DM/kg BW, with seasonal variation of, 5, 5, 6, and 3 and 2, 2, 4 and 3 in High and Low for Spring, Summer, Autumn and Winter, interventions in commercial systems were applied. At farms, the focus was to improve the animal productivity by enhancing the growing of heifers and steers, the cow-calf system, and fattening steers by HA management. Results of stocking rate were diverse, with farms decreasing, maintaining and increasing it throughout the interventions, but in most of the cases under study the animal productivity and economic output was increased. Results in animal productivity can be explained by greater energy intake of the animals as HA increased, spatial optimization of herbage mass and animal requirements was done, and temporal energy requirements was also matched (e.g. moment and duration of breeding season) with temporal grow of native pasture. All together those tools allow to improve animal productivity from 10 to 50%, and economic output was improved even 36 times (from 2 to 72 USD/ha in one case). The dialog between grazing experiments and the beef systems confirm the experimental evidence that greater HA increase system productivity, but the impact at farm scale seems to be even greater than estimated previously.



Poster Session Monday 1: Poster Pod 3, Poster 14

CHANGING IDENTITIES AND LIVELIHOODS OF NORTHEASTERN COLORADO LIVESTOCK PRODUCERS: A GROUNDED THEORY STUDY

Jasmine E. Bruno*; Colorado State University, Fort Collins, CO

ABSTRACT: Ph. D STUDENT

Rangeland systems in Northeastern (NE) Colorado are undergoing linked land-use, livelihood, and identity transitions. As factors such as urbanization influence land-use changes, ranchers may lose their livelihood strategy of extensive livestock production and subsequently their rural identity. This research investigates social change in the context of land-use transition through an examination of linked livelihood and identity changes. By identity we mean how an individual classifies themselves with respect to occupation (i.e. a rancher or farmer), as well as how they behave in relation to what they believe others with their shared identity consider appropriate (i.e. subjective social norms). Thus, the livestock producers' identities inherently link to their decisions about resource management. Despite empirical evidence that identity influences decision-making and theories that recognize identity as a predictor of behavior, researchers have often overlooked the influence of identity on behavior. To remedy this gap, I conducted a grounded theory study using participant observation and semi-structured interviews. Using a modified grounded theory approach, I open coded field notes and interview transcripts using the constant comparator method. In my sample, producer identities extend beyond rancher or farmer to roles such as steward and grass farmer. Producers often participate in multiple, sometimes conflicting social roles that affect decision-making. These identities reflect history, place, and values. I find that individuals with shifting or multiple identities (i.e. farmer and rancher) integrate diverse livelihood strategies in response to the changing socio-cultural and ecological landscape. This research contributes to the rancher decision-making literature by refining concepts of identities for greater application in quantitative research, such as clarifying the norms of stewards versus conservationists. This more complex understanding of producer identities and their relationship to livelihood strategies, calls for extension, researchers, and policy makers to develop strategies to meet the varying needs of a diverse and shifting group of producers.



Poster Session Monday 1: Poster Pod 3, Poster 15

ECOLOGICAL INTENSIFICATION IN COW-CALF SYSTEMS BASED ON NATURAL GRASSLANDS IN URUGUAY: RESULTS OF A CO-INNOVATION PROCESS

Ignacio Paparamborda*¹, Santiago Scarlato², Varinia Figueroa¹, Ana A. Sánchez³, Nelson Rivas⁴, Marcello Martinelli⁵, Mercedes Silva⁶, Santiago Dogliotti¹, Pablo M. Soca⁷; ¹Universidad de la República, Montevideo, Uruguay, ²Universidad de la República, Minas, Uruguay, ³Extension agent, Velazquez, Uruguay, ⁴Extension agent, Tacuarembó, Uruguay, ⁵Extension agent, Montevideo, Uruguay, ⁶Extension agent, Paso de los Toros, Uruguay, ⁷Universidad de la República, Paysandu, Uruguay

ABSTRACT: Ph. D STUDENT

In Uruguay, livestock systems have social, economic and cultural relevance. Most farms are family farms with cow-calf systems grazing on natural grasslands. These farms have low productivity ($72,2 \pm 53,3$ kg ha⁻¹), explained by high grazing intensity and the lack of implementation of management techniques in the herd. There is increasing evidence of negative effects of these systems on the environment greenhouse gas emissions. To help farmers to cope with the challenges of increasing family income and improving ecosystem services provided by grasslands, we proposed an ecological intensification strategy: improving the production, utilization, and conversion of grasslands forage, without the use of external inputs. To implement ecological intensification principles, we used co-innovation as a tool to foster learning by actors towards adaptive management in complex systems. For three years we worked together a team of scientists, four extension agents and farmers' families of 24 farms located in two regions of Uruguay. The sequence of the co-innovation work at farm level was: diagnosis, participatory elaboration (extension agent and farmer and his family) of a production plan and its implementation. On average, the farms in the northern region, improved beef production by 32% and sheepmeat and wool increased by 16%, while net income increased around 100%. The farms in the eastern region increased beef production by around 15% and net income by 45%, on average. Main management changes implemented were differential forage allowance according to cow body condition and physiological stage, setting the matting period starting in spring and restricting it to 90-120 days, temporary weaning, definitive weaning early in autumn and diagnosis of ovarian activity in the middle of the mating period and pregnancy diagnosis in autumn. Co-innovation was a good tool for intervention on complex systems as are the cow-calf systems on grassland and develop social learning.



Poster Session Monday 1: Poster Pod 3, Poster 16

THE CENTRAL ROLE OF GRASS COVER IN SUSTAINABILITY AND RESILIENCE IN SOCIAL AND NATURAL SYSTEMS IN THE NEBRASKA SANDHILLS

Mary Ann Vinton*, Jay Leightner, John O'Keefe, Alexander Larsen; Creighton University, Omaha, NE

ABSTRACT

The Sandhills in north-central Nebraska cover over a quarter of the state and comprise the largest stabilized sand dune formation in the Western Hemisphere. With fragile, grass-stabilized sand dunes vulnerable to large scale movement and a dominant human land use, cattle grazing, that depends on vegetation cover and forage, the region has an intimate connection between the natural and social systems. Thus, the Sandhills are an excellent system in which to study social-ecological resilience. We are using remote sensing, biodiversity surveys, ethnographic analyses, artistic representation and philosophical/theological theory to understand the processes and narratives underpinning social-ecological resilience. The specific question we asked in this phase of the project was: what are the most direct links between the ecological patterns in climate- and landscape-induced variation in grass cover and specific elements in communication and culture that reflect those patterns? To answer this, we measured variation in grass cover in wet vs. dry years and over a complex landscape of dry dunes vs. subirrigated lowlands. We then conducted interviews with landowners in which they reflected on these patterns and noted common phrases, concepts and themes. Satellite and drone-based imagery documented a much more consistent grass cover in subirrigated meadows of the Sandhills than nearby upland dunes. Some years (e.g. 2012, the driest in the past four decades) and some portions of the landscape (e.g. upland dunes) especially exemplify a loss of vegetation cover that landowners consistently referred to as harbingers of “losing their place”. When queried more about this phrase, it became clear that this phrase is not simply a loss of a physical home and livelihood but refers to a loss of identity and a cultural dislocation. Because of the high stakes of “losing their place”, residents in this region may have identified thresholds and resilience strategies that shed light on general mechanisms by which communities can adapt to climate extremes and environmental change.



Poster Session Monday 1: Poster Pod 3, Poster 17

RANGELAND RESILIENCE THROUGH CARBON SEQUESTRATION: COMMUNITY NEEDS DIRECTING RESEARCH

Alexia Cooper*¹, Jennie DeMarco¹, Eric McPhail², MJ Pickett³; ¹Western Colorado University, Gunnison, CO, ²Colorado State University, Fort Collins, CO, ³Cold Harbor Inst., Gunnison, CO

ABSTRACT: MS STUDENT

Land management of rangelands can play an important role in climate change mitigation by influencing soil carbon (C) storage. Soil amendments, such as adding compost, has been shown to increase soil C storage while simultaneously increasing plant productivity and soil water holding capacity (WHC), factors that provide immediate benefits to ranchers. Research to date has mainly focused on temperate annual grasslands however little is known if arid, cold climate, high-elevation rangelands respond similarly. Our objective was to determine the effect an application of 2 inches of locally sourced biosolid compost has on soils on plant productivity, soil WHC and C. Research sites were set up at 4 separate ranches in Gunnison, CO, an arid, cold climate, high elevation region. Within each site, two treatments were established (control and compost addition) with 5 replicate plots within each treatment. Throughout the growing season, we monitored soil moisture and plant productivity. In the fall of 2019, samples were collected to measure the expected changes in C:N ratios, C stocks, pH, available nitrogen, fungal infection rates, and the WHC of the soils. Preliminary analysis at one of the four sites showed an increase in plant biomass in the treatment compared to the control. Throughout the growing season all treatment sites maintained higher soil moisture levels than the control. If our treatment does show a change in C stocks, we hope it could inform the start of a C capture policy. Incentivizing producers to implement practices to store more C as a form of climate mitigation with the co-benefit of improved drought resiliency.



Poster Session Monday 1: Poster Pod 3, Poster 18

OUTREACH ON GRAZING LANDS TO ENHANCE ECONOMIC ANALYSIS (COST BENEFITS) FOR CONSERVATION CHANGES

Greg Clary*¹, Quincy Ellis¹, Monti Golla²; ¹The Matrix Assessment Group, ²National Grazing Lands Coalition

ABSTRACT

The National Grazing Lands Coalition and The Matrix Assessment Group conducted a 3-year outreach/education/demonstration project on how a variety of management and conservation practices impact pasture and range productivity, economics, and sustainability. The project assessed the role economics plays on producer decisions about conservation program participation, on the design of grazing management systems and to what extent multispecies management influences economic performance. Data was collected in additional areas including program participation, use of conservation management practices, costs and returns of programs and practices, productive capacity, socio-economic factors and producers' opinions about conservation issues. The goal of this project was to determine whether agricultural producers are motivated by economics when considering implementing conservation programs and management practices on their farms/ranches. Producers in six regions provided data to identify economic linkages, namely costs and benefits, for conservation programs and practices that were either planned, in progress or completed by agricultural producers. Producers did not provide enough cost and benefit data to develop an investment analyses; however, they readily provided descriptions of costs but were not able to delineate actual total costs for projects. The situation became a challenge for project investigators, and as a result, developed an extremely useful process that producers view as a valuable management tool for the future. The Ag Sustainability Process (ASP) with the Sustainability Assessment Matrix (SAM) as its foundation includes performance evaluation (productivity and financial performance) of conservation programs and practices. Producers will have the appropriate economic data to complete investment analyses that will result in better management decisions about conservation programs and practices that might benefit their operations. Beneficiaries of this project have always been farmers and ranchers across the U.S. Producers now have access to a wealth of information characterizing what their fellow producers are doing in terms of developing sustainable farms and ranches in their region and other regions of the U.S. They now have a process available that will improve their management decision making to evaluate conservation alternatives more carefully.



Poster Session Monday 1: Poster Pod 4, Poster 19

PASSING ON THE GRIT: WOMEN'S STORIES ON THE RANGE

Amanda Botsford*¹; ¹Western Colorado University

ABSTRACT

Women's voices are underrepresented in rangeland management. Young women considering careers in agriculture rarely have access to women mentors and therefore can fail to see ranching as a viable career. In this project, I plan to interview women ranchers in the Gunnison Valley to gain an understanding of their lived experiences working on rangelands and what a women's perspective brings to rangeland management. My intent is to understand how they overcome adversity and empower other women through education and stewardship of the land. Preliminary interviews show that women do not see the work they do as different from that of a man's. Interviews suggest that a woman's role in ranching is varied and many women carry many hats on a working ranch. My goal for this project is to add to the limited body of research surrounding a women's perspective in ranching and elevate a woman's experience in rangeland communities.



Poster Session Monday 1: Poster Pod 4, Poster 20

SCALING BIG DATA ON RANGELANDS: ADVANCES IN REAL-TIME ASSESSMENT OF LIVESTOCK FORAGING BEHAVIOR

Edward J. Raynor*¹, Sheri Spiegel², David Augustine³, Raoul K. Boughton⁴, Patrick E. Clark⁵, Kathy J. Soder⁶; ¹USDA - ARS, Fort Collins, CO, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³USDA-ARS, Fort Collins, CO, ⁴University of Florida, Ona, FL, ⁵USDA Agricultural Research Service, Boise, ID, ⁶USDA-ARS, University Park, PA

ABSTRACT

Precision livestock management is essential to the sustainable intensification of livestock production, a land use that dominates 40% of the Earth's surface. We contend that approaches which improve management can synergistically intensify production with neutral to positive environmental effects and address social concerns about the impacts of grazing on extensive rangeland landscapes. Recent technological advances have begun to empower livestock managers by providing more rapid, near-real-time monitoring of livestock locations and behavior by providing means to track and predict changes in forage resources across broad landscapes, and by enhancing the means to manipulate livestock distribution remotely. Here, we highlight three technological advances: 1) traditional livestock tracking methods (GPS technology), 2) real-time rangeland resource utilization (daily livestock foraging effort and growth rates), and 3) fine-scale measurements of foraging behavior (automatic jaw-movement recorders) to inform management decisions by graziers and other land managers. We demonstrate the use of these approaches across USDA Long-Term Agroecosystem Research (LTAR) Network sites, describe the challenges inherent in conducting research across multiple climatic regions, and identify how this work can inform large-scale questions about rangeland ecology and management. We highlight examples of coordinated cross-site implementation of technological advances and provide inter-regional contrasts of how management actions may lead to optimization of rangeland utilization on a national scale.



Poster Session Monday 1: Poster Pod 4, Poster 21

A COMPARISON OF CATTLE GRAZING DIVERSE, SHORTGRASS PASTURES USING TWO DIFFERENT GRAZING STRATEGIES

Larry D. Fritzler*, Tim Steffens, David Lust, Marty Rhoades; West Texas A&M University, Canyon, TX

ABSTRACT: MS STUDENT

This study used Near-infrared Reflectance Spectroscopy (NIRS) to compare, forage disappearance, fecal crude protein (FCP), and digestible organic matter (FDM) between mature, lactating pairs, grazing continuously (CG) or at a high stocking density with weekly moves (HSD), given the same average stocking rate of 3.96 acres pair-1month-1. Fecal collections occurred five different weeks in both CG and HSD. HSD collections were on the second and seventh day of a paddock grazing period. Within a HSD treatment FCP and FDM were compared between the first half and the second half of the grazing interval for that paddock. The FCP and FDM were compared between treatments at similar points during the grazing season and during the respective grazing periods. We compared the standing forage using the dry weight ranked method (DWR) before and after grazing to estimate standing crop, forage disappearance and regrowth in the HSD treatment. Serial exclosure cages were used to measure forage disappearance and regrowth at four intervals during the grazing season in CG treatments while DWR was used to estimate standing crop at the beginning and end of the study. Composite forage samples by species were analyzed using NIRS for CP and Total Digestible Nutrients (TDN). TDN was adjusted to DOM to compare FDM to DOM of forages. We will report data on diet quality, forage utilization, and grazing distribution between treatments over time.



Poster Session Monday 1: Poster Pod 4, Poster 22

DEVELOPING A TECHNIQUE TO ESTIMATE WHO GRAZED WHAT

Brandon K. Mayer*¹, Andrew M. Antaya¹, Sarah Noelle¹, Judith Dyess², George Ruyle¹;
¹University of Arizona, Tucson, AZ, ²Forest Service, Tucson, AZ

ABSTRACT: MS STUDENT

Rangelands support a variety of grazing animals, and managers often need to determine forage demands for a mix of species. However, where livestock and wildlife cohabitate, differentiating between grazer impacts is sometime contested, and may create conflict between stakeholders and land managers. An evidence-based means of differentiating the level of use among species could reduce contention and improve management decisions. Camera traps are used to automate monitoring and provide data useful for assessing population characteristics such as occupancy by different grazing animals. Expanding on this technique, camera traps can collect a time-lapsed census of a large area and provide detailed measures of grazing activity for the entire grazing season. These measurements include animal species frequency of occurrence over that time period. Paired with vegetation measurements, the allocation of grazing time to a specific species can help partition resource use. During the summer of 2019, this technique was applied to examine grazing interactions among cattle and elk within critical habitat of the New Mexico meadow jumping mouse in New Mexico's Lincoln National Forest. Using a proportional approach, forage removal was differentiated to distinguish species-specific grazing impact.



Poster Session Monday 1: Poster Pod 4, Poster 23

GRAZING BEHAVIOR OF CATTLE IN UPLAND SANDHILLS AND SUB-IRRIGATED MEADOW ENVIRONMENTS

Travis M. Millikan^{*1}, Mitchell Stephenson², Joslyn Beard³, Travis Mulliniks³; ¹Chadron State College, Chadron, NE, ²University of Nebraska - Lincoln, Scottsbluff, NE, ³University of Nebraska - Lincoln, Lincoln, NE

ABSTRACT: UNDERGRADUATE STUDENT

The Sandhills of Nebraska provide a variable range of environments that play a role in determining the behavior of grazing animals over time and space. Our study focused on how different ecological sites (i.e., upland rangelands or sub-irrigated meadows) affected grazing behavior of 2-yr old beef cows with calves. In 2018, GPS collars were placed on two separate herds of 15 cattle at the Gudmundsen Sandhills Laboratory north near Whitman, Nebraska. One herd was placed in an upland rangeland site (400 acres) and the other herd in a sub-irrigated meadow site (36 acres). Location and grazing behavior data were taken every five minutes from the GPS collars from 15 June to 30 August. Visual observations of the grazing behavior of the herds (grazing, non-grazing, and walking) were recorded during the study period. We hypothesized that cattle in the sub-irrigated meadow site would spend less time grazing than cattle on the upland rangeland sites because of greater forage production and higher forage quality associated with meadow sites. Preliminary data analysis during the summer of 2018 indicated that cattle spent 11.2 ± 1.2 SD hrs grazing in the upland pasture and 10.0 ± 1.0 SD hrs on the meadow. Cattle on the upland pasture also walked 3.8 ± 0.5 SD km·d⁻¹ compared to 2.6 ± 0.2 SD km·d⁻¹ on the meadow. While these data represent only one year of data in a single replication, there is evidence that grazing behavior is affected by the characteristics of the pasture and resources available to animals.



Poster Session Monday 1: Poster Pod 4, Poster 24

THE EFFECTS OF FORAGE TYPE, STORAGE METHOD AND TIME ON NUTRIENT COMPOSITION

Michelle Fitterer*, Woodrow Poland; Dickinson State University, Dickinson, ND

ABSTRACT: UNDERGRADUATE STUDENT

Forage quality and storage conditions are important when feeding cattle to ensure nutritional requirements are met during winter months. This study examined two ways of storage; twine wrapped bales and plastic wrapped bales (haylage). This study focuses on how storage methods and time can impact the nutrient composition of different types of forages. Alfalfa and oat pea hay were sampled at three different time periods roughly sixty-five days apart. Samples were analyzed for crude protein, neutral detergent insoluble crude protein, Neutral Detergent Fiber Content (aNDFom and aNDF), nonfibrous carbohydrates, relative feed value, Acid Detergent Fiber Calculations (Total Digestible Nutrients-ADF, Net Energy Gain-ADF, Net Energy Maintenance-ADF, and Net Energy Lactation-ADF). Results determined that storage methods had no impact on crude protein or acid detergent fiber. Alfalfa had higher crude protein, relative feed value and nonfibrous carbohydrates, but lower acid detergent fiber when compared to oat pea. Nonfibrous carbohydrates and relative feed value were much greater in alfalfa haylage when compared to oat pea haylage. Therefore, this study demonstrated that storage method had little effect on the nutrient composition of the forages examined, suggesting that producers can choose the most economical storage method without sacrificing the nutrient quality of the forage.



Poster Session Monday 1: Poster Pod 5, Poster 25

THE GRAZING BEHAVIORS OF HEIFERS ON RANGELAND ARE NOT AFFECTED BY FEED EFFICIENCY

Nolan Craun^{*1}, Laura Goodman², Ryan Reuter², Karen R. Hickman², James Neel³; ¹Bureau of Land Management, Farmington, NM, ²Oklahoma State University, Stillwater, OK, ³Agricultural Research Service, El Reno, OK

ABSTRACT

Feed represents the single largest source of input costs in the beef industry. Residual feed intake (RFI) is the difference between an animal's actual feed intake and expected intake based on body weight and growth. Selection against RFI for improved feed efficiency has been proposed to reduce feed costs. Little research has been conducted evaluating the effect of RFI on beef cattle grazing in extensive environments. This study used global positioning system (GPS) collars to collect spatial data on 38 Angus and 5 Brahman x Angus heifers with known RFI values in a 69ha pasture in the south-central Great Plains. Heifers were categorized by RFI value: low-RFI (efficient), mid-RFI (average), and high-RFI (inefficient). Body weight and average daily gain were similar among RFI group. No differences were observed in the plant community electivity among RFI groups; the Johnsongrass community was most preferred and the woody community was most avoided among each RFI group. Diet quality results indicate heifers were selecting diets with a higher protein content (>5.8%) than the average warm-season grass plant community could provide, and diets did not differ among RFI group ($P \geq 0.60$). Only small differences in diet quality or selection at the plant family level were detected among RFI group. Similarly, differences among RFI groups were not detected when behaviors (24-hour, daytime, sunset to midnight, and midnight to sunrise distance travelled; water and shade use; area explored; and slope use) were compared. On average heifers travelled in excess of 6.3km per day. The culmination of these results indicates a selection against RFI for feed efficient beef cattle is unlikely to affect grazing distribution, diet quality and selection, and grazing behavior.



Poster Session Monday 1: Poster Pod 5, Poster 26

COMPARISON OF DIET SELECTION OF RANGEFED RARAMURI CRIOLLO COWS, HEIFERS AND STEERS DURING FIVE SEASONS

Flavie Audoin*¹, George Ruyle², Dennis Moroney³, Gary P. Nabhan⁴, Samuel R. Garcia², Larry D. Howery⁵, Derek W. Bailey⁶; ¹University of Arizona, School of Natural Resources and the Environment, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³Cross U Cattle Company / 47 Ranch, McNeal, AZ, ⁴University of Arizona, Patagonia, AZ, ⁵The University of Arizona, Tucson, AZ, ⁶New Mexico State University, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

For the past twenty-five years, drought has strongly affected the southwest United States and northwest Mexico; described as arid to semi-arid, with annual precipitation of less than 406.4 mm. Choosing cattle breeds which are adapted to this climate, and topography in order to maximize the feed resources without degrading them is an ongoing challenge in the region. 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. This study was conducted on the 47 Ranch in southeastern Arizona. In order to better understand landscape use and productivity, we estimated diet composition and the influence of gender and stage of production (mature cows, heifers and two-year-old steers), and how diet selection varied according to the season. We collected monthly fecal samples from July 2018 to October 2019. The samples were analyzed with NUTBAL and submitted for DNA analyses. Seasons analyzed included (fall [October-November], winter [December-February], spring [March-April], pre-monsoon [May-June], monsoon [July-September]). Full analyses of the data will be presented.



Poster Session Monday 1: Poster Pod 5, Poster 27

GRAZING BEHAVIOR OF RANGEFED RARAMURI CRIOLLO BULLS DURING FIVE SEASONS

Flavie Audoin*¹, George Ruyle², Dennis Moroney³, Gary P. Nabhan⁴, Samuel R. Garcia², Larry D. Howery⁵, Derek W. Bailey⁶; ¹University of Arizona, School of Natural Resources and the Environment, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³Cross U Cattle Company / 47 Ranch, McNeal, AZ, ⁴University of Arizona, Patagonia, AZ, ⁵The University of Arizona, Tucson, AZ, ⁶New Mexico State University, Las Cruces, NM

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Poster Session Monday 1: Poster Pod 5, Poster 28

INFLUENCE OF RAINFALL EVENTS ON DRINKER VISITATION PATTERNS BY BEEF COWS ON DESERT RANGELAND

Shelemia Nyamuryekunge^{*1}, Adrienne Dawes¹, Matthew M. McIntosh¹, Andres F. Cibils¹, Richard E. Estell², Alfredo L. Gonzalez³, Sheri Spiegel⁴; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS-Jornada Experimental Range, Las Cruces, NM, ³Animal Scientist, Las Cruces, NM, ⁴USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

We sought to compare drinker visitation patterns of Angus x Hereford and Raramuri Criollo on days with precipitation events (PE, n= 13) vs days with no precipitation (NP, n= 106) in extensive Chihuahuan Desert pastures at the Jornada Experimental Range during summer and winter of 2016 and 2017. In all seasons and years, each breed (n = 11 cows/breed/season) grazed two adjacent pastures (1190, 1165 ha) separately for 4-weeks in a crossover design. Position of 7-9 randomly selected cows/breed/trial was logged every 10 min using Lotek 3300-LR GPS collars. Precipitation was recorded by a rain gauge 3 km away from our study pastures. We calculated time spent within 200, 100, and 50 m of a drinker per day for all trial dates (n= 119) and treated individual cows as experimental units. Breed did not influence time spent near the drinker. On days with PE, cows spent detectably less time within 200m (PE= 11.98 vs NP= 56.97 min, $P < 0.01$), 100m (PE= 6.47 vs NP= 31.86 min, $P < 0.01$), and 50m (PE= 2.92 vs NP= 9.63 min, $P < 0.01$) of the drinkers. Cows spent more time within 200m ($P=0.01$) and 100m ($P<0.01$) of the drinkers in summer vs. winter. We found no rainfall*breed nor rainfall*season*breed interaction. Our preliminary results suggest that precipitation events influence drinker visitation patterns regardless of breed or season likely due to the availability of ephemeral watering sources. A decreased need to travel to the drinker on days with precipitation events likely influences spatial distribution patterns of cattle. Further research is needed to determine how frequency and size of precipitation events shapes landscape use patterns of cattle on desert rangelands.



Poster Session Monday 1: Poster Pod 5, Poster 29

LATE-FALL LANDSCAPE USE BY HERITAGE VS CONVENTIONAL BEEF CATTLE ON COLORADO PLATEAU RANGELANDS: A CASE STUDY

Matthew M. McIntosh¹, Danielle M. Duni^{*1}, Andres F. Cibils¹, Richard E. Estell², Alfredo L. Gonzalez³, Shelemia Nyamuryekunge¹, Matthew Redd⁴, Michael C. Duniway⁵, Sheri Spiegel⁶;
¹New Mexico State University, Las Cruces, NM, ²USDA-ARS-Jornada Experimental Range, Las Cruces, NM, ³Animal Scientist, Las Cruces, NM, ⁴The Nature Conservancy, Canyonlands, UT, ⁵US Geological Survey, Moab, UT, ⁶USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT: UNDERGRADUATE STUDENT

Heritage livestock genetics may help improve sustainability of arid rangelands. We compared behavior and landscape use of Raramuri Criollo (RC; heritage) and Red Angus (RA) at the Dugout Ranch in Canyonlands, Utah. We used Lotek LITETRACK LR-GPS collars to track 3 RC and 3 RA cows that grazed in a mixed herd from November 16 – December 25, 2018. We used PROC MIXED in SAS 9.4 to analyze movement patterns (distance traveled, velocity, and path sinuosity [0=more sinuous; 1=straight]), use of riparian areas and upland slopes, as well as vegetation preference (using Ivlev's Electivity Index) during 40 d in a 3560-ha pasture. RC cows traveled farther per day (RC: 6.5 ± 1.4 ; RA 6.1 ± 2.1 km; $P < 0.01$) and during daytime hours (sunrise – sunset; RC: 3.9 ± 1.1 ; RA: 3.2 ± 1.0 km; $P < 0.01$) than their RA counterparts. RC cows also traveled faster during 24 h (RC: 1.6 ± 0.3 ; RA: 1.4 ± 0.5 m*min⁻¹; $P < 0.01$) and daytime hours (RC: 6.6 ± 2.1 ; RA: 5.2 ± 1.7 m*min⁻¹; $P < 0.01$) than RA, though RA moved faster during post-sunset hours (sunset – midnight; RC: 1.3 ± 0.9 ; RA: 1.5 ± 1.4 m*min⁻¹; $P < 0.01$). RC cows displayed more sinuous movement trajectories during all 24 h, daytime, and pre (midnight – sunrise) and post-sunset periods ($P < 0.01$). RC cows spent less time near riparian areas compared to their RA counterparts (RC: 143 ± 1.2 ; RA: 111.1 ± 2.0 m away from streams; $P < 0.01$). RC and RA cows did not differ in their use of slopes nor elevation ($P > 0.10$). RA cows showed a greater preference for riparian shrublands than their RC counterparts (RC: $E 0.23 \pm 0.0$; RA: $E 0.59 \pm 0.03$; $P < 0.01$). Our preliminary results suggest that RC and RA cows use rangelands of the Colorado Plateau differently.



Poster Session Monday 1: Poster Pod 5, Poster 30

THE PIOSPHERE, PREDICTING CATTLE DISTRIBUTIONS ACROSS A LANDSCAPE

Mike T. Anderson*; Open Range Consulting, Salt Lake City, UT

ABSTRACT

With climate change looming into the future an economical and consistent means of calculating available acres for cattle would be an effective tool providing a conduit for communication between resource managers. The term Piosphere put forth by Lange (1969) is a distinct ecological system determined by the existence of a watering point by the capacity of animals to forage away from that point. Further described by Thrash, I. & Darry, J.F. (1999). a Piosphere can be as simple as one isolated watering point in one uniform rangeland type or it may consist of multiple watering points across a wide range of elevations, within a mosaic of many different rangeland types. Using the Piosphere concept in concert with GIS applications Open Range Consulting has built a tool that predicts distributions of cattle across a landscape. This tool can provide an economical and consistent means of calculating available acres for cattle which in turn opens a suite of options or conversations for resource managers.



Poster Session Monday 1: Poster Pod 6, Poster 31

HUMBLED BY NATURE: A RANCHER'S MENTAL-MODEL OF ADAPTATION IN THE GREAT PLAINS

Jim Sturrock*¹, Hailey Wilmer²; ¹Lonesome Pines Land and Cattle, LLC, Grover, CO, ²USDA-ARS, 80526, CO

ABSTRACT

Ranchers in the Great Plains make decisions in complex social and ecological environments. While a great deal of research has studied rancher adaptation, an insider's or "emic" view rancher's mental models is less well understood. In this study a rancher and a researcher collaborate to document ten years of management on a Colorado ranch. Using data from repeated interviews, participatory mapping and records review, we describe a conceptual model for ranch decision-making. Then, we illustrate the spatial ecology of these decisions, via a participatory map. Finally, we show management, climate, and ecological records over ten years. This timeline illustrates how the rancher's management approach and relationship to the ecosystem changed over time from viewing himself as the "controller" of the ecological community to "member of it". We discuss how our results complement existing research about ranch systems adaptation by documenting how climate, weather, economic and ecological dynamics interacted with the rancher's own self-image and how management strategies changed over time. Our collaborative methodology and the resultant mental model may inform other first-generation ranchers seeking to develop adaptive management approaches, and researchers seeking to better understand the decision-making environments of their rancher collaborators.



Poster Session Monday 1: Poster Pod 6, Poster 32

IMPROVING ACCESS TO SPECIES HABITAT INFORMATION ON US GRAZING LANDS THROUGH THE PHONE APP LANDPKS

Tegan May*¹, Terri Schulz², Angela Dwyer³, Jennifer Timmer³, Jeffrey Herrick⁴; ¹The Nature Conservancy Colorado, Boulder, CO, ²The Nature Conservancy Colorado, Fort Collins, CO, ³Bird Conservancy of the Rockies, Fort Collins, CO, ⁴USDA-ARS Research Unit @ The Jornada, Las Cruces, NM

ABSTRACT

Grazing lands support a ranching livelihoods, clean air and water, and provide native habitat for wildlife. Publicly and privately managed lands are the key to maintaining large connected natural landscapes and improving resilience through compatible management. Ranchers manage for multiple goals, and many are becoming increasingly interested in including wildlife species needs. Access to reliable habitat information on which to base adaptive management actions is however limited and often requires consultation with experts. A need exists for clear descriptions of suitable habitat for different species, in language that is recognizable to ranchers and consistent with monitoring measurements they may already be collecting. The free, open source app, LandPKS (Land Potential Knowledge System; <https://landpotential.org/>) connects users with information about their land potential through the collection of basic soil and vegetation cover information. The addition of science-based habitat information translated into outcome descriptions, focusing on clearly identifiable features such as vegetation height, percent of bare ground and soil type is a valuable addition to existing app functionality. The app will provide acceptable ranges for habitat characteristics and a comparison to any collected data. A simple graphic provides visual representation of the habitat structure and vegetation community. Factsheets will be available to download and will provide additional information including activities to avoid and those that may improve habitat for each species. The project team has collated habitat information for the first 20 selected North American species from a variety of taxa and will be available on the app in 2020. The intent is to equip users with information so that, if desired, they have the information to adapt management for species habitat at their own discretion, in line with other ranch goals. Templates created will be relevant globally and allow the addition of other species in the future.



Poster Session Monday 1: Poster Pod 6, Poster 33

CHANGING GRAZING MANAGEMENT THROUGH RECIPROCAL WATERSHED AGREEMENTS IN THE *RIO GRANDE-VALLES CRUCENOS* OF BOLIVIA

Will Munger^{*1}, Claudia Radel¹, Zhao Ma², Johnathan Bauchet², Ricardo Godoy³, Laura Zanotti², Brooke McWherter², Meagan Rathjen²; ¹Utah State University, Logan, UT, ²Purdue University, West Lafayette, IN, ³Brandeis University, Boston, MA

ABSTRACT: Ph. D STUDENT

Conserving rangeland and forest watersheds is a critical strategy to both mitigating and adapting to climate change. Payment for Ecosystem Services (PES) programs create an incentive structure to support conservation in working landscapes used for grazing, agriculture, and forest products. These programs often have dual goals of conservation and reducing inequality, but a number of scholars have critiqued them for reproducing or even exacerbating social inequality. Our multi-year, mixed method study in the *Rio Grande-Valles Cruceños* watershed of Bolivia uses the experimental design of a randomized control trial, paired with quantitative surveys and qualitative interviews to understand how the nonprofit Natura Bolivia's Reciprocal Watershed Agreements, a PES-like program, is changing land management behavior and impacting both participants and nonparticipants. We compare conditional and unconditional agreements for differences in participation rates based on gender, asset base, and other variables and for differences in social outcomes, including program satisfaction, gender relations, and socioeconomic inequalities. Our preliminary findings indicate that there are multiple factors that influence participation including program design around conditionality, local field staff's community relationships, municipal technical-political alliances, and emerging imperatives to adapt agriculture to a changing climate. Our fieldwork suggests that analyses of conservation incentive structures need to expand their framework beyond market values alone and develop a nuanced approach for understanding the relationships formed among residents of natural-resource dependent communities, staff in conservation organizations, local government actors, watershed management strategies, and working landscapes.



Poster Session Monday 1: Poster Pod 6, Poster 34

FINDING NEEDLES IN HAYSTACKS: A SOFTWARE TOOL TO IMPROVE THE ACCESSIBILITY OF RANGE MANAGEMENT INFORMATION

Sean F. Di Stefano*, Jason W. Karl, Jeremy Kenyon; University of Idaho, Moscow, ID

ABSTRACT: Ph. D STUDENT

Ecologically and economically sound management of rangelands rests in the hands of well-informed land managers with access to applicable information of the highest quality. Producers, conservation planners and other rangeland stakeholders need to quickly locate and access relevant reference materials. Finding actionable information is challenging because materials are spread across the internet and search technologies currently do not tag information within sections of important technical references. An application that uses a thesaurus of range science terms to tag, annotate, and search a curated collection of technical references will help get the necessary and most applicable information to land managers. The last collection of terms that was created specifically for rangelands was published by the Society for Range Management in 1998. Much has changed in range science in the past 21 years and the field will continue to evolve with the needs and concerns of land managers. A targeted thesaurus for range science should reflect those changes and have the ability to be updated on a regular basis. In addition, establishing relationships between thesaurus terms can make relevant information more accessible. The thesaurus concepts and relationships are the basis for tagging and referencing source material in search applications. A search application of range science reference material that is tagged, annotated, and organized by a thesaurus of terms will make relevant information more accessible to land managers and will help them to consistently make information-based decisions that are supported by the most up-to-date knowledge in the field of range science. The described application and targeted thesaurus are being developed by the Rangeland Partnership through a NRCS Conservation Innovation Grant.



Poster Session Monday 1: Poster Pod 6, Poster 35

THE HUMBOLDT RANCH STORY

Gregg E. Simonds¹, Jesse Bratz², Eric D. Sant^{*3}; ¹Open Range Consulting, Park City Utah, UT, ²Humboldt Ranch, Winnemucca, NV, ³Open Range Consulting, Park City, UT

ABSTRACT

The Humboldt Ranch, located in North Central Nevada, is managed with time and timing of livestock grazing and has been over the last 18 years. Prior to this the Ranch was managed as season long grazing. The results of season long grazing were riparian areas that were barely functioning and sagebrush monocultures with limited understories. During the past 18 years extensive on-the-ground and remote sensing monitoring has occurred to document and quantify changes on the landscape. The resulting changes have been mixed with some portions of the Ranch, like riparian areas, showing significant improvement while other areas have been at the mercy of wildfire and have had negative effects.



Poster Session Monday 1: Poster Pod 6, Poster 36

MITIGATING WOLF LIVESTOCK DEPREDACTION

Donald J. Kaleta*; MOM and POP PRODUCTS CO, Rome, OH

ABSTRACT

As Wolf Depredation on Domestic Livestock escalates, throughout the World with the Wolves successful populations spread, the contentious anger between Livestock Producers and Conservationists does also grow. My published research Blog at WWW.FENCEFLAGWOLFTRAINING.COM is a tangible suggestion, with minimal cost, to mitigate the anger on both sides!



Poster Session Monday 1: Poster Pod 7, Poster 37

DEVELOPMENTAL MORPHOLOGY OF SIX GRASSES OF NORTH AMERICA

Leobardo Richarte, Carlos Villalobos*; Texas Tech University, Lubbock, TX

ABSTRACT

There has not been done a comparative developmental morphology study among short, mid and tall grasses in North America. The main objective of this study was to determine developmental morphology and tiller recruitment differences among these species which represent three of the major grasslands of North America. Developmental morphology and number of tillers per plant were evaluated once a month from July to November. An analysis of variance was performed at each evaluation date to determine significant differences in MSC among the grasses. Results of this study indicated significant differences in MSC among species at every evaluation time. KL showed the highest MSC values at every evaluation. There were no significant differences between AL and CI, but CII had lower MSC values than the other switchgrass types. BG and ST had the higher number of tillers and lower MSC values than the switchgrasses at each evaluation date. Early internode elongation and lack of fall regrowth in switchgrass were the main reasons for those differences. We concluded that there is a difference in developmental morphology and tiller recruitment pattern between switchgrasses and the short and mid-grass species. However, there were no differences between the short grass (BG) and the mid grass (ST), both of which seem to follow the same maturation and tiller recruitment pattern over the growing season.



Poster Session Monday 1: Poster Pod 7, Poster 38

SEASON AND INTENSITY OF DEFOLIATION IN BIOMASS PRODUCTION OF SHORT, MID AND TALL GRASSES

Leobardo Richarte, Carlos Villalobos*; Texas Tech University, Lubbock, TX

ABSTRACT

Grazing schemes are an important tool to maintain a balance between cattle production and rangeland health. These schemes must be designed considering grazing animal type, topography, weather and vegetation species response to defoliation. Although, not all grass species respond in the same way to defoliations especially if they are defoliated earlier or later in the growing season. Differences in plant response after defoliation relates to the developmental morphology stage at which they are at defoliation time. Although this is a very important factor to consider, there is not enough information about it. The objective of this study was to identify the effects of moderate and heavy utilization on plant biomass allocation to the main plant structures in short, mid and tall grass species. This study was performed during the 2015 and 2016 growing seasons under field conditions. Species evaluated were blue grama, sideoats grama, switchgrass, as common species of the short, mid and tall grass prairie of North American, respectively. In addition, we used WW-B. Dahl as reference species due to its high productivity. Plants were clipped with 50% and 75% of the total aboveground biomass during the vegetative and reproductive phenological stages. At the end of the growing season total plant biomass was harvested and separated into aerial tillers, crown and roots. An analysis of variance was conducted per response variable to detect significant differences among the defoliations treatments combinations. Response variables in this study were aerial tiller, crown, roots and total biomass. There was a significant ($P<0.05$) three-degree interaction between species, defoliation intensity and phenological plant stage for each response variable. Heavy utilization at plant's vegetative stage (75xVeg) was the treatment that significantly reduced biomass productions in all grass structures. In contrast, moderate utilization at plant's reproductive stage (50xRep) was the treatment combination that always produced similar values to control plants. In conclusion, biomass production in these species was significantly affected by our defoliations treatments. The effects on biomass production varied depending on the species, plant's morphological stage, and clipping intensity.



Poster Session Monday 1: Poster Pod 7, Poster 39

HERBIVORY DURING THE SEEDLING PHASE MAY INCREASE SURVIVAL IN SOME PERENNIAL GRASSES

Elsie M. Denton^{*1}, Lysandra Pyle², Roger Sheley³; ¹USDA-ARS, Burns, OR, ²University of California, Berkley, CA, ³USDA-Agricultural Research Service, Burns, OR

ABSTRACT

The sensitivity of adult perennial grasses to herbivory has been extensively researched. However, there is little corresponding study of defoliation during the seedling life stage. Seedling survival can determine the fate of restoration efforts and the shape of natural demographic processes. To determine the importance of herbivory in a field settings we conducted a controlled defoliation experiment using three perennial grasses (crested wheatgrass [*Agropyron cristatum* {(L.) Gaertn.}, bluebunch wheatgrass [*Psuedoroegnaria spicata* {Pursh} Á. Love], Sandberg bluegrass [*Poa secunda* J Presl]). Species were fall-seeded at the Northern Great Basin Experimental Range, Oregon, in 1 m² plots randomly assigned to four blocks and five treatments (0%, 30%×1, 30%×2, 70%×1 or 70%×2 defoliation) [N=60]. In the spring, all seedlings reaching the 2-leaf stage in late March were tagged and treated [n=423]; seedlings receiving multiple defoliations were treated again 4 weeks later. Survival was tracked through the end of first and second growing seasons and assessed at the plot level using a Bayesian binomial model with informative priors. We found that Sandberg's bluegrass survival was unaffected by our defoliation treatments. In crested wheatgrass, repeated defoliation increased survival by 14% over undefoliated controls. Increases in crested wheatgrass survival persisted through the second growing season. No difference was found in bluebunch wheatgrass survival during the first growing season, but at the end of the second growing season, seedlings that had experienced a single defoliation were 10% more likely to have survived than controls. These findings could help inform decisions regarding which species to seed when herbivory is a concern.



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EFFECT OF GRAZING ON PRODUCTION AND QUALITY OF PASTURE IN THE SOUTHEAST OF COAHUILA, MEXICO

Eliseo Suarez*¹, Eduardo Garcia¹, Miguel Mellado², Juan Encina¹, Jose Dueñez¹, Jose Arevalo³;
¹Autonomous Agrarian University Antonio Narro, Saltillo, Mexico, ²Autonomous Agrarian University Antonio Narro, Saltillo, Mexico, ³University of La Laguna, Tenerife island, Spain

ABSTRACT: MS STUDENT

Cattle grazing is one of the most important disturbance agents in grasslands. It has been documented that overgrazing prevents the development of forage species. In degraded grasslands of arid regions, the application of livestock exclusion is useful because it can restore vegetation and conserve species diversity. A study of livestock exclusion and grazing was carried out to determine the effect on biomass production and protein content in a medium open grassland of southeast Coahuila. Forage sampling was carried out in the summer of 2018 and 2019. The data were analyzed using PROC GLM of SAS. In this case, biomass production revealed significant differences ($p < 0.0001$) between treatments (exclusion vs. grazing) from year to year. Being the site of exclusion with better productivity with averages of 947 ± 44 and 931 ± 21 kg of Ms / ha-1 in the years 2018 and 2019 respectively. While the grazing treatment was 754 ± 25 and 720 ± 32 kg of Ms / ha-1 for 2018 and 2019 respectively. The protein content did not reveal significant differences ($p > 0.05$) between the treatments in both years, the exclusion site in 2019 presented a better level with an average of $8.2 \pm 1.3\%$. The deficit in pasture management that has been done to date has led to the invasion of unproductive and nutritious species. The increase in biomass productivity in exclusion areas may be related to the recovery of vegetation and the presence of good quality forage species such as *Bouteloua gracilis* and *B. curtipendula*. If the pressure of overgrazing in the studied pasture continues, it could be replaced in the medium term by unproductive species. Preliminary results suggest that these ecosystems should be conserved for high natural values, for landscape diversity, and for being agostadero lands.



Poster Session Monday 1: Poster Pod 7, Poster 41

GRAZING AND ENVIRONMENT CHANGE CAN AFFECT PURPLE PRAIRIE CLOVER FREQUENCY: EVIDENCE FROM NORTH AMERICA PASTURE

Tianqi Zhao^{*1}, Alan D. Iwaasa²; ¹Agriculture and Agri-Food Canada Swift Current Research and Development Center, Swift Current, Canada, ²Agriculture and Agri-Food Canada, Swift Current, SK

ABSTRACT: Ph. D STUDENT

Purple prairie clover (PPC, *Dalea purpurea* Vent.) is an important native perennial legume widely distributed across North America. The PPC is a nutritious forage that can be grazed by domestic livestock and wildlife and an important forb for prairie restoration and improving biodiversity. Research objective was to summarize and evaluate PPC frequency responses to deferred rotational and continuous grazing systems and two different native seed mixtures (7 species and 14 species) in the context of environment changes over the length of the study (9 years). The experimental data were divided into three different moisture types for the year: dry, wet and normal (according to grazing season precipitation, $P < 0.05$). Results found as the study duration increased, the PPC frequency was increased ($P < 0.001$). Grazing system and year was the only significant interaction ($P = 0.05$) and seed mixtures did not affect PPC frequency. In the dry years, the PPC frequency decreased as study duration and precipitations increased ($P < 0.05$). However, with increasing average annual temperatures and snow depths, the PPC frequency increased ($P < 0.05$). Further, in the dry years, the rotational grazing PPC frequency was higher than the continuous grazing system ($P < 0.05$), but only in the spring and summer grazing period. In the wet years, the PPC frequency increased with duration, average temperatures and precipitations ($P < 0.05$). In particular, the frequency of spring grazed PPC was higher than all other treatments. In normal years, the PPC frequency did not change with duration, temperatures, precipitations and snow depths ($P > 0.05$). Also, in the normal years, only the PPC frequency in spring rotational grazing was higher ($P < 0.05$) than the continuous grazing system. In conclusion, PPC frequency increased under spring deferred rotational grazing compared to the continuous grazing system, regardless of the environmental conditions. Selecting the right grazing management system with favorable environmental conditions can increase PPC in our rangelands.



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ABOVE AND BELOW BIOMASS ALLOCATION IN SHORT, MID AND TALL GRASS SPECIES DURING DIFFERENT PHENOLOGICAL STATES

Carlos Villalobos*, Leobardo Richarte; Texas Tech University, Lubbock, TX

ABSTRACT

There are three main morphological grass types, which dominate North America rangelands. Morphological differences among these grasses might influence biomass allocation patterns to the main grass structures (aerial tillers, crown and roots) as a result of resource limitation. The objective of this study was to identify biomass allocation patterns among plant structures in short, mid and tall grass species. This study was performed during the 2015 and 2016 growing seasons under field conditions. Species evaluated were blue grama, sideoats grama, switchgrass, as common species of the short, mixed and tallgrass prairie of North America, respectively. In addition, we used WW-B. Dahl as reference species due to its high productivity. Plants were established in 19-L pots and grew until biomass collection. Biomass was harvested during the vegetative, reproductive and post-reproductive phenological stages. Total plant biomass was separated into aerial tillers, crown and roots. An analysis of variance was conducted to detect differences in biomass allocation means amount among grass structures. There were significant differences in the amount of biomass allocated to each grass structure. Results showed that regardless of phenological stage, all grasses, besides switchgrass, allocated significantly higher biomass portions to the aerial tillers, followed by roots and finally crowns. Even though roots allocated higher biomass than crowns, there was no significant difference between them in most of the species. WW-B. Dahl was the species which produced significantly higher total biomass. Biomass differences between tall grass switchgrass and the mid grass sideoats grama were not as significant as we expected. Finally, blue grama presented the lower biomass production of all the species. In most of the cases biomass allocation patterns followed our hypothesis; however, switchgrass significantly allocated higher biomass to the belowground portion, even though it is a tall grass species, we expected higher biomass in the aboveground portion. Our results suggested that biomass accumulation in grass structures is a dynamic process affected by species and phenological stage.



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EVALUATION OF CUTTING FREQUENCY ON YIELD AND NUTRITIONAL QUALITY OF HERBACEOUS FORAGE SPECIES IN ENCLOSURE OF BORANA RANGELANDS, SOUTHERN ETHIOPIA

Bikila N. Gilo^{*1}, Bedasa E. Tebeje², Jaldessa D. Liban¹; ¹Yabello Pastoral and Dryland Agriculture Research Center, Yabello, Ethiopia, ²International Livestock Research Institute, Addis Ababa, Ethiopia

ABSTRACT

A study was carried out in the semi-arid environments of Borana rangelands, southern Ethiopia to determine the yield responses of grass and non-grass species to four cutting frequencies over a two years period. Four treatments of cutting frequencies i.e. cutting once after the end of main growing season (T1), cutting every week (T2), cutting every two weeks (T3) and cutting every three weeks (T4) were laid out in a randomized complete block design (RCBD) with three replications. Sampling herbaceous vegetation attributes was carried out in 2015 and 2016. In total, 37 different herbaceous species comprising of 15 grass species and 22 non-grass species were sampled. Cutting frequency had a highly significant effect ($P < 0.01$) on herbaceous biomass with yield decreasing as the number of cutting frequencies increased. Grass species composition, dried biomass and density were significantly affected ($P < 0.05$) by frequency of cutting being the highest for T1. However, non-grass species richness, diversity and evenness were significantly affected ($P < 0.05$) by treatments. Cutting grasses subsequently over years reduced species richness and diversity excepting when cut every three weeks which did not affect species richness but increased species diversity. Like grass, non-grass species richness was reduced when all the treatments were applied across subsequent years. Cutting both grass and non-grass species once after the end of main growing season (T1) enhanced percentages dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). Cutting both grass and non-grass species every week (T2) favored percentage crude protein (CP) and true invitro organic matter digestibility (TIVOMD). For short-term rangeland management, cutting once after main growing season per year can be recommended because of the high yield in herbaceous species composition, dried biomass, basal cover and density.



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AUTUMN BCS AND POSTPARTUM HERBAGE ALLOWANCE ON PRODUCTIVE AND REPRODUCTIVE RESPONSES OF PRIMIPAROUS SPRING CALVING BEEF COWS GRAZING NATIVE GRASSLANDS

Martin Claramunt*¹, Pablo M. Soca²; ¹Centro Universitario Regional del Este, Treinta Y Tres, Uruguay, ²Universidad de la República, Paysandu, Uruguay

ABSTRACT: MS STUDENT

Beef cows grazing native grasslands are subject to a great variability that affects the pre and/or postpartum nutrition. The objective of the study was to test the autumn BCS (aBCS)/second third of gestation and postpartum herbage allowance (HA; herbage mass: stocking rate, kg DM/kg LW) interaction in primiparous spring-calving beef cows. Treatments were 2 aBCS (HaBCS > 6, LaBCS ≤ 6) and two HA postpartum (HHA = 4 vs LHA = 2 kg DM/kg LW) (High-High = H-H n= 29; High-Low = H-L n= 27; Low-High = L-H n= 27; Low-Low = L-L n= 30). The BCS was 0.6 units greater prepartum in HaBCS than LaBCS ($P < 0.05$) and did not differ postpartum. The cows BCS tended to be greater in HHA compared to LHA at 85 days postpartum (DPP) ($P < 0.1$). aBCS did not affect LW and liveweight postpartum increased in HHA while did not change in LHA cows, and cows in HHA were heavier at 100 and 135 DPP compared to cows in LHA ($P < 0.05$). Cows of H-H, L-H, and H-L treatments had a greater probability of ovulation than L-L cows ($P < 0.1$). Early pregnancy was greater in HaBCS than LaBCS (0.58 vs 0.29 ± 0.07 ; $P < 0.05$) and in HHA compared to LHA (0.56 vs 0.31 ± 0.065 ; $P < 0.05$). Pregnancy rates were greater in HaBCS compared to LaBCS (0.98 vs 0.88 ± 0.03 ; $P < 0.05$). Cows in HHA had greater milk yield and heavier calves compared to LHA ($P < 0.05$) while aBCS did not affect calf weight and milk yield. A HaBCS had a greater reproductive response and attenuate the negative effect of LHA. An HHA improves the probability of ovulation and early pregnancy in LaBCS cows but were at the limit to did not overcome the effect of a LaBCS.



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SHEEP GRAZING FOR THE CONSERVATION OF BIODIVERSITY IN DRY GRASSLANDS IN THE ITALIAN ALPS

Alessandra Gorlier^{*1}, Michele Lonati², Marco Pittarello², Mitchel P. McClaran³, Giampiero Lombardi²; ¹The University of Arizona, TUCSON, AZ, ²University of Turin, Turin, Italy, ³The University of Arizona, Tucson, AZ

ABSTRACT

The European LIFE Program promotes the development and implementation of the European Union (EU) environmental policy by financing innovative projects aimed at the conservation of biodiversity. In 2013, the program funded the LIFE Xero-Grazing project to promote the conservation and restoration of two grassland formations classified as priority habitats by the EU's Habitat Directive: "Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*), important orchid sites" and "Sub-Pannonic steppic grasslands". These dry grasslands are valuable all over Europe due to their rarity and the richness in orchids and other rare species. However, they are also vulnerable to vegetation changes (i.e. tree and shrub encroachment) that usually follow the interruption of agro-pastoral activities. To improve the status of these habitats and species, the LIFE Xero-Grazing project has implemented conservation grazing in a protected area of the south-western Italian Alps abandoned since the 1950'. A flock of sheep and all equipment necessary for grazing were bought thanks to European funds. In the period 2014-2019, botanists and pastoralists working on the project carried out 541 vegetation surveys on 129 permanent observation stations to monitor yearly the effects of grazing on plant species composition. Moreover, in 2015, they investigated plant-species selection by sheep by means of post-grazing surveys and animal GPS tracking. The aims were, respectively, to identify habitats and plant species, assess their grazing value, and compare the effects of different aspects of grazing (e.g. spring and fall grazing, night penning areas), and to understand animal preferences and grazing spatial patterns depending on stocking density. Results confirmed the remarkable species richness and number of rare species of the habitats. They also confirmed that sheep grazing is an effective tool for the conservation of abandoned and shrub- and tree-encroached dry grasslands.



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SUPPLEMENTATION STRATEGIES TO ENHANCE INTAKE OF ROMERILLO (*CHILIOTRICHUM DIFFUSUM*) BY SHEEP IN SOUTHERN PATAGONIA

Raul Lira¹, Jennifer MacAdam², Francisco Sales¹, Juan J. Villalba^{*2}; ¹Instituto de Investigaciones Agropecuarias, INIA Kampenaike, Punta Arenas, Chile., Punta Arenas, Chile, ²Utah State University, Logan, UT

ABSTRACT

Romerillo (*Chiliotrichum diffusum*) is an unpalatable and invasive shrub occurring in over 1 M ha of rangelands in southern Chile, which constraints livestock operations and reduces biodiversity. Low nutrient content and the presence hydrolyzable tannins (HT) explain the low palatability of the shrub. We determined whether supplemental macronutrients (Exp. 1) or polyethylene glycol (PEG; Exp. 2), a polymer that reduces bioavailability of tannins, enhance intake of romerillo by sheep. In Exp. 1, 28 yearling ewes were penned individually and randomly assigned to 4 groups (7 ewes/group) in a split-plot design, where they received during 10 min./d supplements high in energy (HE; corn), high in protein (HP, canola meal), or a choice between HE and HP (CH). A Control (C) group was not supplemented. Subsequently, all ewes had *ad libitum* amounts of freshly cut romerillo for 7 h/d, and finally 1% BW of grass hay. Intake of romerillo was HP > C > HE (8.4, 6.3, 4.5 g/Kg BW, respectively; $P < 0.05$), and ewes in CH selected a 67:33 proportion of corn:canola meal, consuming amounts of romerillo (6.8 g/Kg BW) that did not differ from HP. In Exp. 2, 32 yearling ewes were assigned to a 2x2 factorial design (8 ewes/group), with PEG (1-yes, 2-no) and Supplement (1-HP; 2-Mix selected by ewes in Exp. 1) as factors. PEG did not affect romerillo (3.4% HT) intake ($P > 0.05$), but ewes supplemented with HP showed the greatest intakes of romerillo (6.6 g/Kg BW; $P < 0.0002$). Thus, protein supplementation or choices between energy- and protein-dense supplements have the potential to enhance use of romerillo by ewes in southern Patagonia. In contrast, energy-dense supplements reduced intake of romerillo relative to unsupplemented animals, and PEG did not influence intake, likely due to the chemistry and structure of the tannins present in the shrub.



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ANALYSIS OF IN-SEASON REGROWTH ON CALIFORNIA ANNUAL RANGELAND VEGETATION FOR LIVESTOCK CARRYING CAPACITY

Alan R. Bower*¹, Nicholas Gallagher²; ¹USDA, Chico, CA, ²USDA, Woodland, CA

ABSTRACT

Carrying capacity for livestock grazing on California annual rangelands has generally been calculated by total production known to occur at the end of a growing season in a typical climatic year, minus the recommended residual dry matter for a given location. However, the vegetation found on these types of rangelands can experience regrowth after clipping or grazing in relation to in season climatic conditions. What appears to be unknown is if the amount of regrowth is commensurate with previously calculated total production and/or if the regrowth post grazing (or clipping) has an additive effect on total production. To determine this, cages have been placed at a variety of locations in the northern Sacramento valley. The locations have various ecosites and soil types. Plots within the cages are clipped four times a year, but individual plots are clipped at varying intervals to simulate changes in frequency of grazing that the vegetation may experience depending on types of management. The results of the clippings were then compared to a control plot (unclipped until the end of the season) to determine if there is a difference in production across the season. The preliminary results of this study show that the regrowth plots tended to either exceed or were equal to production of the control plots. This study will be carried out for at least 2 more years. We hope to determine if the amount of regrowth within a season on annual rangelands influences the carrying capacity on the annual rangelands found in California.



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USFS VACANT ALLOTMENT CASE STUDY: EMERSON ALLOTMENT, WARNER MOUNTAIN RANGER DISTRICT CALIFORNIA

Laura K. Snell^{*1}, Haley M. Dancer², Selby L. Boerman²; ¹University of California, Alturas, CA, ²University of California Cooperative Extension, Modoc County, Alturas, CA

ABSTRACT

The Emerson allotment on the Modoc National Forest is located on the southeast side of the Warner Mountain Ranger District in Modoc County, California. The Warner Mountains begin in northeastern California and stretch into southern Oregon. The Emerson allotment has three pastures totaling 1150 acres ranging in elevation from 5000-9000 feet. There are many small and moderately sized spring-fed meadows throughout the allotment. Public land grazing is essential to the local rural economy as Modoc County is over 70% public land. Emerson is one of the 209 vacant allotments in United States Forest Service (USFS) Region 5 (California) out of 696 total allotments. Of those 209 vacant allotments, 179 do not have current National Environmental Protection Act (NEPA) clearance, including this one. The Emerson allotment was historically used for cattle grazing but has not been grazed since 2012. Grazing has been reduced on USFS land from 1980 to 2010 by 49% in part due to allotments being left vacant. There are a variety of reasons why allotments are left vacant but one of the biggest reasons is the need for current NEPA and data collection to support the NEPA process. We began collecting data on the Emerson allotment in August 2019 and will continue through 2021. We are looking at forage and browse production, plant vigor, topography, species richness including forb diversity, and adequate water and infrastructure. Several objectives guide our research including ecological considerations of grazing, best class of livestock to utilize the allotment, season of use, concerns for designated wilderness, and fine fuels reduction and wildfire mitigation. We are building off work completed by colleagues from UC Rangelands on annual and long-term use of USFS meadows in California.



Poster Session Monday 1: Poster Pod 9, Poster 50

VEGETATION AND ARTHROPOD COMMUNITY RESPONSE TO LONG-TERM GRAZING EXCLUSION AND DEFERRED GRAZING IN SOUTH BRAZIL.

Bianca O. Andrade*¹, Pedro Maria A. Ferreira², Luciana R. Podgaiski³, Milton A. Mendonça³, Gerhard E. Overbeck⁴, Valerio D. Pillar³, Ilse I. Boldrini⁵; ¹University of Nebraska-Lincoln, LINCOLN, NE, ²PUCRS, Porto Alegre, Brazil, ³Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, ⁴Universidade Federal Rio Grande do Sul, Porto Alegre, Brazil, ⁵Universidade Federal Rio Grande do Sul, Porto Alegre, Brazil

ABSTRACT

Grazing exclusion may lead to biodiversity loss and homogenization of species-rich and heterogeneous grassland ecosystems, and these effects may cascade to higher trophic levels and ecosystem properties. To date, there is no empirical evidence for the effects of alleviating the disturbance regime in grassland ecosystems. Using data of the first four years of a long-term experiment, with randomized block experimental design in native grasslands of southern Brazil, we examined the effects of three grazing treatments on plant and arthropod communities. The evaluated treatments were: (i) deferred grazing, (ii) grazing exclusion and (iii) a control under traditional continuous grazing, which were applied to 70 x 70 m experimental plots, in six regionally distributed blocks. We assessed the plant community responses regarding taxonomic and functional diversity (life-forms) in separate spatial components: alpha (1 x 1 m subplots), beta, and gamma (70 x 70 m plots), as well as the cascading effects on arthropod high-taxa. By estimating effect sizes (treatments vs. control) by bootstrap resampling, both deferred grazing and grazing exclusion mostly increased vegetation height, plant biomass and standing dead biomass. The effect of grazing exclusion on plant taxonomic diversity was negative. Conversely, deferred grazing increased plant taxonomic diversity, but both deferred grazing and exclusion reduced plant functional diversity. Reduced grazing pressure in both treatments promoted the break of dominance by prostrate species, followed by fast homogenization of vegetation structure towards dominance of ligneous and erect species. These changes in the plant community led to increases in high-taxa richness and abundance of vegetation-dwelling arthropod groups under both treatments but had no detectable effects on epigeic arthropods. Our results indicate that decision-making regarding the conservation of southern Brazil grasslands should include both intensive and alleviated levels of grazing management, but not complete grazing exclusion, to maximize conservation results when considering plant and arthropod communities.



Poster Session Monday 1: Poster Pod 9, Poster 51

EFFECT OF GRAZING STRATEGIES ON BOTANICAL COMPOSITION IN THE NEBRASKA SANDHILLS

Cheryl Dunn^{*1}, Jessica Milby², Walt Schacht¹, Jerry D. Volesky³; ¹University of Nebraska-Lincoln, Lincoln, NE, ²University of Nebraska - Lincoln, North Platte, NE, ³University of Nebraska-Lincoln, North Platte, NE

ABSTRACT

Implementation of management intensive grazing strategies requires significant monetary and labor input by land managers, justified with the expectation of increases in desirable plants, production, and harvest efficiency leading to increases in carrying capacity. Conflicting results in the literature makes further study of the impacts of grazing period length and intensity of management on rangeland vegetation necessary; therefore, a grazing study was conducted from 2010 to 2018 on upland range at the Barta Brothers Ranch (BBR) in the Nebraska Sandhills to determine the effects of grazing period length and intensity on botanical composition. Treatments represented three grazing period lengths consistent with grazing strategies used in the Nebraska Sandhills: 1) a 150-day grazing period corresponding to season-long continuous grazing, 2) a 37-day average grazing period corresponding to a four-pasture deferred rotation, and 3) a 3-day grazing period corresponding to a 50-pasture rotation. Treatments were applied at a moderate stocking rate ($1.85 \text{ AUM} \cdot \text{ha}^{-1}$) based on long-term research conducted at BBR, and at a stocking rate 1.5 times the moderate rate ($2.77 \text{ AUM} \cdot \text{ha}^{-1}$). Frequency of occurrence data were collected and the 35 most frequently occurring plant species were grouped into high, medium, or low forage value (considers growth form, production, abundance, growth potential, and palatability) and the grasses were also grouped into cool- or warm-season. From 2010 to 2018, high forage value cool-season and low forage value warm-season grasses as well as high and medium forage value forbs increased on the study site; however, the change in frequency of the forage value groups over the 8 years did not differ among the 3 grazing period lengths and the 2 stocking rates. We concluded that the principal plant species on upland range in the Nebraska Sandhills were not affected by the commonly-used grazing period lengths at 2 stocking rates.



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FINE FUELS MANAGEMENT TO IMPROVE WYOMING BIG SAGEBRUSH PLANT COMMUNITIES USING DORMANT SEASON GRAZING

William J. Price*¹, April Hulet¹, Sergio A. Arispe², Scott Jensen³; ¹University of Idaho, Boise, ID, ²Oregon State University Extension Service, Ontario, OR, ³University of Idaho, Marsing, ID

ABSTRACT: MS STUDENT

The invasive annual grass, medusahead (*Teaniatherum caput-medusae*), dominates secondary succession in many sagebrush steppe plant communities, ultimately degrading wildlife habitat, decreasing forage available to livestock, and increasing the frequency of wildfire. Medusahead, a winter annual, germinates and sprouts in the fall, providing forage for livestock when perennial bunchgrasses are dormant. The focus of our research is to measure the impacts of grazing treatments on medusahead across four treatments: 1) no livestock grazing (control), 2) traditional grazing between May and September, 3) dormant season grazing from October to February, and 4) traditional plus dormant season grazing where livestock graze during both seasons. Our specific objective is to promote healthy and functional landscapes within the sagebrush steppe of southeastern Oregon by one, reducing fine fuel loads to lower fire risk, and two, promote perennial bunchgrasses by taking advantage of phenological differences between perennial and invasive annual grasses. The research is taking place on the Vale District Bureau of Land Management Three Fingers allotment 80 km southwest of Boise, ID. Vegetative cover and density data was collected in June 2018 and 2019 and will continue to be collected over the next three years. From 2018 to 2019, annual grass cover increased by 10% in the control treatment; across all grazing treatments the average increase was 13%. Introduced perennial grass cover also increased by 5-10% in three of the four treatments, with no measured change in the dormant season only treatment. Native perennial grass cover remained $\pm 3\%$ across all treatments. Perennial grass density from 2018 to 2019 decreased by 2-3 plants/m² in all three grazing treatments and remained the same in the control. Findings from this research will contribute to our understanding of dormant season grazing as a means to reduce medusahead and improve rangeland health across the sagebrush steppe.



Poster Session Monday 1: Poster Pod 9, Poster 53

QUANTIFYING THE BENEFITS OF COLLABORATIVE ADAPTIVE MANAGEMENT IN RANGELAND SYSTEMS.

Justin D. Derner^{*1}, David Augustine², David D. Briske³, Hailey Wilmer⁴, Lauren M. Porensky², Maria Fernandez-Gimenez⁵, Dannele E. Peck⁶, John Ritten⁷, CARM Stakeholder Group⁸; ¹US Department of Agriculture - Agricultural Research Service, Cheyenne, WY, ²USDA-ARS, Fort Collins, CO, ³Texas A&M University, College Station, TX, ⁴USDA-ARS, 80526, CO, ⁵Colorado State University, Fort Collins, CO, ⁶Northern Plains Climate Hub, USDA-ARS, Fort Collins, CO, ⁷University of Wyoming, Laramie, WY.

ABSTRACT

Collaborative adaptive management (CAM) is hypothesized to benefit management of rangeland ecosystems. Despite the popularity of CAM, the presumed benefits have seldom been quantified. Here, we evaluate the contributions of an 11-member Stakeholder Group to livestock production during 2016-2018 in the semiarid shortgrass steppe of the western Great Plains. Our study provides clear evidence that in the absence of adaptive management, livestock weight gains decline approximately linearly with increasing stock density. These declines can only be partially offset via adaptive decision-making. Contributions attributed to CAM were persistently positive across the three years compared to a traditional non-adaptive grazing strategy. Absolute production increases of 0.10 to 0.28 kg/steer/day and relative increases of 16-49% for animal weight gains were attributed to CAM. This increased the economic value of individual steers by \$34.66 to \$55.54 over the 3-year period. CAM provided the adaptive capacity to flexibly match animal forage demand with the spatial and temporal heterogeneity in forage quantity and quality among ecological sites and years. The beneficial contributions of CAM to livestock production in a semiarid environment characterized by high intra- and inter-annual variability demonstrates the importance of science-management partnerships to sustainable rangeland management. Adaptive decision-making has significant benefits to livestock production but could not fully overcome the negative effects of management at high stock density.



Poster Session Monday 1: Poster Pod 9, Poster 54

RIPARIAN PROPER FUNCTIONING CONDITION ASSESSMENT TO SOUTH FORK OF THE TAMIR RIVER, MONGOLIA

Baldandugar Tsoggerel*¹, Sherman R. Swanson², Ganbaatar Erdenetsolmon¹, Otgonsuren Burenjargal¹, Namsraijav Tsegmid¹, Tuulaikhuu Baigal-Amar¹, D. Bulgamaa³; ¹Mongolia University of Life Science, Ulaanbaatar, Mongolia, ²University of Nevada, Reno, Reno, NV, ³Green Gold, Ulaanbaatar, Mongolia

ABSTRACT: UNDERGRADUATE STUDENT

We used riparian Proper Functioning Condition (PFC) assessment to provide a consistent approach for assessing the physical functioning of riparian-wetland areas by considering hydrology, vegetation, and soil/landform attributes at two locations occupied by nomadic herders on South Tamir River, Mongolia. The upper site is below the confluence with upstream tributary valleys was in Properly functioning condition (PFC) but at a low level of functionality. There were few woody stabilizers along the north bank which is rapidly eroding. While a gravel bar has much woody debris from upstream, little wood from the riparian woody plants along this reach is available to the river because it moved. The gravel bar was wide and accessible but lacked woody vegetation that had escaped browsing height. Vegetation could provide a veneer of fine soil above the gravel and sand base. The lower site is below the confluence of a newly re-watered alternate channel. It was nonfunctional (NF) with no woody stabilizers effective along the north or south banks and the south bank was rapidly eroding. A wide and accessible gravel bar lacked woody vegetation that had escaped browsing height, or even germinated seedlings. Transverse bars indicate unstable banks, an over-wide channel and accelerated sediment supply from upstream. These assessments indicate that riparian grazing management must change to avoid the problems observed along the lower reach of the South Fork of the Tamir River and to strengthen riparian functions that could create stability and multiple resource values. This change in grazing management must include periods of nonuse or possibly very light use that allows most or all of the establishing woody stabilizer species to escape browsing height. Additional density of woody stabilizers could be started with pole plantings on banks.



Poster Session Monday 1: Poster Pod 10, Poster 55

TARGETING THE SOIL SEEDBANK OF INVASIVE BROADLEAF WEEDS FACILITATES LONG-TERM RANGELAND RESTORATION

Shannon L. Clark^{*1}, Jim Sebastian², Derek Sebastian³, Scott Nissen¹; ¹Colorado State University, Fort Collins, CO, ²Boulder County Parks and Open Space, Loveland, CO, ³Bayer, Greeley, CO

ABSTRACT

Broadleaf weed management on rangelands remains a constant challenge faced by land managers. Herbicides often fail to provide long-term control of invasive broadleaves, even when adequate first-year control is achieved, due to weeds reinvading from the soil seedbank. Indaziflam is pre-emergent (PRE) herbicide with activity on both monocots and dicots. Indaziflam can provide 3+ years of winter annual grass control, yet there is limited information regarding the use of this herbicide for PRE control of broadleaf weed seedlings on rangeland sites. A field study was conducted to evaluate the performance of broadleaf herbicides, picloram and aminocyclopyrachlor, applied with and without indaziflam to control three broadleaf weed species. Nine herbicide treatments and one non-treated control were applied with a tractor boom sprayer to 0.8-hectare plots at two sites in March 2016. Plots consisted of dense downy brome (*Bromus tectorum*) cover (~80%) along with common mullein (*Verbascum thapsus*), Dalmatian toadflax (*Linaria dalmatica*), and diffuse knapweed (*Centaurea diffusa*) infestations. Downy brome, perennial grass, and forb biomass along with species richness and percent cover by weed species were collected 1 and 2 years after treatment (YAT). Every herbicide treatment reduced broadleaf weed cover 1 YAT, while only treatment combinations which included indaziflam continued to control all weed species 2 YAT. Increases in cool-season grass biomass occurred at both sites among treatments which included picloram plus indaziflam, while warm-season grass increases occurred in treatments containing aminocyclopyrachlor plus indaziflam. At 2 YAT, indaziflam treatments had greater species richness (12.3 species) compared to the nontreated (4.8 species). Using indaziflam in combination with broadleaf herbicides has the potential to provide multi-season weed control by managing the seedbank of both grass and broadleaf weeds, potentially allowing enough time for re-establishment of the native plant community.



Poster Session Monday 1: Poster Pod 10, Poster 56

A STUDY OF THE ALLELEPATHIC EFFECTS OF TWO SPECIES OF OLD WORLD BLUESTEM

Dean A. Stramel*; Fort Hays State University, Hays, KS

ABSTRACT: MS STUDENT

Invasive species have become a major ecological problem worldwide. Invasive plants are moving into new habitats and displacing native plants, often to the detriment of these native ecosystems. Two grasses commonly called Old World Bluestems, (OWBs), *Bothriochloa ischaemum* and *B. bladhii*, were introduced into the central and southern Great Plains in the last century and have become problematic invaders. Once established OWBs tend to eliminate, potentially through allelopathic mechanisms, all other plants, effectively becoming monocultures. Our research intends to study the allelopathic effects of these two species of OWB on the germination of each other's seeds and the seeds of one native grass, *Andropogon gerardii*. Leachate will be produced using whole plant tissues of each of the OWBs and the native grass. These leachates will then be added to seeds of each of the three species.

Combinations of seeds and leachates will be grown in a growth chamber to observe effects on germination of the seeds. We hypothesize that leachates of OWBs will inhibit the germination of the native species but will not inhibit the germination of each other's seeds. This study could lead to strategies for controlling the spread and establishment of OWBs and aid in restoration of native grasslands.



Poster Session Monday 1: Poster Pod 10, Poster 57

BUFFELGRASS (*CENCHRUS CILIARIS* L.) INVASION PATHWAYS ACROSS TEXAS

Juan G. Garcia-Cancel*, Robert D. Cox; Texas Tech University, Lubbock, TX

ABSTRACT: Ph. D STUDENT

Introduced plant species have been an occurrence for millennia yet only within the last few centuries have geographic barriers due to improving global transportation and networks of commerce allowed widespread transportation of novel plants. Plants have been moved across continents, accidentally or intentionally, to improve settled areas. Buffelgrass (*Cenchrus ciliaris* L.) introductions have occurred worldwide since the late 19th century yet it only now with accelerated climatic change that somewhat restricted populations are expanding into newer habitats that are susceptible to their invasion. We are studying potential pathways and outcomes of buffelgrass invasion in Texas. Using the known location of buffelgrass clumps and patches in Texas, we created maps using available soil, vegetation and weather data provided by state and national agencies and analyzed them with MaxEnt habitat suitability models. We found that the model predicted present locations of buffelgrass and show a potential spread throughout most of the drier areas of the state, specifically the arid deserts and northern prairies of Texas, with potential avenues being the development of roads and other urban infrastructure that alters the local soil structure.



Poster Session Monday 1: Poster Pod 10, Poster 58

THE IMPACT OF NON-NATIVE PERENNIAL GRASSES ON GRASSLAND DIVERSITY AND FORAGE PRODUCTION

Lisa J. Rew*, Tim Seipel, Theodore Weaver; Montana State University, Bozeman, MT

ABSTRACT

Many higher elevation temperate grasslands are invaded with non-native, often rhizomatous, perennial grasses. Rhizomatous species can form dense patches, potentially impacting the composition and productivity of grasslands. We assessed the effect of two rhizomatous grasses, smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*), on plant biodiversity and forage productivity in a natural mesic grassland. We recorded cover of all species (1 m²) in three habitats (uninvaded, Kentucky bluegrass, smooth brome) at peak vegetative season, and harvested biomass by functional group in late summer. All treatments were replicated. Plant richness declined dramatically along a gradient from the uninvaded to smooth brome, the latter had a third less species. Species evenness (*ESimpson*) decreased along this same gradient. The reduction in evenness was due to increasing dominance and biomass of the target grass species, particularly the smooth brome. The forage quality (% nitrogen) did not differ between habitats but the higher productivity of Kentucky bluegrass, and smooth brome especially, meant that these habitats had more forage per unit area. Thus, the rhizomatous non-native species increased forage productivity but greatly reduced plant species richness and evenness at a local scale, extended to a larger scale this would impact ecosystem function and services.



Poster Session Monday 1: Poster Pod 10, Poster 59

MICROBIOMES OF GRASS RHIZOSPHERES AS POTENTIAL MECHANISMS OF INVASION

Scout M. Harrison*, Mitchell J. Greer; Fort Hays State University, Hays, KS

ABSTRACT: MS STUDENT

Old World Bluestem (OWB) is a name for a group of non-native, perennial, warm-season grasses from the genus *Bothriochloa*. OWBs were intentionally introduced to the Great Plains region from Asia, Europe, Russia, and Australia, and are now known to be aggressive invasive species, often outcompeting native grasses. This ability of OWBs to outcompete native grasses creates monospecific stands of OWBs, which negatively impact plant, mammal, and avian species richness, as well as arthropod biomass. Soil microbes are an integral part of these prairie environments, as they can have a major influence on plant communities. Microbes, such as bacteria and fungi, can act as parasites and decrease the health of plants, or act as nitrogen fixers or other mutualistic partner to plants, thus increasing their fitness. This study will analyze the rhizosphere microbial community of two native and two non-native grass (OWBs) species across the precipitation gradient in Kansas. We will use the number of operational taxonomic units (OTUs) to analyze microbial community variation between the four species of grass, and across the precipitation gradient using ANOVA. We will derive the OTUs using the 16S gene for bacteria, and large subunit ribosomal DNA for fungi. We expect microbial communities surrounding OWB root systems to have lower OTU richness than native grasses, and lower OTU richness moving westward across the precipitation gradient. Soil microbial community variation between invasive OWBs and native grasses could indicate the soil microbial community composition plays a role in plant invasion, which could potentially influence future management strategies.



Poster Session Monday 1: Poster Pod 10, Poster 60

EVALUATING THE EFFICACY OF VARIOUS HERBICIDES ON BULBOUS BLUEGRASS CONTROL

Jordan L. Skovgard^{*1}, Brian A. Meador²; ¹University of Wyoming, Laramie, WY, ²University of Wyoming, Laramie, WY

ABSTRACT: MS STUDENT

Bulbous bluegrass (*Poa bulbosa* L.) is a widespread invasive cool-season perennial grass that reproduces via bulblets. Although it is relatively common, research is limited on bulbous bluegrass and few herbicides are labeled for its management in rangelands. Our objective was to evaluate the efficacy of various herbicides in controlling bulbous bluegrass. We established 2 field sites in northeastern Wyoming in May of 2018 to assess bulbous bluegrass control with 11 different herbicides alone and mixed with Roundup. We applied herbicide treatments to 3 x 9-meter plots as a split-plot randomized complete block design with four replicates at each site. Roundup (520 g ae·ha⁻¹) was applied to 1/3 of each block following other herbicide applications. We collected post-treatment data 30 and 160 days after treatment (DAT) and 1 year after treatment (YAT). We recorded canopy cover by species in ¼ m² quadrats at a density of 6 quadrats per 0.3 are. Additionally, we visually estimated bulbous bluegrass control (%) and damage (%) to perennial grasses and forbs. Data collected 1YAT indicate that Landmark and Matrix effectively controlled bulbous bluegrass alone, combined and mixed with Esplanade at different rates. Plateau and Esplanade tank mixes effectively controlled bulbous bluegrass but were less effective when applied alone. All combination treatments provided greater than 90% control of bulbous bluegrass. Herbicides performed similarly regardless of Roundup application when combined herbicide treatments were applied. Our data shows several effective options for control of bulbous bluegrass. Further research should look to understand the implications of non-target effects in treatment areas.



Poster Session Monday 1: Poster Pod 11, Poster 61

MESQUITE CONTROL IN THE SOUTHWEST

Kert Young*; NMSU, Las Cruces, NM

ABSTRACT

New Mexico contains 67 million acres of rangelands (86% of NM). Invasive shrubs and weeds degrade the condition and productivity of NM rangelands. Mesquite has overtaken hundreds of thousands of acres in NM. We tested the effectiveness of herbicides at reducing mesquite dominance and increasing herbaceous productivity and community composition. Herbicide treatments were applied to four working ranches in 2016 and three ranches in 2017 throughout eastern NM. Initial study results suggest that herbicides effectively control invading mesquite when applied correctly and improve rangeland condition.



Poster Session Monday 1: Poster Pod 11, Poster 62

DURACOR: INTRODUCTION OF A NEW HERBICIDE FOR USE IN RANGELAND, PASTURES, AND NON-CROP SITES

Byron Sleugh*¹, D CHAD Cummings², William Hatler³, E Scott Flynn⁴; ¹Corteva Agriscience, Indianapolis, IN, ²Corteva Agriscience, Bonham, TX, ³Corteva Agriscience, Meridian, ID, ⁴Corteva Agriscience, Lee Summit, MO

ABSTRACT: UNDERGRADUATE STUDENT

DuraCor is a new herbicide developed by Corteva Agriscience™, for control of broadleaf weeds, including invasive and noxious weeds, and certain woody plants. DuraCor represents an innovative new tool that is a non-ester, non 2,4-D containing, low odor, low use rate formulation that provides post emergence and reemergence residual control of susceptible broadleaf plants and seedlings and some woody plants. It will provide control of all species known to be controlled by Milestone® herbicide plus many additional species and offers flexibly in application (ground, aerial, broadcast, or spot treatment). A key component of DuraCor is Rinskor™ active, a novel new active ingredient never before used rangeland and pastures and is an EPA Reduced Risk Pesticide just like Milestone. In trials over multiple years across the United States, DuraCor provided excellent control of many noxious and invasive weeds. Based on these efficacy data, it is anticipated that DuraCor will be a useful tool in the management of troublesome weeds in various use sites.



Poster Session Monday 1: Poster Pod 11, Poster 63

INITIAL EFFICACY OF *INDAZAFLAM* ON CHEATGRASS RANGELANDS

Charlie D. Clements^{*1}, Dan Harmon², Harry Quicke³; ¹USDA, Reno, NV, ²USDA ARS, Reno, NV, ³Bayer, Windsor, CO

ABSTRACT

The accidental introduction and subsequent invasion of cheatgrass (*Bromus tectorum*) throughout millions of hectares of Intermountain West rangelands has resulted in astronomical changes to many plant communities. Cheatgrass is native to the cold deserts of central Asia where humans are first thought to have domesticated animals. These native habitats are very similar to the big sagebrush (*Artemisia tridentata*)/bunchgrass and salt desert ranges of the Intermountain Area of North America. Resource managers need tools to conduct aggressive and effective weed control practices on cheatgrass-infested rangelands to improve restoration/rehabilitation efforts. The use of pre-emergent herbicides has proven to be very effective in decreasing cheatgrass densities and seed banks which are limiting to the establishment of perennial species through competition for limited resources. *Indazafam*, Esplanade, is a pre-emergent herbicide recently available for research on Nevada rangelands. In 2018 we started a research project to measure the efficacy of Indazafam on cheatgrass control in northern Nevada compared to other pre-emergent herbicides that we have experienced good cheatgrass control with, *Imazapic* and *Sulfometuron methyl*. Due to the environments of the cold desert of Nevada rangelands, we applied these pre-emergent herbicides in the fall of the year, fallow the site for 1-year and then seed with desirable perennial species. *Indazafam* plots reduced cheatgrass initial densities by 94.8%, while *Sulfometuron methyl* experienced 99.9% followed by 97.8% for *Imazapic*. When attempting cheatgrass control efforts it is important to understand that control must nearly reach 100% due to the prolific ability of cheatgrass to produce seed and build persistent seed banks. As few as 43 cheatgrass seedlings/m² can outcompete perennial grasses at the seedling stage. The reported residual ability of *Indazafam* for up to 4-years may add longer-term control of cheatgrass that could benefit residual and seeded perennial species.



Poster Session Monday 1: Poster Pod 11, Poster 64

MEDUSAHEAD SILICON, CONSTRAINING FACTORS OF CONTROL, AND RESEARCH NEEDS

Casey Spackman*¹, Thomas A. Monaco², Juan J. Villalba³; ¹Utah State University, 84333, UT, ²Forage & Range Research Laboratory, Logan, UT, ³Utah State University, Logan, UT

ABSTRACT

Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) is currently one of the most detrimental invasive plants impacting rangeland sustainability and livestock operations. Furthermore, it decreases wildlife habitat, plant diversity, and increases the frequency of fires. These impacts are further compounded by the fact that traditional control techniques are often unsuccessful, likely due to high silicon tissue concentrations [Si]. There is a critical need to assess the underlying causes for medusahead invasion and potential obstacles to its control in an ongoing effort to better understand its ecology and develop improved mechanistic and conceptual approaches for effective management. High [Si] are known to increase medusahead invasion through three key aspects: 1) increased plant fitness and production; 2) increased litter accumulations; and 3) decreases in herbivory. For instance, [Si] has been shown to provide delayed litter decomposition which provides better microsite conditions for germination and seedling growth, ultimately increasing plant production and decreased competition of native species. Furthermore, [Si] has been shown to decrease digestibility of the plant through the formation of a varnish on the stems, leaves, and awns, which deters herbivory and increases selection pressure for more palatable plant species. We propose to address each aspect of the medusahead invasion processes by discussing: 1) What do we currently understand about [Si] in medusahead and its role in the invasion process? 2) What is currently being done to control medusahead? 3) Which research approaches are needed to better address the knowledge gaps concerning medusahead invasion? and 4) Which new control strategies may originate from such efforts?



Poster Session Monday 1: Poster Pod 11, Poster 65

TIMING OF GLYPHOSATE APPLICATION TO INCREASE CATTLE CONSUMPTION OF MEDUSAHEAD

Alexis Cooper¹, Casey Spackman*¹, Clint Stonecipher², Juan Villalba¹; ¹Utah State University, Logan, UT, ²USDA-ARS-PWA-PPR, Logan, UT

ABSTRACT

Grazing has been shown to be the preferred method of medusahead (*Taeniatherum caput-medusae* (L.) Nevski) control; an invasive annual grass. However, animals tend to avoid the weed due to its anti-nutritional factors (silicon) and undesirable oral texture. Emerging control techniques of a glyphosate-based herbicide in combination with livestock grazing has been shown to increase utilization of the otherwise unpalatable plant. The objective of this study was to determine at what stage of plant development will the application of glyphosate maximize cattle intake and control medusahead. Treatments of glyphosate at 946 g ae ha⁻¹ were applied to medusahead-infested plots (N=4) at four different stages of plant maturation: early seedling (ES); boot stage (BO); reproductive stage (RE); and control (CT). Vegetation was estimated by hand clipping five squares (0.098 m²) to a 1cm stubble height in each treatment prior to (PrH) and after herbicide application (PoH), and after grazing (PoG) by cattle. Eight beef steers were randomly clustered in pairs and assigned to their respective plots and allowed to graze from 0700 to 1800 for 6 d. Preliminary data shows that there was a large reduction in medusahead biomass between PrH and PoH application for ES (320.3 ± 53.9 and 69.0 ± 24.9 Kg ha⁻¹) and BO treatments (413.7 ± 74.4 and 132.5 ± 25.6 Kg ha⁻¹). Medusahead utilization by cattle PoH to PoG was greatest for RE (442.9 Kg ha⁻¹) with the least occurring in the ES (12.7 Kg ha⁻¹). Cattle preferred the RE treatment, however control of medusahead through the greatest biomass removal occurred in the ES and BO treatments. This suggest a tradeoff between available medusahead as a forage source and control of medusahead. Overall, livestock grazing in combination with a glyphosate containing herbicide can be used to reduce medusahead abundance in the plant community.



Poster Session Monday 1: Poster Pod 11, Poster 66

EFFICACY OF DURACOR AND TERRAVUE HERBICIDES ON NOXIOUS AND INVASIVE SPECIES IN RANGELAND AND NON-CROP

William Hatler*¹, D CHAD Cummings², Byron Sleugh³, E Scott Flynn⁴; ¹Corteva Agriscience, Meridian, ID, ²Corteva Agriscience, Bonham, TX, ³Corteva Agriscience, Indianapolis, IN, ⁴Corteva Agriscience, Lee Summit, MO

ABSTRACT

DuraCor and TerraVue are new herbicides developed by Corteva Agriscience™, for control of broadleaf weeds, including invasive and noxious weeds, and certain woody plants. DuraCor and TerraVue represent an innovative new tool that is a non-ester, non 2,4-D containing, low odor, low use rate formulation that provides post emergence and reemergence residual control of susceptible broadleaf plants and seedlings and some woody plants. They will provide control of all species known to be controlled by Milestone® herbicide plus many additional species and offers flexibly in application (ground, aerial, broadcast, or spot treatment). A key component of DuraCor and TerraVue is Rinskor™ active, a novel new active ingredient never used on rangeland and pastures and is an EPA Reduced Risk Pesticide just like Milestone. In trials over multiple years across the United States, DuraCor and TerraVue provided excellent control of weeds such as yellow starthistle (*Centaurea solstitialis*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), wild carrot (*Daucus carota*), spotted knapweed (*Centaurea maculosa*), poison hemlock (*Conium maculatum*), woolly croton (*Croton capitatus*), annual marshelder (*Iva annua*), common caraway (*Carum carvi*), and many more. Based on these efficacy data, it is anticipated that DuraCor and TerraVue will be useful tools in the management of noxious, invasive and other weeds in various sites.



Poster Session Monday 1: Poster Pod 12, Poster 67

INTEGRATED CHEATGRASS (*BROMUS TECTORUM*) MANAGEMENT WITH HERBICIDE AND SHEEP

Erik A. Lehnhoff^{*1}, Lisa J. Rew², Jane Mangold², Tim Seipel²; ¹New Mexico State University, Las Cruces, NM, ²Montana State University, Bozeman, MT

ABSTRACT

Cheatgrass (*Bromus tectorum* L.) is one of the most widespread and difficult to manage invasive plants in the western United States rangelands. While herbicide and targeted grazing often fail to provide adequate long-term cheatgrass control or promote desirable species, integrating herbicide and grazing may provide multiple stressors leading to better control than either method alone. We studied the impacts of herbicide, targeted sheep grazing and integrated herbicide plus grazing on cheatgrass and the plant community in southwestern Montana from 2015 – 2017. Herbicide treatments included spring-applied (May 2015 and 2016) glyphosate, fall-applied (October 2015) glyphosate, imazapic and rimsulfuron, and spring-applied glyphosate + fall-applied imazapic. Grazing (May 2015 and 2016) consisted of four sheep for approximately 24 hours in 5 m × 20 m plots. While no treatments were effective in reducing cheatgrass biomass or seed production, grazing integrated with fall-applied imazapic or rimsulfuron decreased cheatgrass cover from approximately 29% to 23% in 2016 and from 24% to 14% in 2017 compared to control plots. By 2017, all treatments except spring-applied glyphosate had increased total plant cover (excluding cheatgrass) by 8-12% compared to the control plots. The increase in cover was generally the result of an increase in forb cover, but ungrazed plots treated with fall-applied glyphosate and imazapic, as well as spring-applied glyphosate + fall-applied imazapic increased native grass cover. Results highlight the difficulties of cheatgrass management and point to a potential management paradox: integrating grazing and fall-applied herbicide decreased cheatgrass cover but did not increase native grass cover, while some herbicides without grazing increased native grass cover, but failed to control cheatgrass. Nonetheless, integrated management of cheatgrass appears to have promise compared to grazing or herbicide alone. Additional research should target strategies that will complement herbicide control of cheatgrass while also stimulating native grass recovery.



Poster Session Monday 1: Poster Pod 12, Poster 68

TARGETED CHEATGRASS GRAZING - PREDICTING ANIMAL SELECTIVITY IN THE WESTERN GREAT PLAINS

Dana M. Blumenthal*¹, Mitchell Stephenson², Julie Kray¹, Lauren M. Porensky¹, David Augustine¹, Matthew C. Mortenson³, Justin D. Derner⁴; ¹USDA-ARS, Fort Collins, CO, ²University of Nebraska - Lincoln, Scottsbluff, NE, ³USDA-ARS, Cheyenne, WY, ⁴US Department of Agriculture - Agricultural Research Service, Cheyenne, WY

ABSTRACT

Cheatgrass (*Bromus tectorum*) has invaded tens of millions of hectares of North American rangeland, leading to increases in fire frequency and reductions in forage production, plant and animal diversity, and carbon storage. Targeted early-season grazing may provide land managers with a low-input method of controlling cheatgrass. Two characteristics of the western Great Plains make the region ideal for controlling cheatgrass with targeted grazing. First, its native plants evolved with large herds of wild ungulates and are well-adapted to grazing. Second, there is relatively little overlap (weeks to a month) between the primary growth period of cheatgrass and that of native cool-season perennial grasses, which provides an opportunity to schedule grazing to favor native grasses. To maximize the efficacy of targeted grazing in this region, we need to answer two questions: (1) which phenological stages of cheatgrass are preferentially grazed by livestock?, and 2) how do the amount and quality of available forage influence livestock selectivity? We used DNA metabarcoding of fecal samples and GPS collars to quantify temporal patterns of cattle consumption of cheatgrass and native, cool-season perennial grasses. The study was conducted for three years at two mixedgrass rangeland sites in Wyoming and Nebraska. At each site, a 4-ha pasture containing a mixture of cheatgrass and native perennial grasses was grazed by 3-4 yearling heifers between mid-April and early July. Results show that the timing of cheatgrass use varies widely among years but can be predicted from a combination of cheatgrass height and phenological stage. Cheatgrass consumption, as a proportion of the overall diet, was highest during periods when cheatgrass was relatively tall and within 10 days of the onset of flowering, corresponding to periods of maximum protein and energy content. Fence-line comparisons demonstrated that early season grazing can lead to 30%-75% reductions in cheatgrass seed set.



Poster Session Monday 1: Poster Pod 12, Poster 69

EVALUATING NATIVE PLANT COMMUNITY RESPONSE USING PRESCRIBED BURNING AND CHEMICAL CONTROL IN AREAS INVADED BY DOWNY BROME

Rachel Seedorf^{*1}, Shannon Clark², Scott Nissen¹; ¹Colorado State University, Fort Collins, CO, ²Weed Sciences, Colorado State University, Ft. Collins, CO

ABSTRACT: MS STUDENT

Downy brome (*Bromus tectorum*) is known for its ability to accumulate large quantities of litter on the soil surface as it annually senesces and degrades slowly. Research has shown that about 84% of a soil-active applied herbicide can be intercepted by downy brome litter, preventing it from reaching the soil and downy brome seedlings. Prescribed burning has been used as an option to remove this litter layer to eliminate fine fuel and increase the performance of soil-active herbicides. Field studies have shown the combination of burning and applying annual grass herbicides increases downy brome control because of the litter removal. However, little research has been done to determine whether burning increases the efficacy of a new annual grass herbicide, indaziflam. Field studies were conducted at two different locations, to evaluate whether burning does provide extended control with the addition of indaziflam plus different post-emergent products. At each location, there was a burned and non-burned site. The same herbicide treatments were applied at each to control downy brome. Additionally, we wanted to determine the native forb community response in the burned versus the non-burned treatments. Applications were made in March 2018 and treatments included indaziflam (44, 73, 102 g ai ha⁻¹) alone and in combination with four post-emergent herbicides. Visual downy brome and forb cover evaluations were taken in July 2019. At each location, the burned site had significantly greater downy brome control compared to the non-burned site for all indaziflam treatments. Native forb richness also increased on the burned side versus the non-burned side at both locations. This study shows that burning plus herbicide treatments with indaziflam can be used as a tool for land managers to help restore degraded sites and increase native forb richness, while providing increased downy brome control.



Poster Session Monday 1: Poster Pod 12, Poster 70

PRESCRIBED FIRE IS EFFECTIVE FOR REDUCING ANNUAL BROMES IN MIXED-GRASS PRAIRIE AT LOWER INVASION LEVELS

Amy J. Symstad*¹, Deborah A. Buhl², Brennan J. Hauk³, Daniel J. Swanson⁴; ¹U.S. Geological Survey, Hot Springs, SD, ²U.S. Geological Survey, Jamestown, ND, ³National Park Service, Rapid City, SD, ⁴National Park Service, Hot Springs, SD

ABSTRACT

Concern about the impacts of two Eurasian annual brome grasses, *Bromus tectorum* and *B. arvensis*, on the native mixed-grass prairie of the northern Great Plains (NGP) is growing. *Bromus tectorum* is well known west of the NGP, where replacement of fire-intolerant, native sagebrush steppe by fire-prone, exotic annual grasslands is widespread. Consequently, fire is generally not considered as a tool for controlling annual bromes. This should not be the case in the NGP, where mixed-grass prairie is adapted to frequent fires. Fire's efficacy may vary with the degree of invasion, though; suppressing post-fire annual brome populations or enhancing the native plant community may improve post-fire annual brome control in highly invaded areas. To test this, we performed an experiment at two sites to evaluate the relative effectiveness of prescribed fire alone, fire followed by imazapic application, and fire followed by native seeding across a pre-treatment gradient of annual brome:native species cover ranging from 0.05 to 2.35. Autumn prescribed fire alone greatly reduced annual bromes, but by the second year after treatment the effect was significant only at invasion ratios <1.2. Post-fire imazapic application reduced annual bromes even further than fire alone, but only for one year at the less invaded site, and only at invasion ratios >1.2 in year 2 at the other site. Native species cover and total species richness responded positively to all treatments, but the degree of response varied along the invasion gradient, between sites, with time since treatment, and slightly among treatments. Also, at one site, fire yielded a lagged stimulation of short-lived, exotic forbs. Seeding had little or no effect. Fire is an effective tool for reducing annual bromes in the NGP at lower invasion levels, but more tools are needed for long-term effective control at highly invaded sites.



Poster Session Monday 1: Poster Pod 12, Poster 71

ABAM: DEVELOPMENT AND IMPLEMENTATION OF AN ADAPTIVE RESOURCE MANAGEMENT FRAMEWORK FOR NATIONAL PARKS WITHIN THE NORTHERN GREAT PLAINS

Heather Q. Baldwin^{*1}, Amy J. Symstad², Max Post van der Burg³, Isabel Ashton⁴, Daniel J. Swanson⁵, Brennan J. Hauk⁴, Erin Borgman⁶, Steven Bokedam⁷; ¹U.S. Geological Survey, Rapid City, SD, ²U.S. Geological Survey, Hot Springs, SD, ³U.S. Geological Survey, Jamestown, ND, ⁴National Park Service, Rapid City, SD, ⁵National Park Service, Hot Springs, SD, ⁶National Park Service, Fort Collins, CO, ⁷National Park Service, Yellowstone National Park, WY

ABSTRACT

National Park Service units in the Northern Great Plains (NGP) have recorded an increase in invasive annual brome grasses within their native mixed-grass prairies, but management targeting their control has so far been minimal. Parks in the NGP preserve and protect historical landscapes and natural ecosystems. Invasion by annual brome grasses into these landscapes reduces historical and ecological integrity, in part by reducing native plant diversity, which is hallmark of high-quality prairie. Managing annual bromes is a complex problem because land managers are uncertain about the effectiveness of specific management treatments in controlling annual bromes. Monitoring data from NGP parks suggest that prescribed fire reduces annual bromes for at least two years, and results from outside the NGP show promisingly strong but expensive 4-year annual brome suppression by the herbicide indaziflam, but this information is insufficient to guide managers on how to best use their limited capacity to implement management treatments. The Annual Brome Adaptive Management project (ABAM) is addressing this problem through a cooperative effort among seven parks; their supporting Inventory & Monitoring networks, Exotic Plant Management Teams, and Fire Management Office; and U.S. Geological Survey scientists. ABAM is developing a structured adaptive management framework comprised of a decision tool and a formal communication structure among the natural resource experts and park decision makers. The decision tool is a state-transition Bayesian network developed using 20 years of NPS monitoring data. The tool considers the state of the vegetation in each management unit, compares the predicted outcome of each potential treatment within the next 5 years, and determines the optimal management action according to managers' relative preferences for different vegetation communities and the cost of treatment. The framework will guide parks and their supporting networks in making more effective and strategic vegetation management decisions.



Poster Session Monday 1: Poster Pod 12, Poster 72

USING 30-M, CLOUD-FREE REMOTELY SENSED DATA TO DEVELOP EARLY ESTIMATES OF ANNUAL INVASIVE HERBACEOUS COVER IN SAGEBRUSH ECOSYSTEMS

Stephen P. Boyte^{*1}, Bruce K. Wiley², Devendra Dahal³, Sujan Parajuli⁴, Neal J. Pastick⁵; ¹KBR, Inc at U.S. Geological Survey EROS Center, Sioux Falls, SD, ²USGS EROS Center, Sioux Falls, SD, ³KBR, Inc. @ USGS EROS Center, Sioux Falls, SD, ⁴KBR, Inc @ USGS EROS Center, Sioux Falls, SD, ⁵KBR, Inc @USGS EROS Center, Sioux Falls, SD

ABSTRACT

Since 2015, we have developed and publicly released one-of-a-kind early estimates of cloud-free, 250-m spatial resolution annual herbaceous or cheatgrass cover maps during the spring and/or summer of the current year. These maps provide early predictions of potential fine fuel beds across broad geographic areas, fuel beds that can effectively spread fire into neighboring intact sagebrush ecosystems and induce the return of fire through positive feedback mechanisms. A similar product with a finer spatial resolution could prove helpful to a broader range of users and still serve current users. The current study tests the development of early estimates of cloud-free, 30-m spatial resolution invasive annual herbaceous cover maps for release in 2020. The technique processes NASA's Harmonized Landsat-8 Operational Land Imager (OLI) and Sentinel-2 Multispectral Instrument (MSI) (HLS) data into weekly normalized difference vegetation index (NDVI) composites. We remove residual cloud, shadow, or snow contamination in the HLS data using regression-tree algorithms. To produce the early estimates of invasive annual herbaceous cover, weekly NDVI data within each year is integrated with relevant environmental, vegetation, remotely sensed, and geophysical drivers into regression-tree models with BLM Assessment Inventory and Monitoring (AIM) data as the dependent variable. For a preliminary test area, we show a test R^2 of 0.70 and a mean average error (MAE) of 12.89 for the 2017 invasive annual herbaceous cover mapping model. We anticipate that the finer spatial resolution invasive annual herbaceous maps could, for example, be used to analyze effects from fuel breaks in sagebrush ecosystems and evaluate the efficacy of targeted aerial spraying or cluster seeding with drones.



Poster Session Monday 1: Poster Pod 13, Poster 73

**IMPACTS ON HERPETOFAUNA IN THE PRESENCE OF OLD WORLD BLUESTEMS
(*BOTHRIOCHLOA* SPP.)**

Colton Zink*, Mitchell J. Greer; Fort Hays State University, Hays, KS

ABSTRACT: MS STUDENT

Global environmental change is having negative impacts on rangelands and the multiple native species communities that occupy them. These negative impacts include the introduction of nonnative plant species. These nonnative species once established, many times begin to spread and out compete native species for resources and transform once diverse rangelands into monocultures. Mono-specific stands of nonnative species have been found to alter soil microbial communities as well as cause changes in plant and animal communities. An example of these detrimental invasions includes Old World bluestem species such as *Bothriochloa ischaemum* and *Bothriochloa bladhii*. Monocultures of these species cause changes to many different rangeland communities. Studies show that monocultures of Old World bluestem have effects on avian and small mammal communities by changing the availability of food items such as arthropods. Research has shown that herpetofauna are good indicators of change both globally and locally. However, data on changes of herpetofauna in result to specific invasive species is very minimal and to our knowledge non-existent in relation to OWB. The objective of this study is to determine if the invasion of OWB has impacts on the native herpetofauna in rangeland systems. We will collect data on herpetofauna abundances and richness comparing sites of predominately native vegetation to those of monocultures of Old World bluestem. Results of this study will show potential negative impacts that Old World bluestem has on native herpetofauna and add to the body of knowledge on these problematic species and aid in development of policy to control/eradicate them.



Poster Session Monday 1: Poster Pod 13, Poster 74

IMPACTS OF SIMULATED TRAMPLING ON TOTAL NONSTRUCTURAL CARBOHYDRATES IN YELLOW-FLAG IRIS (IRIS PSEUDACORUS L.)

Alex L. Stoneburner*, Paul Meiman, Troy W. Ocheltree; Colorado State University, Fort Collins, CO

ABSTRACT: MS STUDENT

It has been well documented that the presence of invasive species negatively impacts biodiversity, system interactions, and the local economics of the areas they invade. It is also well understood that one of the most complex challenges associated with invasive species is how best to manage them once they are established. Yellow-Flag Iris (YFI) is a non-native, invasive wetland species that, due to its physiology, has the capacity to exclude native vegetation in riparian areas and form extensive monocultures. While chemical management techniques are often utilized for larger stands, cattle trampling has been shown to be effective as well. Previous work suggests that after multiple years of trampling YFI density and height decrease significantly. It has also been shown that saturated soil conditions amplify these results. While cattle trampling of YFI could be an effective management tool, the question of what is mechanistically driving these responses remains. One such mechanism could be a reduction in total nonstructural carbohydrates (TNC). To investigate this question, a simulated trampling study was performed. Six treatment groups consisting of both trampled and un-trampled samples, as well as saturated and unsaturated samples, were analyzed. Saturation levels were held constant, and trampling was simulated by applying concentrated pressure to the plant crown. Prior to implementing treatments, as well as again at the conclusion of the study, rhizome samples were collected from each replicate and a molecular assay was performed to determine TNC concentrations. It is our hypothesis that YFI exposed to both trampling and saturated conditions will show the greatest reduction TNCs. Results are pending, but initial observation supports this theory.



Poster Session Monday 1: Poster Pod 13, Poster 75

WILDLIFE BROWSE SPECIES RESPOND TO CHEATGRASS CONTROL WITH INDAZIFLAM

Jim Sebastian^{*1}, Joe Swanson², Derek Sebastian³, Steve Sauer²; ¹Boulder County Parks and Open Space, Loveland, CO, ²Boulder County Parks and Open Space, Longmont, CO, ³Bayer, Greeley, CO

ABSTRACT

Boulder County Open Space (BCOS) manages properties in the lowland, foothills and mountains of Colorado that provides critical overwintering habitat for mule deer, elk, and other wildlife. One concern of BCOS ecologists and wildlife biologists is the loss of native forbs, shrub, and brush species in these critical wildlife habitat areas due to increased spread of invasive annual grasses like cheatgrass (*Bromus tectorum*). In winter 2017 and 2018 six sites were sprayed with indaziflam (Esplanade 200 SC, Bayer CropScience) plus glyphosate, while desirable shrub species were in dormancy and no leaves were present. These sites were 2 to 5 acres in size with dense stands of mountain mahogany, four-lobed sumac, antelope bitterbrush, winterfat, rubber rabbitbrush, four-winged saltbush, and fringed sage. Permanent random transects (3 X 200') were created inside treated and immediately adjacent non-treated plots to monitor native shrub growth. Visual percent canopy cover was collected for cheatgrass and all desirable perennial grasses, forbs, and shrubs, in addition to cheatgrass litter biomass to determine fine-fuel weights in treated v. non-treated plots. Fine-fuel biomass provided an indication of how quickly litter degrades. All shrub species' longest leader growth nearly doubled in length for all species in treated v. non-treated plots. Three key browse species on BCOS properties (mountain mahogany, bitterbrush, and rabbitbrush) had 6 to 12" vs 15 to 28" long leaders in non-treated v. indaziflam treated sites, respectively. There was 0% cheatgrass canopy cover in treated v. 85 to 100% cheatgrass cover in non-treated areas. Reduction in cheatgrass with indaziflam treatments resulted in 2-3X increase in perennial grass cover. Cheatgrass fine-fuels decomposed extremely fast at all these sites, averaging 899 lb/A in non-treated plots and 120 lb/A in treated plots, approximately 6 months after treatment (MAT). Cheatgrass fine fuels were eliminated (0 lb/A) at all 6 sites 24 MAT. There was no visible shrub or brush species injury from indaziflam plus glyphosate treatments sprayed during dormancy at these or any other BCOS sites. This research suggests that indaziflam could be a useful tool in wildlife habitat improvement projects on invasive winter annual grass dominated sites.



Poster Session Monday 1: Poster Pod 13, Poster 76

POLLINATOR COMMUNITY AND FLORAL RESOURCE RESPONSE TO CHEATGRASS CONTROL WITH ESPLANADE

Jim Sebastian*¹, Joe Swanson², Derek Sebastian³, Steve Sauer²; ¹Boulder County Parks and Open Space, Loveland, CO, ²Boulder County Parks and Open Space, Longmont, CO, ³Bayer, Greeley, CO

ABSTRACT

Colorado is home to over 900 native bee genera, many of which are found on rangeland, open spaces, and natural areas across the state. Because pollinators have adapted over countless generations to identify the flowers that will provide them the highest pollen and nectar nutrition, a diverse native plant community is crucial to support the bee populations. Through the Urban Bee Project, researchers have found that native bees are four times more likely to visit native flowers than non-native flowers and native plant genera support three times as many butterfly and moth species. Plant diversity leads to pollinator diversity; however, invasive annual grasses like cheatgrass (*Bromus tectorum*) pose a major threat to pollinator habitat. An experiment was initiated in 2019 to evaluate pollinator species habitat enhancement on 12 Boulder County Open Space properties. The focus of this research is to monitor the response of native flowering plants on invasive annual grass invaded sites that were treated with indaziflam (Esplanade 200 SC, Bayer CropScience), compared to directly adjacent non-treated control plots. Field studies at Colorado State University demonstrate that indaziflam provides long-term cheatgrass control (3+ years) with no documented injury to native perennial species. In this study, we documented flowering plant diversity, cover, abundance, flower numbers, and available floral resources. Comparing treated and non-treated plots, plots treated with indaziflam resulted in 2-4X increases across all the flowering plant metrics collected. This provides evidence that long-term invasive winter annual grass control with indaziflam results in additional resource availability to flowering plants, facilitating successful pollinator conservation. This is the first study evaluating the response of pollinator habitat following an indaziflam treatment on an operational scale, and these results suggest that it could be a useful tool for pollinator habitat restoration across rangeland ecosystems in the western US.



Poster Session Monday 1: Poster Pod 13, Poster 77 – Poster Withdrawn

REMOTE SENSING OF INVASIVE ANNUAL PLANTS AROUND ENERGY DEVELOPMENTS

Miguel L. Villarreal*, Christopher E. Soulard, Eric K. Waller; U.S. Geological Survey, Menlo Park, CA

ABSTRACT

Invasive annual grasses are of concern in much of the western United States because they tolerate resource variability and have high reproductive capacity, with propagules that are readily dispersed in disturbed areas like those created and maintained for energy development. Early season invasive grasses “green up” earlier than most native plants, producing a distinct pulse of greenness in the early spring that can be exploited to identify their location using multi-date imagery. To determine if invasive annual grasses increased around energy developments after the construction phase, we used Google Earth Engine cloud-computing to calculate a 34-year time series of an invasives index from Landsat imagery and assessed trends for 1,755 wind turbines installed between 1988-2013 in the southern California desert. The index uses the maximum NDVI for early season greenness (January-June), and mean NDVI (July-October) for the later dry season. We estimated the relative cover of invasive annuals (primarily red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*)) each year at turbine locations and control sites and tested for changes before and after each turbine was installed. The time series was also mapped across the region and temporal trends were assessed relative to seasonal precipitation. The results showed an increase in early season invasives at turbine sites after installation, but also an increase in many of the surrounding control areas. Maps of the invasive index show a region-wide increase starting around 1998, and much of the increase occurred in areas surrounding wind development sites. These results suggest that invasions around the energy developments occurred within the context of a larger regional invasion, and while the development did not necessarily initiate the invasion, annual grasses were more prevalent around them.



Poster Session Monday 1: Poster Pod 13, Poster 78

CHANGES IN VEGETATIVE COMMUNITY COMPOSITION FOLLOWING TWO-LINED SPITTLE BUG (*PROSAPIA BICINCTA*) INFESTATIONS IN HAWAII RANGELANDS

Mark Thorne^{*1}, Mark G. Wright², Shannon Wilson², Jennifer Mack³, Melelani Oshiro⁴;
¹University of Hawaii - Manoa, Kamuela, HI, ²University of Hawaii at Manoa, Honolulu, HI,
³University of Hawaii at Manoa, Kealahou, HI, ⁴University of Hawaii at Manoa, Kamuela, HI

ABSTRACT

Two-lined 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 separate locations were selected for long-term, monthly monitoring of TLSB activity and 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 sites were located outside of the northern and southern boundaries of the known distribution of the pest to estimate rate of spread. At each location a series of transects were established along elevational gradients between 1850 and 500 m. Along each transect ten sample points were systematically established every 10 m alternating between the left and right side of the transect line. A 0.25 m² ring was used at each sample point to record vegetative cover by species, percent live and dead grass by species, vegetation height by functional group (grass, forb, shrub), and a count of TLSB nymphs and adults. Data were collected across all transects and sites monthly. The monthly surveys revealed that TLSB expanded its range from the initial 2,000-acre infestation to over 130,000 acres of rangelands in approximately six 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. The loss of these important livestock forages provided entry for the establishment of invasive plants including Pamakani (*Eupatorium adenophorum*), wild blackberry (*Rubus* spp.), fireweed (*Senecio madagascariensis*), Hilo grass (*Paspalum conjugatum*), and several other weeds. The pest was active between March and October with two population peaks before entering diapause over the winter months. Nymph densities during the peaks reached well over 150 nymphs/m² with this density resulting in complete loss in grass cover.



Poster Session Monday 2: Poster Pod 14, Poster 79

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

Jessica D. Mikenas^{*1}, James Hensleigh², Thomas Gushue², Tara B. Bishop¹, Michael C. Duniway¹; ¹US Geological Survey, Moab, UT, ²US Geological Survey, Flagstaff, AZ

ABSTRACT

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



Poster Session Monday 2: Poster Pod 14, Poster 80

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

Stella M. Copeland*¹, Seth Munson², John Bradford³, Bradley J. Butterfield⁴, Kevin Gunnell⁵;
¹Agricultural Research Service, Burns, OR, ²U.S. Geological Survey, Flagstaff, AZ, ³USGS Southwest Biological Science Center, Flagstaff, AZ, ⁴Northern Arizona University, Flagstaff, AZ, ⁵Utah Division of Wildlife Resources, Ephraim, UT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 14, Poster 81

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

Rachel K. Hosna*¹, Sasha Reed², Akasha M. Faist³; ¹New Mexico State University, Las Cruces, NM, ²U.S. Geological Survey, Moab, UT, ³New Mexico State University, LAS CRUCES, NM

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 14, Poster 82

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

Sabrina McCue*¹, Sherman R. Swanson²; ¹Bureau of Land Management, Winnemucca, NV, ²University of Nevada, Reno, Reno, NV

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 14, Poster 83

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

Alan Iwaasa*¹, Chen Gu², Craig Gatzke¹, Ken Wall³, Jun Zhang²; ¹AAFC, Swift Current, SK, ²Inner Mongolia Agricultural University, Hohhot, Peoples Republic, ³Pioneer COOP, Swift Current, SK

ABSTRACT

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



Poster Session Monday 2: Poster Pod 14, Poster 84

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

Sergio A. Arispe¹, Kirk Davies², Dustin Johnson³, Noah Poulin^{*4}, ¹Oregon State University Extension Service, Ontario, OR, ²Agricultural Research Service, Burns, OR, ³Oregon State University, Burns, OR, ⁴Oregon State University, Sandy, OR

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 15, Poster 85

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

Sean L. Hoy-Skubik^{*1}, David L. Hoover², Alix Pfennigwerth¹, Michael C. Duniway¹; ¹US Geological Survey, Moab, UT, ²USDA-ARS, Fort Collins, CO

ABSTRACT

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



Poster Session Monday 2: Poster Pod 15, Poster 86

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

Rory C. O'Connor^{*1}, Matthew J. Germino¹, David M. Barnard², Caitlin Andrews³, Robert S. Arkle⁴, John Bradford³, David S. Pilliod¹; ¹US Geological Survey, Boise, ID, ²USDA-ARS, Fort Collins, CO, ³USGS Southwest Biological Science Center, Flagstaff, AZ, ⁴USGS, Boise, ID

ABSTRACT

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



Poster Session Monday 2: Poster Pod 15, Poster 87

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

Mohamed A. Abdallah*, Nicole Durfee, Ricardo Mata-Gonzalez, Carlos G. Ochoa, Jay S. Noller; Oregon State University, Corvallis, OR

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 15, Poster 88

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

Robert Blank¹, Charlie D. Clements*², Tye A. Morgan³, Dan Harmon⁴, Fay L. Allen²; ¹USDA-ARS retired, Reno, NV, ²USDA, Reno, NV, ³USDA, Sparks, NV, ⁴USDA ARS, Reno, NV

ABSTRACT

Long-term control of the invasive annual grass, cheatgrass, is predicated on its biological suppression. Perennial grasses, which have been shown to effectively suppress cheatgrass, vary in their suppressive ability. We compared the ability of a non-native grass ('Hycrest' crested wheatgrass) and two native grasses (Snake River wheatgrass and bluebunch wheatgrass) to suppress cheatgrass. In a greenhouse setting with separate tubs, 5 replicates of each perennial grass were established for 96 days upon which two seeds of cheatgrass were then sown at distances of 10, 30, and 80 cm from the established plants. Water was not limiting to growth of cheatgrass. Relative to cheatgrass grown at 80 cm, all perennial grasses significantly reduced aboveground biomass at 30 cm (68% average reduction) and at 10 cm (98% average reduction). Sown at 10 cm from established perennial grasses, cheatgrass aboveground biomass was inversely related with perennial grass root mass per unit volume of soil. All cheatgrass sown at 10 cm from 'Hycrest' crested wheatgrass died within 38 days. Before sowing of cheatgrass, soil 10 cm from established perennial grasses had significantly less mineral N than soil taken at 30 and 80 cm. Relative to cheatgrass tissue N for plants grown at 80 cm, cheatgrass nearest to the established perennial grasses contained significantly less tissue N. All perennial grasses inhibited the NO₂⁻ to NO₃⁻ nitrification step; for 'Hycrest' crested wheatgrass, soil taken at 10 cm from the plant had a molar proportion of NO₂⁻ in the NO₂⁻ + NO₃⁻ pool of greater than 90%. In summary, a combination of reduced nitrogen availability, occupation of soil space by perennial roots, and attenuation of the nitrogen cycle contribute to suppression of cheatgrass.



Poster Session Monday 2: Poster Pod 15, Poster 89

TIMING TO GERMINATION BY FUNCTIONAL PLANT GROUPS ACROSS FOUR DIFFERENT DESERTS

Trenda L. Roper*¹, Rachel Hosna¹, Akasha Faist²; ¹New Mexico State University, Las Cruces, NM, ²New Mexico State University, LAS CRUCES, NM

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 15, Poster 90

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

John R. Hendrickson^{*1}, Vannessa Yeoman², Aaron Field³, Andrew Carrlson⁴; ¹USDA-ARS, Mandan, ND, ²Colorado State University, Fort Collins, CO, ³Chadron State University, Chadron, NE, ⁴USDA-Agricultural Research Service, Mandan, ND

ABSTRACT

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



Poster Session Monday 2: Poster Pod 16, Poster 91

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

Matthew B. Rigge*¹, Collin G. Homer², Hua Shi¹, George X. Xian²; ¹Inuteq Contractor to USGS, Sioux Falls, SD, ²U.S. Geological Survey, Sioux Falls, SD

ABSTRACT

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



Poster Session Monday 2: Poster Pod 16, Poster 92

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

Erica Christensen^{*1}, Brandon T. Bestelmeyer², Connie Maxwell³, Amy Slaughter³, Darren James³, Kirsten B. Romig³, Kris Havstad³; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³Jornada Experimental Range, Las Cruces, NM

ABSTRACT

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



Poster Session Monday 2: Poster Pod 16, Poster 93

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

Xavier A. Jaime*¹, Jose Mata¹, Zheng Li¹, Weiqian Gao¹, Jay P. Angerer², Chenghai Yang³, Douglas R. Tolleson⁴, Sam D. Fuhlendorf⁵, X. Ben Wu⁶; ¹Texas A&M University, College Station, TX, ²Texas A&M AgriLife Research, Temple, TX, ³USDA, College Station, TX, ⁴Texas A&M University, Sonora, TX, ⁵Oklahoma State University, Stillwater, OK, ⁶Texas A&M University, COLLEGE STATION, TX

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 16, Poster 94

PREDICTING WOODY PLANT ENCROACHMENT RISK ON SONORAN DESERT RANGELANDS

William A. Rutherford*, Steven R. Archer; University of Arizona, Tucson, AZ

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 16, Poster 95

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

Wayne Polley^{*1}, Chenghai Yang², Brian J. Wilsey³, Philip A. Fay¹; ¹USDA/Agricultural Research Service, Temple, TX, ²USDA, College Station, TX, ³Iowa State University, Ames, IA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 16, Poster 96

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

Khislat K. Khaydarov*¹, Adiba S. Bobaeva²; ¹Samarkand state university, Samarkand, Uzbekistan, ²Research institute karakul sheep breeding and ecology desert, Samarkand, Uzbekistan, Boboeva A., 1Rabbimov A., 2Khaydarov Kh

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 17, Poster 97

POST-FIRE ECOLOGICAL RESILIENCE ACROSS FIVE SOUTHWESTERN US DESERTS

Akasha M. Faist^{*1}, Rachel K. Hosna², Armin Howell³, Cara Lauria³, Ellie McCann², Nicholas Melone³, Robin Reibold³, Jenny Shostrand³, Megan Starbuck³, Sasha Reed³; ¹New Mexico State University, LAS CRUCES, NM, ²New Mexico State University, Las Cruces, NM, ³U.S. Geological Survey, Moab, UT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 17, Poster 98

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

Justin P. Roemer*¹, Matthew Bain², Mitchell J. Greer¹; ¹Fort Hays State University, Hays, KS, ²The Nature Conservancy, Oakley, KS

ABSTRACT

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



Poster Session Monday 2: Poster Pod 17, Poster 99

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

Jasmine A. Cutter*¹, Torre Hovick¹, Ben A. Geaumont², Devan A. McGranahan¹, Ryan F. Limb¹, Jason P. Harmon¹; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 17, Poster 100

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

Chyna K. Pei^{*1}, Torre Hovick¹, Ryan F. Limb¹, Jason P. Harmon¹, Ben A. Geaumont², Adrienne K. Antonsen¹; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 17, Poster 101

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

Christina Herron-Sweet*¹, Kiley Friedrich¹, Katie Lee¹, Marla Spivak¹, Daniel Cariveau;

¹Department of Entomology, University of Minnesota, Saint Paul, MN

ABSTRACT

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



Poster Session Monday 2: Poster Pod 17, Poster 102

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Poster Session Monday 2: Poster Pod 18, Poster 103

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

Megan R. Wanchuk^{*1}, Jonathan W. Spiess¹, Devan A. McGranahan¹, Kevin K. Sedivec¹, Ben A. Geaumont², Erin M. Gaugler¹, Torre Hovick¹, Ryan F. Limb¹; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 18, Poster 104

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

Shelemia Nyamuryekunge*¹, Andres F. Cibils¹, Richard E. Estell², Alfredo L. Gonzalez³, Matthew M. McIntosh¹, Sheri Spiegel⁴, Fatima G. Continanza¹; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS-Jornada Experimental Range, Las Cruces, NM, ³Animal Scientist, Las Cruces, NM, ⁴USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 18, Poster 105

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

Douglas R. Tolleson^{*1}, John Walker², Matthew Vajdos³, Vitaly Vogelman³, Nick E. Garza¹, Kaylee Hollingsworth³, Thomas Welsh Jr³; ¹Texas A&M University, Sonora, TX, ²Texas A&M AgriLife Research, San Angelo, TX, ³Texas A&M University, College Station, TX

ABSTRACT

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



Poster Session Monday 2: Poster Pod 18, Poster 106

IMPACT OF ALTERNATIVE GRAZING MANAGEMENT PRACTICES ON ARTHROPOD COMMUNITY

Alyssa E. Vachino*¹, Lan Xu¹, Patricia S. Johnson²; ¹South Dakota State University, Brookings, SD, ²South Dakota State University, Rapid City, SD

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 18, Poster 107

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

Corey A. Moffet*; USDA-ARS, Woodward, OK

ABSTRACT

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



Poster Session Monday 2: Poster Pod 18, Poster 108

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

Josh P. Averrett*, Bryan A. Endress; Oregon State University, La Grande, OR

ABSTRACT

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



Poster Session Monday 2: Poster Pod 19, Poster 109

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

Doug Cram*, Pradip Saud; New Mexico State University, Las Cruces, NM

ABSTRACT

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



Poster Session Monday 2: Poster Pod 19, Poster 110

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

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

ABSTRACT

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



Poster Session Monday 2: Poster Pod 19, Poster 111

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

Yasser M. Almalki*¹, Alexander G. Fernald², Andres F. Cibils²; ¹New Mexico State University, las cruces, NM, ²New Mexico State University, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 19, Poster 112

CURRENT CONDITION AND USE OF PASTURES OF FOOTHILL DISTRICTS OF UZBEKISTAN

Tolibjon K. Mukimov*, Khislat K. Khaydarov; Samarkand state university, Samarkand, Uzbekistan, Muxtasov Sh., Khaydarov Kh., Rajabov T., Mukimov T. Samarkand State University, Uzbekistan, Samarkand Department of Biology

ABSTRACT

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



Poster Session Monday 2: Poster Pod 19, Poster 113

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

Daniel Cook^{*1}, Benedict T. Green², Kevin D. Welch², Dale R. Gardner², James A. Pfister²;
¹USDA ARS Poisonous Plant Research Laboratory (PPRL), Logan, UT, ²USDA-ARS-PPRL, Logan, UT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 19, Poster 114

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Poster Session Monday 2: Poster Pod 20, Poster 115

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

Andrea Clemensen^{*1}, Juan Villalba², George Rottinghaus³, Stephen T. Lee⁴, Fred Provenza², Jennifer Reeve²; ¹USDA - ARS, Mandan, ND, ²Utah State University, Logan, UT, ³University of Missouri, Columbia, MO, ⁴USDA-ARS-PPRL, Logan, UT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 20, Poster 116

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

Jonathan J. Maynard*¹, Jeffrey Herrick², Shawn Salley³, Dylan Beaudette⁴, Anthony T. OGeen⁵;
¹USDA-ARS, Las Cruces, NM, ²USDA-ARS Research Unit @ The Jornada, Las Cruces, NM,
³Jornada Experimental Range, Las Cruces, NM, ⁴USDA-NRCS-CA, Sonora, CA, ⁵University of California, Davis, Davis, CA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 20, Poster 117

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

Jaide H. Allenbrand*, Lydia H. Zeglin; Kansas State University, Manhattan, KS

ABSTRACT: MS STUDENT

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

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



Poster Session Monday 2: Poster Pod 20, Poster 118

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

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

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 20, Poster 119

LAND RESOURCE UNITS AS SOIL SYSTEMS

Hunter B. Winsor*, Colby Brungard; New Mexico State University, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

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



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Poster Session Monday 2: Poster Pod 21, Poster 121

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

Brekke Munks*¹, David Augustine², Elizabeth H. Boughton³, Jean L. Steiner⁴; ¹USDA, El Reno, OK, ²USDA-ARS, Fort Collins, CO, ³Archbold Biological Station, Lake Placid, FL, ⁴KSU, Manhattan, KS

ABSTRACT

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



Poster Session Monday 2: Poster Pod 21, Poster 122

SOIL CARBON UNDER DIFFERENT GRAZING MANAGEMENT ACROSS THE NORTHERN GREAT PLAINS

Clare Kazanski^{*1}, Joe Fargione¹, Forest Isbell², John Ritten³; ¹The Nature Conservancy, Minneapolis, MN, ²University of Minnesota, St. Paul, MN, ³University of Wyoming, Laramie, WY

ABSTRACT

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



Poster Session Monday 2: Poster Pod 21, Poster 123

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

Dave Evans^{*1}, Andrew Paolucci¹, Kendra Moseley Urbanik², Jon Gustafson³; ¹USDA-NRCS-CA, Sonoma, CA, ²USDA-NRCS, Davis, CA, ³USDA-NRCS-CA, Davis, CA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 21, Poster 124

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

Ashly Dyck*, Jackie Kroeger, Eric Lamb, Dale Gross, Hannah Hilger, Melissa Arcand;
University of Saskatchewan, Saskatoon, SK

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 21, Poster 125

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

Jonathan W. Spiess^{*1}, Caley K. Gasch¹, Devan A. McGranahan¹, Ben A. Geaumont²; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT: Ph. D STUDENT

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



Poster Session Monday 2: Poster Pod 21, Poster 126

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

Kaylee M. Littlefield*¹, Brogan L. Watson¹, Lesley Morris², Scott Lukas³, Sandra J. DeBano³, Heidi Schmalz⁴; ¹Oregon State University, La Grande, OR, ²SRM, Bismarck, SD, ³Oregon State University, Hermiston, OR, ⁴The Nature Conservancy, Enterprise, OR

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 22, Poster 127

EVOLUTION OF CONSERVATION EASEMENTS IN CALIFORNIA'S SIERRA VALLEY

Tracy Schohr*; UC Cooperative Extension, Quincy, CA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 22, Poster 128

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

Jennifer Perkins*¹, Lauren Connell², Angela Dwyer²; ¹Bird Conservancy of the Rockies, Steamboat Springs, CO, ²Bird Conservancy of the Rockies, Fort Collins, CO

ABSTRACT

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



Poster Session Monday 2: Poster Pod 22, Poster 129

USING REMOTE SENSING TO PREDICT SAGE GROUSE CONSERVATION CREDITS

Timothy M. Bateman*¹, Eric D. Sant², Gregg E. Simonds³, Margaret Walch⁴; ¹Open Range Consulting, Logan, UT, ²Open Range Consulting, Park City, UT, ³Open Range Consulting, Park City Utah, UT, ⁴Western Biological, Elko, NV

ABSTRACT

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



Poster Session Monday 2: Poster Pod 22, Poster 130

LANDSCAPE IMPACTS OF UNMAINTAINED SOIL AND WATER CONSERVATION STRUCTURES

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

ABSTRACT

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



Poster Session Monday 2: Poster Pod 22, Poster 131

FIELD ESTABLISHMENT OF LITTLE BLUESTEM IN A DROUGHT YEAR

Tim Springer*; USDA, Woodward, OK

ABSTRACT

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



Poster Session Monday 2: Poster Pod 22, Poster 132

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

Tyler Bain¹, Caitlin Gillespie¹, Hunter Hamel¹, Keegan Lancaster¹, William Purdy¹, Kyrsten Wolterstorff^{*1}, Clayton B. Marlow¹, John Fisher¹, Raymond Schell²; ¹Montana State University, Bozeman, MT, ²Montana Fish, Wildlife and Parks, Decker, MT

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 23, Poster 133

ENHANCING IRRIGATED PASTURE FOR MULTIPLE ECOSYSTEM BENEFITS

Danny J. Eastburn*¹, Grace E. Woodmansee², Josh Davy³, Morgan Doran⁴, Betsy Karle⁴, David Lile⁵, Daniel K. Macon⁶, Carissa Koopman Rivers⁷, Tracy Schohr⁸, Laura K. Snell⁹, Kenneth W. Tate¹⁰, Leslie Roche²; ¹UC Davis, Woodland, CA, ²UC Davis, Davis, CA, ³UC Cooperative Extension, Red Bluff, CA, ⁴UC Cooperative Extension, Woodland, CA, ⁵UC Cooperative Extension, Susanville, CA, ⁶University of California Cooperative Extension, Auburn, CA, ⁷UC Cooperative Extension, Yreka, CA, ⁸UC Cooperative Extension, Quincy, CA, ⁹University of California, Alturas, CA, ¹⁰Plant Sciences Department, UC Davis, Davis, CA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 23, Poster 134

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

Jennifer M. Muscha*¹, Mark K. Petersen², Kurt O. Reinhart²; ¹USDA-ARS Fort Keogh, Miles City, MT, ²USDA-ARS, Miles City, MT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 23, Poster 135

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

Fevziye Aslan*¹, David E. Prado-Tarango¹, Ricardo Mata-Gonzalez¹, Derek Godwin², Carlos G. Ochoa¹; ¹Oregon State University, Corvallis, OR, ²Oregon State University, Corvallis, OR

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 23, Poster 136

PROPER FUNCTIONING CONDITION ASSESSMENT OF THE NORTH TAMIR RIVER, MONGOLIA

Rentsenkhand Munkhbat*¹, Sherman R. Swanson², Sukhbaatar. Tsogt¹, Mookhor Khishigjargal¹, Myangan Orgilbold¹, Tuulaikhuu Baigal-Amar¹, D. Bulgamaa³; ¹Mongolia University of Life Science, Ulaanbaatar, Mongolia, ²University of Nevada, Reno, Reno, NV, ³Green Gold, Ulaanbaatar, Mongolia

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 23, Poster 137

BRINGING RANGELAND TAXONOMY INTO THE 21ST CENTURY

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

ABSTRACT: UNDERGRADUATE STUDENT

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



Poster Session Monday 2: Poster Pod 23, Poster 138

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

Clint Stonecipher*¹, Kevin D. Welch², Stephen T. Lee², Daniel Cook³; ¹USDA-ARS-PWA-PPR, Logan, UT, ²USDA-ARS-PPRL, Logan, UT, ³USDA ARS Poisonous Plant Research Laboratory (PPRL), Logan, UT

ABSTRACT

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



Poster Session Monday 2: Poster Pod 24, Poster 139

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

Miranda A. Meehan^{*1}, Peter L. OBrien²; ¹North Dakota State University, Fargo, ND, ²USDA-ARS National Laboratory for Agriculture and the Environment, Ames, IA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 24, Poster 140

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

Selby L. Boerman*¹, Haley M. Dancer¹, Laura K. Snell²; ¹University of California Cooperative Extension, Modoc County, Alturas, CA, ²University of California, Alturas, CA

ABSTRACT

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



Poster Session Monday 2: Poster Pod 24, Poster 141

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

Sebastian A. Tsocanos*¹, Jacob Burdick², Sabrina McCue³, Sherman R. Swanson⁴; ¹University of Nevada Reno, Reno, NV, ²University of Nevada, Reno, Reno, NV, ³BLM, University of Nevada, Reno, Winnemucca, NV, ⁴University of Nevada, Reno, Reno, NV

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 24, Poster 142

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

Jacob M. Burdick*¹, Sebastian A. Tsocanos², Sherman R. Swanson¹; ¹University of Nevada, Reno, Reno, NV, ²University of Nevada Reno, Reno, NV

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 24, Poster 143

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

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

ABSTRACT: Ph. D STUDENT

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



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

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

Joe Nett¹, Taylor Young², Christina Hargiss², Laurie Richardson*³; ¹ND Dept of Health, Bismarck, ND, ²North Dakota State University, Fargo, ND, ³FWS, Kenmare, ND

ABSTRACT

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



Poster Session Monday 2: Poster Pod 25, Poster 145

VALUING U.S. CATTLE RANCHING BASED ECOSYSTEM SERVICES

Anna T. Maher^{*1}, Kristie Maczko², David "Tex" Taylor³, Nicolas E. Quintana Ashwell⁴, John A. Tanaka³; ¹University of Wyoming, Portland, OR, ²Sustainable Rangelands Roundtable - University of Wyoming, Laramie, WY, ³University of Wyoming, Laramie, WY, ⁴Mississippi State University, Stoneville, MS

ABSTRACT

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



Poster Session Monday 2: Poster Pod 25, Poster 146

ECONOMIC SUSTAINABILITY OF A PERENNIAL GRASS SYSTEM GRAZED BY STOCKER CATTLE

Elizabeth K. Widder*¹, Daren Redfearn², Robert Mitchell¹, Marty Schmer², Virginia Jin², Jay Parsons³, Mary Drewnoski³; ¹University of Nebraska Lincoln, Lincoln, NE, ²University of Nebraska-Lincoln, Lincoln, NE, ³University of Nebraska- Lincoln, Lincoln, NE

ABSTRACT: MS STUDENT

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



Poster Session Monday 2: Poster Pod 25, Poster 147

THE WATER FOOTPRINT OF BEEF CATTLE RAISED ON NEW MEXICO RANGELAND

Mohammed N. Sawalhah¹, Andres F. Cibils^{*2}, Jerry L. Holechek², Hatim M. Geli²; ¹Hashemite University, Zarqa, Jordan, ²New Mexico State University, Las Cruces, NM

ABSTRACT

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



Poster Session Monday 2: Poster Pod 25, Poster 148

DEVELOPMENT AND CHANGING POLICIES TRANSFORMING THE FACE OF RANGELANDS IN BHUTAN

Kuenga Namgay*; Royal Government of Bhutan, Thimphu, Bhutan

ABSTRACT

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



Poster Session Monday 2: Poster Pod 25, Poster 149

PROFITABLE GRAZING SYSTEMS FOR IMPROVED LANDSCAPE CONDITION AND SUSTAINABILITY REPORTING

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

ABSTRACT

Feedbase Four – grassroots pathways to a profitable grazing system

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



Poster Session Monday 2: Poster Pod 25, Poster 150

WHAT IS THE FUTURE FOR MONGOLIA'S RANGELANDS?

Daniel J. Miller*¹, Sherman R. Swanson²; ¹retired U.S. Agency for International Development (USAID) Agriculture Officer, Missoula, MT, ²University of Nevada, Reno, Reno, NV

ABSTRACT

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



Poster Session Monday 2: Poster Pod 26, Poster 151

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

Philip Bravo, Peach Springs Livestock Association

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

Philip Bravo
Peach Springs Livestock Association President
Peach Springs, AZ
philipbravo@yahoo.com



Poster Session Monday 2: Poster Pod 26, Poster 152

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

Oswald Cattle Company – Ranching in Sync with Nature

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

Oswald Cattle Company
Steve and Nancy Oswald
Cotopaxi, CO
stepheno@centurylink.net



Poster Session Monday 2: Poster Pod 26, Poster 153

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

Broken Box Ranch's Rangeland Stewardship

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

Broken Box Ranch
Russ, Angela, and Cheyenne Sundstrom
Moorefield, NE
rsundstrom@nebnet.net



Poster Session Monday 2: Poster Pod 26, Poster 154

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

Open Range Management: Achieving Their Goals

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

Open Range Management, LLC
Adam Gourley
Copan, OK
adam@openrangemanagementllc.com



Poster Session Monday 2: Poster Pod 26, Poster 155

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

Treadwell Cattle Company: 132 Years with 5 Tools

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

Treadwell Cattle Company
Brian and John Treadwell
Christoval, TX
bet@wcc.net



Poster Session Tuesday 1: Poster Pod 28, Poster 1

USING TECHNOLOGY TO HELP QUANTIFY CALF LOSS IN RANGELAND CATTLE: AN INTERNATIONAL EFFORT

Raoul K. Boughton^{*1}, Kelly J. Koriakin², Kieren McCosker³, Tim Schatz³; ¹University of Florida, Ona, FL, ²University of Florida, Jacksonville Beach, FL, ³Northern Territory Department of Primary Industries and Resources, Katherine, Australia

ABSTRACT

The use of birthing sensors in controlled dairy environments have been effectively employed to decrease dystocia rates and increase cow and calf survival at birth yet they have not been developed or utilized in large-scale environments such as ranching operations. We evaluated vaginal birthing sensors, specifically adapted for large-scale environments, as an effective calving alert system. The intra-vaginal sensor monitored temperature and sent calving alerts when the sensor was expelled, coinciding with labor and the expulsion of the amniotic sac. A Long Range Wide Area Network (LoRaWAN) communication system LinkLabs© Symphony Link™ gateway was deployed within each study system to capture sensor alerts and inform clients/researchers real time. We deployed a total of 297 birthing sensors from JMB North America (product # JMB-10005) in dams on three Florida ranches. Average sensor deployments were 72.1 days (range 0.5-146 days) and a total of 140 (47.1%) sensors failed. Of the 140, 65% were determined to be drained of battery power and 12% were in locations unable to communicate with the gateway. The time sensors were deployed negatively affected success rate. At best, the probability of success was 81.8% at day zero and was reduced to 63.8% after 50 days deployed in cattle. The vaginal birthing sensor technology used was not as an effective tool to monitor calving as it should be. A second follow-up study in Northern Territory, Australia, has deployed 197 improved sensors from August 2019 to Dec 2019 in combination with every cow having a LoRaWAN SmartPaddock™ GPS accelerometer collar. Using successful alerts, we will model if calving can be predicted from cattle movement, thus alleviating the need of birthing sensors. If successful, the relatively cheap LoRaWAN communication combined with GPS may be a system to allow remote monitoring of calving events for both research on calf loss and for farm practices.



Poster Session Tuesday 1: Poster Pod 28, Poster 2

BIOMASS ESTIMATION USING UNMANNED AERIAL VEHICLES TECHNOLOGY

Alexandria M. DiMaggio^{*1}, Humberto L. Perotto², Alfonso Ortega¹, Chase H. Walther³, Karelys N. Labrador-Rodriguez³, Sandra Rideout-Hanzak⁴, David B. Wester⁴; ¹Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ²Texas A&M University - Kingsville, Kingsville, TX, ³Texas A&M University-Kingsville, Kingsville, TX, ⁴Texas A&M University Kingsville, Kingsville, TX

ABSTRACT: MS STUDENT

The application of Unmanned Aerial Vehicles (UAVs) in the monitoring and management of rangelands has exponentially increased in recent years due to the miniaturization of sensors, pictures with high spatial resolution, lower altitude platforms, and the ease of flying UAVs in remote environments. Lengthening the radius of usable area and improving the stability, control, and camera quality of the UAV gives the potential for a more precise, but less troublesome field sampling method. The application of UAVs could be used to provide a more exact estimate the vegetation biomass that can be incorporated into management decisions. The methods of field data collection widely used for decades to estimate aboveground biomass do not account for the real-life variability that commonly occur in rangelands. The aim of this research is to estimate vegetation biomass in rangelands using high-resolution imagery derived from the UAV. The specific objectives are (1) to evaluate the feasibility of quantifying biomass in semi-arid rangelands with high-resolution imagery and (2) determine altitude for optimal pixel resolution of UAV imagery. Imagery at very high resolution (<5 cm) resolution will be acquired by flying an UAV at altitudes of 30, 40, and 50 meters above ground level. Study sites are located in Kleberg, Duval, and Jim Hogg County; thus, giving three significantly different topographic sites and land management practices. The imagery will produce 3D models of the study sites to estimate volumes for the vegetation. Biomass data collected in the field is used to calibrate and assess accuracy the 3D biomass production model derived from exceptionally high-resolution imagery at each level of altitude.



Poster Session Tuesday 1: Poster Pod 28, Poster 3

A TEST OF LORA WAN REAL-TIME GPS TRACKING ON BEEF CATTLE IN DESERT PASTURES

Matthew M. McIntosh^{*1}, Andres F. Cibils¹, Shelemia Nyamuryekunge¹, Richard E. Estell², Andrew Cox¹, Adrienne Dawes¹, Tony Waterhouse³, John Holland³; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS-Jornada Experimental Range, Las Cruces, NM, ³Scotlands Rural College, Crainlarich, Scotland

ABSTRACT: Ph. D STUDENT

Monitoring livestock behavior in real time using GPS, movement sensors, and data-mining algorithms has potential to help improve animal wellbeing and livestock production on western ranches. We sought to evaluate GPS fix rate (10-min intervals; expecting 144 fixes*d-1) of LoRa WAN-enabled GPS devices housed in water-tight PelicanTM cases fixed to WeaverTM nylon cattle collars or fixed to the top of a nylon cattle halter. We tested two AbeewayTM industrial tracker devices for 13 d (Trial 1 [T1]: 4/18– 4/30, 2019) in a 2.4 ha planted triticale pasture at the New Mexico State University (NMSU) campus farm and for 13d and 15d, respectively (Trial 2 [T2]: 6/29 – 7/7, 2019; Trial 3 [T3] 8/27 – 9/10) at the NMSU Chihuahuan Desert Rangeland Research Center (largest pasture >1475 ha). We used a KerlinkTM LoRa antenna and gateway (with an expected 10 km reach) to receive and route GPS data from the trackers to the cloud. We were able to configure trackers, visualize GPS data on a map, and download GPS points using an online application developed by AbeewayTM and ActilityTM. In T1 (planted pasture), the industrial tracker devices recorded 93% ± 1% of the expected fixes whereas in T2 (rangeland pasture) trackers recorded 57% ± 4% of expected fixes. In T3 (rangeland pasture) trackers recorded 77% ± 5% of expected fixes and no GPS fix rate differences were found between the collar vs halter design ($P > 0.40$). Differences in GPS fix rates among trials are possibly related to GPS battery and antenna location which was approximately 100 m away from the farm pasture (T1) and up to 5 -7 km away from the farthest points in our rangeland pastures (T2, T3). Our preliminary results suggest that LoRa-enabled GPS tracking is a promising technology for development of precision grazing tools for western rangelands.



Poster Session Tuesday 1: Poster Pod 28, Poster 4

GPS VS ACCELEROMETERS: THE BATTLE BETWEEN TECHNOLOGY TO MONITOR CATTLE BEHAVIOR AND WELFARE

Colin T. Tobin*, Derek W. Bailey; New Mexico State University, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

Monitoring livestock in a rangeland setting can be an arduous task and may not be observed on daily basis. The increased ability to monitor livestock behavior remotely gives managers the ability to reduce labor costs while having the ability to improve animal welfare. In an arid or semi-arid rangeland, failure of livestock water delivery systems is a very critical issue. Real and near-real time devices are becoming available, such as HerdDogg (near-time accelerometer-based) and Moovement (real time GPS) that can remotely monitor livestock behavior. The objective of this study was to evaluate efficacy of GPS tracking and accelerometer sensing for detecting a water delivery failure, a major animal welfare concern. During 2018 and 2019, eight and nine, respectively, Corriente cows were fitted with GPS tracking collars and accelerometers during the summer in a 1090 ha pasture at the Deep Well Ranch near Prescott, Arizona. Cattle were tracked at 2-minute intervals and movements were recorded at a frequency of 12 Hz by ear tag accelerometers. Cattle behavior was visually observed and recorded with video. Activity was predicted using random forest procedures. Movement rate was the most important variable for predicting behavior followed by side to side and fore and aft accelerometer movements. Variation of accelerometer metrics and other combinations of metrics may also be effective. Simulated water delivery failure was evaluated on 5 occasions in June 2018 and July 2019. Panels were used to keep cattle away from the water drinker for 4 hours at mid-day. Cattle remained near the water tank and displayed aggressive behavior during the period when water was not available. Preliminary analyses suggest that simulated water failure may be more accurately predicted by remotely collected data from GPS tracking collars rather than by accelerometers.



Poster Session Tuesday 1: Poster Pod 28, Poster 5

CHARACTERIZING CATTLE BEHAVIOR IN THE RUGGED RANGELAND OF SOUTHEASTERN OREGON USING LOW-COST GPS COLLARS

Angela N. Malliaras*; Boise State University, Boise, ID

ABSTRACT: UNDERGRADUATE STUDENT

Our understanding cattle terrain use in the rugged high desert of southeastern Oregon is limited. Characterizing cattle behavior, using low-cost GPS collars, provides an insight into grazing distribution on public rangelands. Across the west, grazing is usually permitted on these lands to promote functionally healthy landscapes and mitigate risk of large-scale wildfires. The high desert exhibits rough terrain and it is important to learn cattle behavior across this landscape so land managers can make more informed rangeland management decisions. The objective of this study was to characterize individual cow behavior on rugged high desert rangelands in southeastern Oregon using the low cost igotU GT-120 GPS device. Data were collected from 20 GPS collared cows over a 30-day period, 10 cows from spring and 10 cows from winter from separate pastures, using a 10-minute interval. We characterize individual cow behavior related to slope, elevation, distance traveled, and vertical and horizontal distance to water. Individual cow differences demonstrate different cattle terrain use across adjacent pastures. We also captured 360-degree images inside the pastures to provide visual understanding of the terrain use beyond satellite images to understand terrain use more clearly. Characterizing differences and trends between individuals provides a better understanding of variations in cattle movement, which can lead to more informed management decisions on rangelands.



Poster Session Tuesday 1: Poster Pod 28, Poster 6

CORRECTION ALGORITHM TO REDUCE BIAS IN DAILY TRAVEL DISTANCE ESTIMATED FROM GPS COLLARS

Jameson R. Brennan*, Patricia S. Johnson, Kenneth C. Olson; South Dakota State University, Rapid City, SD

ABSTRACT

Numerous studies have demonstrated the utility of GPS technology to study movement patterns of free-ranging livestock. Among the most common metrics derived from GPS collar data are estimates of daily travel distance (DTD) for collared animals. Sampling error associated with GPS technology is a source of concern for researchers estimating DTD. A significant portion of livestock daily behavior consists of non-movement activities, such as resting or ruminating, which have an additive effect on distance error over time. Additionally, as GPS technology and battery life improve, researchers are able to sample livestock locations at increasing frequency, which may further increase DTD measurement error. Although distance errors as a result of GPS collar data have been acknowledged, no research has been conducted to correct this problem. To address this, a study was conducted in 2016-2018 at the Cottonwood Research Facility in southwestern South Dakota using a non-commercial GPS collar outfitted with an accelerometer to predict livestock behavior. GPS devices were set to record fixes at 1-minute intervals. An algorithm was developed to identify large GPS point clusters associated with specific periods of resting behavior (e.g. overnight sleeping periods). To correct for DTD GPS error, latitude and longitude values of point cluster periods were averaged, and average coordinate values assigned to all points within a cluster, reducing distance between resting points to zero. For each GPS collar, DTD was calculated before and after the correction algorithm was applied to test for differences. Results from the study indicate that, at 1-minute GPS fix intervals, DTD may be overestimated by 2-3 km per day. By utilizing the distance correction algorithm, researchers will be able to reduce sampling bias and get a more precise measurement of livestock DTD, resulting in improved estimates of energy expenditure and travel distances associated with treatment effects.



Poster Session Tuesday 1: Poster Pod 29, Poster 7

THE RANGELANDS PARTNERSHIP: YOUR SOURCE FOR RELIABLE SCIENCE-BASED INFORMATION ON RANGELAND ECOLOGY & MANAGEMENT

Amber Dalke*, Barbara Hutchinson, Sheila Merrigan, Sarah Noelle, Jeanne Pfander; University of Arizona, Tucson, AZ

ABSTRACT

The Rangelands Partnership (RP) is a collective effort by rangeland specialists, IT experts, and academic librarians from 19 U.S. land-grant universities working to bring together resources and expertise needed to inform public debate and decision-making regarding today's grand challenges of food security, climate adaptation, public health, environmental impacts, and economic development as they relate to rangelands around the world. Through numerous projects and initiatives, the RP has been developing the *Rangelands Gateway* website, which features a database of rangelands resources and tools and offers 11 collections of rangeland content. These collections include full-text resources from professional societies such as the Society for Range Management, Grassland Society of Southern Africa, The Land Portal, and the Australian Rangelands Society as well as carefully selected best of the best materials. Topics address a wide variety of rangeland issues and content is available in many formats including journal articles, images, videos, podcasts, maps, reports, and educational tools. In addition, the RP is involved with other rangelands groups from around the world to gain support for a United Nations designated International Year of Rangelands and Pastoralists (IYRP), coordinating numerous meetings and events as well as working with IYRP initiative members to gain support from their governments. Members of the Partnership are also actively involved in projects dealing with research, outreach and forging collaborations. The Partnership is committed to facilitating sustainable management of rangelands, informed decision-making, professional enhancement, and education for a wide audience of rangeland stakeholders. Visit *Rangelands Gateway* and learn more!



Poster Session Tuesday 1: Poster Pod 29, Poster 8

OPTIMIZATION OF MULTI-MODEL ENSEMBLE SEASONAL FORECASTS FOR RANGELAND MANAGEMENT APPLICATIONS IN THE WESTERN UNITED STATES

Merilynn Schantz^{*1}, Stuart P. Hardegree², Roger Sheley³, John T. Abatzoglou⁴, Katherine C. Hegewisch⁴, ¹Red Rock Resources LLC, Miles City, MT, ²USDA-ARS, Boise, ID, ³USDA-Agricultural Research Service, Burns, OR, ⁴University of Idaho, Moscow, ID

ABSTRACT

Skillful seasonal climate forecasts could improve the cost-effectiveness of rangeland management practices for both land management agencies and private-land owners across the western US. Previous problems with the adaptation of forecasting tools to rangeland management applications include difficulty in accessing forecast information at the spatial and temporal scale useful for management, and lack of tools to assess the usefulness, dependability and effectiveness of forecast information. Previous studies of forecast utility have also shown relatively low forecasting skill over much of the western US. In this study we evaluated the potential utility of statistically downscaled and spatially-disaggregated estimates of monthly precipitation and temperature for site-specific management applications in the Desert Southwest, California Annual Grassland, Great Plains, and Great Basin. For this, we used 7 component models of the North American Multimodel Ensemble (NMME) forecast, that were disaggregated to provide monthly estimates of total precipitation and average temperature on a 4-km grid, with lead times of 1-7 months, for every month of the period 1982-2016. Unlike previous studies that have evaluated forecasting skill of both individual and full-ensemble models, we are using rank correlation tests to evaluate individual, full-ensemble, and all combinations (127) of multi-model ensemble predictions. Our general objective was to evaluate the potential utility of monthly and seasonal forecasts for specific regional management applications and to provide general guidance for a preliminary forecast-skill assessment. We found that that sub-ensemble multi-model forecasts were generally more skillful than either single-model forecasts or the full multi-model ensemble; general forecasting skill was better in the DS than any of the other ecoregions; optimal seasonal forecasts were application-specific for a given location; and confirmed that forecast skill for individual locations and applications was better for temperature than precipitation. Lead time did not generally affect optimal-forecast skill for either temperature or precipitation.



Poster Session Tuesday 1: Poster Pod 29, Poster 9

SAGEDAT: DATA AND TOOLS TO SUPPORT COLLABORATIVE SAGEBRUSH ECOSYSTEM CONSERVATION AND MANAGEMENT

Steven E. Hanser^{*1}, John L. Long², Paul Steblein¹, Lief Wiechman³, Karen Prentice⁴, Ken Mayer⁵, John Tull⁶, Michael Houts⁷; ¹U.S. Geological Survey, Reston, VA, ²U.S. Geological Survey, Ft. Collins, CO, ³U.S. Fish and Wildlife Service, Ft. Collins, CO, ⁴Bureau of Land Management, Washington, DC, ⁵Western Association of Fish and Wildlife Agencies, Reno, NV, ⁶U.S. Fish and Wildlife Service, Reno, NV, ⁷Western Association of Fish and Wildlife Agencies, Lawrence, KS

ABSTRACT

Collaborative and science-informed management has been at the heart of the large-scale efforts to conserve the sagebrush ecosystem for greater sage-grouse and over 350 other species that rely on the sagebrush ecosystem. The development and use of geospatial data and decision support tools to inform management of rangeland fire, restoration of sagebrush habitats, and conservation of sage-grouse has resulted in exciting new opportunities, but the volume of data and tools has resulted in challenges for providers and users of this information. SageDAT is a web-based system that uses the latest technology to reduce barriers to data sharing and increase access to information through the development of a multi-agency data catalog. For data providers, this effort will increase communication and coordination on data management and provide tools to help protect sensitive/proprietary locations and information, which can alleviate past impediments to participation in previous large-scale planning efforts. For users, SageDAT will provide access to a comprehensive list of datasets and decision support tools via a web interface and improve mechanisms for increased communications and cooperation between federal, state, and local agencies, tribes, non-governmental organizations, universities, and industry across 11 western States to enhance long-term stewardship of the sagebrush ecosystem.



Poster Session Tuesday 1: Poster Pod 29, Poster 10

RESULTS OF STUDYING THE NORMS OF SEEDING SORGO "ORANGE 160" AFTER GROWING RYE (SECALE CEREALE)

Shodier K. Sindarov, Eldorbek U. Mirzayev*, Erach F. Mamedov; Research institute karakul sheep breeding and ecology desert, Samarkand, Uzbekistan

ABSTRACT

E-mail: uzkarakul30@mail.ru

Deserts and foothills regions that occupy half of the country's territory have an important place in the development of the astrakhan sector. The lack of attention to this sector in recent years and the degradation of pastures have a significant impact on the development of the industry. Sustainable use of this area requires the efficient and effective use of available water resources. The only way to solve this problem is to effectively use the available water resources of artesian wells existing in the desert. Taking this into account, the staff of the Research Institute of Karakul sheep breeding and Ecology of Deserts conducted a series of field experiments on the irrigated plots of this area for the first time and studied the peculiarities of the cultivation of sort "Oranjevoe 160" sorghum in the irrigated area of the Konimekh district of the Navoi region after the main crop of rye. Sorghum seeds were sown at a rate of 10, 15, 20 kg. Seeds were sown on June 7 and immediately irrigated. Seeds germinate about 5-6 days. Full shoots were obtained in 13-14 days. The highest yield was obtained at a seeding rate of 20 kg / ha. In this variant, the first yield was $32.3 + 0.55$ t / ha, and the second yield was $30.6 + 0.56$ t / ha, for a total of two mowing, the yield was 62.9 t / ha of green mass. In the variant with a seeding rate of 15 kg / ha, the yield was lower by 14.7 t / ha, and when sown with a seed rate of 10 kg / ha, the yield was 23.3 t / ha of green mass less than the variant with a seeding rate of 20 kg / ha . Summing up, it should be noted that a good result can be obtained from a sowing variant of 20 kg / ha of sort "Oranjevoe 160" sorghum from a sown area that was used during the year.



Poster Session Tuesday 1: Poster Pod 29, Poster 11

INDICATORS OF GROWTH, DEVELOPMENT AND PRODUCTIVITY OF TRITICALE CULTURE BY WATERING IN THE DESERT KYZYLKUM

Shodier K. Sindarov, Orzu K. Mamedov*; Research institute karakul sheep breeding and ecology desert, Samarkand, Uzbekistan, Sindarov Sh., Mamedov O., Sindarov K.

ABSTRACT: UNDERGRADUATE STUDENT

Research Institute of Karakul sheep breeding and Ecology of Deserts, Uzbekistan, Samarkand,
E-mail: uzkarakul30@mail.ru

The Kyzyl Kum desert and adjacent areas occupy more than half of the total area of the country and play an important role in animal husbandry, especially in areas where Karakul sheep are raised. However, the annual increase in pasture degradation in these areas due to inefficient use of pasture has a negative effect on livestock production. The only way to solve this problem is to effectively use the available water resources of artesian wells existing in the desert. Taking this into account, for the first time, the staff of the Research Institute of Astrakhan and Desert Ecology conducted a series of field experiments in the irrigated areas of this area for growing intermediate crops. Intermediate cultures are primarily an important source of feed. They make it possible to significantly increase the utilization of arable land in crop rotations of intensive farming. In desert conditions, the best precursors for triticale will be maize and perennial grasses. Phosphorus and potassium are introduced before sowing. Nitrogen - during the growing season. The first dose of nitrogen-containing fertilizers should be no more than 60-70 kg / ha. Carry it out before tillering. The second is carried out in the period of release into the tube. At the same time, it is desirable to introduce foliar fertilizing with micronutrient fertilizers. In the experiment on the cultivation of triticale as an intermediate crop, the indicators of growth, development and productivity of the variety "Prag serebristy" were studied. Triticale seeds were planted on October 22. Plant density was 1640.0 ± 30.2 thousand units per hectare and in spring decreased to 147.0 thousand units. The height of the plants before the cutting was 60.77 ± 0.99 cm, and the number of shoots was 4.03 ± 0.30 pieces. Triticale formed a yield of 29.6 ± 0.95 t / ha of green, 6.3 ± 0.2 t / ha of dry feed, and 2.1 ± 0.1 t / ha of grain. **Conclusion.** In the Kyzylkum desert, you can grow Triticale in the irrigated areas of this region, using self-pouring wells and get high yields of forage and grain.



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Poster Session Tuesday 1: Poster Pod 30, Poster 13

EVALUATING MESQUITE DISTRIBUTION USING UAVS AND OTHER GEOSPATIAL METHODOLOGIES

Michael T. Page*¹, Victoria Cavazos¹, Hunter Carroll¹, Kiri Baca², Waylon D. Daniels³, Humberto L. Perotto⁴; ¹Texas A&M University-Kingsville, Kingsville, TX, ²New Mexico State University, Las Cruces, NM, ³Central National Technology Support Center NRCS, Fort Worth, TX, ⁴Texas A&M University - Kingsville, Kingsville, TX

ABSTRACT: MS STUDENT

Recent advancements in technology such as UAVs have opened new opportunities for Natural Resource personnel to better quantify features within the landscape. Encroachment of invasive plant species on rangelands is of critical concern and Honey Mesquite (*Prosopis glandulosa*) is one of the most invasive species in Texas and the southwest. The first phase, step 1, of a multiyear study included collection of additional imagery and field data for comparisons with the Sentinel and LiDAR data analysis products. Different methodologies were used to evaluate mesquite extent on a ranch in Hood County, TX. The methods used in this project included: on-site data and tree height measurements, LiDAR elevation Data, Sentinel 2 Satellite Imagery, and Unmanned Aerial Vehicle (UAV) imagery. A DJI Phantom IV paired with Pix4D® software was used to collect the UAV images. Drone2Map for ArcGIS® was used to process the images to create 2D and 3D outputs and used Esri ArcPro® 2.3.3 to evaluate and perform analyses for mesquite distribution. Thresholds of spectral values from RGB bands of Satellite Imagery were identified and then reclassified into a preliminary extent of mesquite tree occurrence. This was filtered through the plant height derived from the LiDAR first return data. This procedure was replicated with UAV RGB imagery paired with created LAS data that were used for evaluating mesquite extent within the landscape. Due to the variety of color values in the higher resolution UAV imagery, an attempt was made using zonal statistics to determine the thresholds of RGB values identifying the presence of mesquite trees. This process is still under development. Initial results suggest good agreement between on-site field measurement plant height values and UAV plant height that was interactively measured with the Esri ArcPro® 2.3.3 software vertical measurement tool.



Poster Session Tuesday 1: Poster Pod 30, Poster 14

MORPHOLOGICAL ONTOGENESIS STRUCTURE (LYCIUM BARBARUM L.) IN THE CONDITIONS OF SAMARKAND REGION

Khislat K. Khaydarov, Nodira S. Nurullaeva*; Samarkand state university, Samarkand, Uzbekistan

ABSTRACT: Ph. D STUDENT

Introduction. The effective use of plant materials for food, pharmacy and medicine in order to improve the welfare of the population is a very urgent problem. *Lycium barbarum* L. is a perennial deciduous branched shrub 1–2.5 m tall of the family Solanaceae. *Lycium barbarum* berries are widely used in traditional medicine in a number of countries (China, USA, Argentina, etc.) as an immunomodulator. The study of *Lycium barbarum* is of scientific and practical interest for expanding the range of herbal remedies. Therefore, it is important to study the biomorphology and reproduction of this species. **Material and research methods.** Plants were sown in 2018 from seeds. A study of the growth and development of *L. barbarum* L. was carried out according to the methodology for herbaceous plants. **Research results.** Studied the individual development of *L. barbarum* L., which can be divided into the following periods:

1. The latent period. This period of *L. barbarum* L. is determined by the formation of egg cells in the seeds and physiological processes in them. Seeds of *L. barbarum* L. in the form of a kidney, 2-2.5 mm long and 1-1.2 mm wide. The outer coating is covered with a dark brown or lowered coating. The average weight of 1000 seeds is 1.1-1.2 g.
2. Plant developmental period
This period of *L. barbarum* L. includes the time interval from which the seed develops to the first flower. It was determined that the virgin phase lasts 2-3 years. During this growing season, the following stages of development can be distinguished: lawn, juvenile, immature (young shoots), formed vegetative plants.
3. Stage of seedling. Germination of seeds of *Lycium barbarum* begins with the appearance of the main root, the young stem extends and grows into the interior of the soil. When this root reaches a depth of 0.4-0.6 cm, leaves appear. The aim of the work was to study the individual development of *Lycium barbarum* in a culture. Ontogenesis of this plant in Uzbekistan has not been studied. Thus, the study of the ontogenesis of the plant *L. barbarum* L. is of theoretical and practical importance.



Poster Session Tuesday 1: Poster Pod 30, Poster 15

RESULTS OF STUDYING THE DEVELOPMENT AND EFFICIENCY OF THE SECALE CEREALE IN KIZILKUM DESERT

Erach F. Mamedov*, Shodier K. Sindarov; Research institute karakul sheep breeding and ecology desert, Samarkand, Uzbekistan, Mamedov E., Sindarov Sh., Sindarov K.

ABSTRACT

*Research Institute of Karakul sheep breeding and Ecology of Deserts, Uzbekistan, Samarkand,
E-mail: uzkarakul30@mail.ru*

Karakul sheep is mainly concentrated in the Kyzyl Kum desert. Due to the drought in the last 4-5 years, the maintenance of animals on pastures was difficult, they had to be additionally fed. There are many artesian wells in this desert region that can be used efficiently and effectively. Taking this into account, the staff of the Research Institute of Karakul sheep breeding and Ecology of Deserts, for the first time conducted a series of field experiments on irrigated plots of the area and studied the features of cultivation, development and productivity of non-traditional rye plants (*Secale cereale*) in the region. Seeds of rye were sown in experiments in October. Due to the lack of moisture in the soil per hectare, irrigation was carried out at a rate of 700 m³ of water per hectare. Seeds germinated on the 5-6 day, full shoots marked on the 13-14 day. The number of plants is 1120.0 ± 45.51 thousand units/ha. In order to study the viability of this crop in the KyzylKum desert, it was noted that in January of this year the number of plants decreased by 88.0 thousand units or by 7.86%, and in spring - by 149.0 thousand units or by 13.35%. During the growing season, it was noted that the rye plant loses 217.0 thousand individuals per hectare, or 19.5% of the total. The growth of plants before cutting was 90.18 ± 2.77 cm, and the number of shoots was 3.66 ± 0.22 thousand per hectare. The yield of this crop was 25.4 ± 1.4 t / ha of green or 5.6 ± 0.32 t / ha of dry food. When irrigating in an Kyzylkum desert environment, an unconventional plant like rye (*Secale cereale*) can produce high yields of forage and grain.



Poster Session Tuesday 1: Poster Pod 30, Poster 16

A RAPID ASSESSMENT OF DROUGHT INDUCED FORAGE REDUCTIONS TO AID REHABILITATION

Matt C. Reeves*¹, Iric B. Burden²; ¹USDA Forest Service, Florence, MT, ²USDA, Forest Service, Williams, AZ

ABSTRACT

In March, 2019 Ag. Department Secretary Sonny Purdue designated four Arizona counties as primary natural disaster areas due to the persistent drought conditions. Subsequently, on 7 May, 2019, the USDA Natural Resources Conservation Service (NRCS) announced the availability of financial and technical assistance for producers in the designated counties to aid recovery from the impacts of drought. Traditional assessment of the most affected lands to determine which producers and what areas might be eligible for assistance is costly, time consuming and covers only a fraction of the affected area. Under normal circumstances quantifying the amount of lost forage and identifying the most affected areas would require weeks to months' worth of assessment including costly ground reconnaissance such as conducting vegetation sampling along transects across numerous Ecological Sites to evaluate production relative to a long-term baseline. However, given the rapid increase in remote sensing tools and datasets (e.g. Rangeland Production Monitoring Service; RPMS) scientists and managers sought to develop a more rapid and precise process to increase the area evaluated and speed up the overall drought assessment and mitigation process. In this vein, the USDA NRCS and Forest Service developed the Northeastern Arizona Drought Responsive Seeding Strategy which aids evaluation of eligibility to provide financial assistance to agricultural producers to aerial seed rangeland areas within the designated boundaries. This is an inaugural effort by the NRCS and USFS to work together to rapidly quantify the impact of drought on vegetation production across large areas to inform a reseeding strategy for affected areas.



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Poster Session Tuesday 1: Poster Pod 31, Poster 19

EFFECTS OF FIRE INTENSITY ON RESPROUTING VIGOR OF MESQUITE (*PROSOPIS GLANDULOSA*)

Heath D. Starns*¹, Carissa L. Wonkka², Alexandra G. Lodge³, Dirac Twidwell⁴, Morgan L. Russell-Treadwell⁵, Kathleen L. Kavanagh⁶, Matthew B. Dickinson⁷, Douglas R. Tolleson¹, William Rogers³; ¹Texas A&M University, Sonora, TX, ²University of Nebraska, Lincoln, NE, ³Texas A&M University, College Station, TX, ⁴University of Nebraska, Institute of Agriculture and Natural Resources, Lincoln, NE, ⁵Texas A&M AgriLife Extension Service, San Angelo, TX, ⁶Oregon State University, Corvallis, OR, ⁷U.S. Forest Service, Delaware, OH

ABSTRACT

Woody plant encroachment has occurred across millions of hectares of rangelands in the southern Great Plains since the start of the 19th century. While fire suppression has been cited as a major cause, reintroduction of fire has often been ineffective at reversing woody encroachment due to the resprouting capability of many species. Initial resprouting vigor is linked to overall survival of such species, including honey mesquite (*Prosopis glandulosa*). Recent studies have indicated that high-intensity fires are more effective at reducing survival of resprouters. We evaluated effects of fire intensity, soil moisture, root collar exposure and weather factors on the ability of honey mesquite to resprout following fire in central Texas semi-arid savanna. Fire intensity was the only significant predictor of number of resprouts, with low-intensity treatments having more resprouts by a factor of 30.39. Fire intensity also significantly predicted resprouting occurrence. Low-intensity fires treatments were more likely to resprout the next growing season by a factor of 46.65. Our results support previous works that suggest high-intensity fires can reduce survival of resprouting woody plants.



Poster Session Tuesday 1: Poster Pod 31, Poster 20

EVALUATING GRAZING EFFECTS ON PONDEROSA PINE HABITAT TYPES FOLLOWING A LARGE SUMMER WILDFIRE

Amanda R. Williams*¹, Lance T. Vermeire², Richard C. Waterman², Clayton Marlow³;
¹Montana State University, Miles City, MT, ²USDA-ARS, Miles City, MT, ³Montana State University, Bozeman, MT

ABSTRACT: MS STUDENT

The Lodgepole Complex fire burned 109,346 ha in east-central Montana in July 2017, and re-burned areas burned in 2003 by the Bureau of Land Management for fuels mitigation. Previous research indicated areas need rest before allowing livestock grazing, while others show that grazing the first year following fire has no negative effects on the plant community. Our objectives are to 1) determine plant community response to grazing or rest the first growing season after fire in ponderosa pine grassland communities, 2) determine how timing of defoliation during the first growing season after fire affects the plant community, and 3) learn if prescribed fire before wildfire alters plant community response to wildfire. Exclosures were built, 4 on re-burn (Rx) area and 4 on wildfire (Wild) area. To determine seasonal defoliation effects, 5x10-m plots were mowed in the exclosure to 10 cm in June, July, or August, or not mowed. A non-grazed section in the exclosure was paired with a grazed section outside the exclosure. Biomass samples were clipped at peak production, and species composition and diversity were measured with point-intercept transects in 2019. The only difference between grazed and non-grazed (NG) sites in 2019 was greater shrub production on NG sites than grazed or RX NG sites ($P=0.0469$). On mowed sites, cool-season perennial grass standing crop was greater on control than June and August mowed sites ($P=0.0366$), there were more annual grasses on control than June mowed sites ($P=0.0462$), and more total standing crop on control sites than the three mowing treatments ($P=0.0241$). Most of the difference in standing crop was due to previous years' standing dead. Results show that this community is resilient to post-fire defoliation and that although prescribed fire 16 years before wildfire altered fire behavior, it had little to no impact on the herbaceous community.



Poster Session Tuesday 1: Poster Pod 31, Poster 21

PRESCRIBED FALL FIRES DECREASE ANNUAL BROME AND SAGEBRUSH ABUNDANCE IN THE THUNDER BASIN ECOREGION IN NORTHEASTERN WYOMING

Catherine E. Estep^{*1}, J. Derek Scasta¹, Lauren M. Porensky², Jacqueline P. Ott³, Troy W. Ocheltree⁴, Amy J. Symstad⁵, Caleb Grey¹, Brian E. Dickerson⁶, Jim Reardon⁷; ¹University of Wyoming, Laramie, WY, ²USDA-ARS, Fort Collins, CO, ³South Dakota State University/USFS- Rocky Mountain Research Station, Rapid City, SD, ⁴Colorado State University, Fort Collins, CO, ⁵U.S. Geological Survey, Hot Springs, SD, ⁶USFS- Rocky Mountain Research Station, Rapid City, SD, ⁷USFS-RMRS Fire Science Laboratory, Missoula, MT

ABSTRACT: MS STUDENT

In the Thunder Basin Ecoregion of northeast Wyoming, fire is a natural disturbance to which native grasses and forbs are adapted. There is strong evidence that fires promote a positive feedback-loop enhancing annual brome invasion in the Great Basin. One recent study found that historical wildfires did not promote annual brome in the Thunder Basin Ecoregion, but these historical wildfires did eliminate sagebrush from the burned areas for many decades. My research supplements this study by investigating effects of fall prescribed burns on annual brome (*Bromus tectorum* and *B. arvensis*) and Wyoming Big Sagebrush (*Artemisia tridentata*) in the Thunder Basin Ecoregion. Prescribed fires typically have lower wind speeds, higher relative humidity, higher soil moisture, and lower temperatures than wildfires. We hypothesized that if burn severity and intensity were high enough, prescribed fall fires would reduce annual brome abundance without completely eliminating sagebrush from the sites. In October 2018, we burned a 2x4m plot at 16 sites selected to represent a gradient of annual brome cover, which ranged from 0-45% across sites. In the first year following fire, fall burns reduced brome cover by 59% (p-value=0.0008) relative to unburned plots. Fall prescribed burns also dramatically reduced sagebrush densities. Prescribed fall burns may represent a proactive approach to reducing annual brome abundance in northeastern Wyoming, but tradeoffs exist between management goals for brome and sagebrush. Further investigation using spring prescribed fire, which could have lower fire intensities than fall prescribed fire, will provide additional information for managers working to maintain quality forage for livestock and wildlife and habitat for the Greater Sage-Grouse.



Poster Session Tuesday 1: Poster Pod 31, Poster 22

ESTABLISHING FUEL BREAKS TO PROTECT SAGE-GROUSE HABITAT IN NW UTAH

William J. Price*¹, Rayce Bryan²; ¹University of Idaho, Boise, ID, ²Utah State University, Logan, UT

ABSTRACT: MS STUDENT

Frequent wildfires in the Great Basin have caused significant shifts in species composition. These frequent fires are driven by invasive annual grasses, particularly cheatgrass (*Bromus tectorum*). The annual grass fueled fires can permanently alter critical habitat for sage-grouse. Recently the Bureau of Land Management and Utah's Watershed Restoration Initiative have implemented fuel breaks to help defend critical sage-grouse habitat. In an effort to reduce the impact of wildfire on critical sage-grouse habitat in Box Elder County, UT, fuel breaks were put in two locations. A 19-mile fuel break at Badger Flat in 2010 and 13 miles at Dry Basin in 2016. Both fuel breaks were created using a chain-harrow followed with a treatment of Plateau herbicide, then seeded with a seed mix. Badger Flat received a second application of seed in 2016 as well. We assessed functional group frequency in in the late-summer of 2017, 2018, and 2019. Both sites average 200mm – 250 mm precipitation annually, with the majority coming as snowfall and spring rain. A lower frequency of cheatgrass was observed in the treatment compared to the control in 2017 (46% versus 20% at Badger Flat and 60% versus 25% at Dry Basin). But in subsequent years there has not been a difference between the treatment and control. There has not been a discernable difference in native perennial grass frequency from 2017-2019. Introduced perennial grasses were not seeded at Dry Basin, but at Badger Flat there was no difference between the treatment and control in 2018 and 2019 despite a difference of 17% in 2017 (25% in the treatment and 8% in the control). Despite the initial success of both fuel breaks, it is necessary to consider their ability to resist reinvasion by invasive annual grasses. Otherwise we may see these fuel breaks become to fuel runways.



Poster Session Tuesday 1: Poster Pod 31, Poster 23

SILVER SAGEBRUSH FIRE RESPONSE

Marcus A. Comfort*; University of Saskatchewan, Saskatoon, Canada

ABSTRACT: UNDERGRADUATE STUDENT

Artemisia cana (Silver Sagebrush) is a low shrub species common in northern mixed grass prairies that provides important wildlife habitat. Sagebrush habitat has historically experienced frequent wildfires, but post-settlement fire control efforts have reduced fire frequencies. The effects of fire on Silver Sagebrush growth and regeneration are not clearly understood; here we examine the effects fire on Sagebrush regeneration using two years of post-fire plant size and distribution data. Sites were in the northern mixed prairie in Saskatchewan, Canada, and included pastures where the plant community was recovering following both prescribed fires and an intense wildfire. *Artemisia cana* responded to fire by rapidly producing new shoots via rhizomes, with some plants also regenerating from the crown. Larger plants and dense stands of Silver Sagebrush appear to regenerate more successfully than lone plants. No seedlings were observed. Our results demonstrate that Sagebrush recovery is primarily vegetative, with clone mortality rare.



Poster Session Tuesday 1: Poster Pod 31, Poster 24

ECOLOGICAL AND ECONOMIC IMPACT OF PATCH-BURN GRAZING IN SUBTROPICAL HUMID GRASSLANDS

Elizabeth H. Boughton^{*1}, Nuria Gomez-Casanovas², Raoul Boughton³, Britt Smith¹, Carl Bernacchi⁴, Jed Sparks⁵, Evan Delucia², Hilary M. Swain⁶; ¹Archbold Biological Station, Lake Placid, FL, ²University of Illinois, Champaign-Urbana, IL, ³University of Florida, Ona, FL, ⁴USDA, Champaign-Urbana, IL, ⁵Cornell University, Ithaca, NY, ⁶Archbold Biological Station, Venus, FL

ABSTRACT

Subtropical, humid grasslands (SHG) are an important global land-use, and support ~30% of the US beef herd. Research is lacking on how SHG management can be improved to sustain ecosystem services and economic viability. Patch-burn-grazing (PBG) is an innovative tool with multiple benefits in temperate grasslands. Our objective was to determine how PBG affects provisioning and regulating ecosystem services in SHG, including forage production, plant diversity, and greenhouse gas regulation, as well as assess economic impacts.

A randomized block experiment was established in 2017 with 16 pastures (16 ha each) in two different pasture-types (intensively-managed (IM) vs. semi-natural (SN)) at Archbold's Buck Island Ranch, FL, USA. Eight pastures were completely burned ("full-burn grazing": FBG) and eight pastures were partially burned ("patch burn grazing": PBG) under a fire regime of one-third burned annually (2017, 2018, 2019). Economic analysis was based on average calf production in FL, forage productivity, stocking density, calf production, and recent calf \$ values. In 2017, ANPP was greater in burned areas (in FBG and PBG) than unburned areas ($F=4.64$, $p=0.006$). In 2018, ANPP was greater in the PBG patches (both one year since fire and the recently burned patch) compared to the FBG that was one year since fire and the unburned patch in PBG ($F = 4.78$, $p=0.005$). Forage quality was greater in recently burned areas and declined with time since fire in both years. Cattle grazing intensity was greater and more even in recently burned patches compared to unburned patches in PBG. Preliminary analysis indicates that using PBG compared to FBG in SN pastures benefits cattle production by \$19.40/ha. In contrast the same PBG to FBG comparison in IM pasture suggests a loss of -\$46.94/ha. Outcomes will likely change with increased time since fire in FBG pastures.



Poster Session Tuesday 1: Poster Pod 32, Poster 25

THE VISUAL IMPACT OF FIRE SCARS, EFFECT OF FIRE RECOVERY TREATMENTS, AND NEXT STEPS

Sabrina McCue*; Bureau of Land Management, Winnemucca, NV

ABSTRACT

In the past 10 years, the Bureau of Land Management Winnemucca District has experienced roughly 219 fires, totaling roughly 922,072 acres. In response to those fires, the district has applied stabilization and protection actions to control non-native invasive plants and assist revegetation. Remote sensing imagery and the visual appearance of a viewshed indicate a sea of cheatgrass or non-natives are present in a large part of burned areas. This visual impact begs the question, what plant community really occupy these areas? In this case study, the author takes a closer look at several treatment areas throughout the district to find out what is behind the visual impact of fire effected areas, the seeding effort, and what further management action may be required to shift the plant community. Site selection is based on a visually dominant landscape with a fire recovery treatment overlap. Three fire recovery treatment types will be considered; natural recovery, aerial seeding, and drill seeding. Assessment, Inventory, and Monitoring data will be used to reveal the plant community composition found on that landscape within the treatment area, using the associated Ecological Site Description to evaluate the potential plant community. The goal of this exploration is to see what is really on the ground in a burned area that appears to have only non-native vegetation, what result came from the seeding effort, and what can land management do to further promote a desirable plant community?



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SEASON OF BURN EFFECTS ON FORAGE PRODUCTION AND COMPOSITION OF GULF CORDGRASS COMMUNITIES

Jose S. Avila Sanchez^{*1}, Victoria Haynes², Sandra Rideout-Hanzak³, David B. Wester³, Alfonso Ortega⁴, Tyler Campbell⁵; ¹Texas A&M University-Kingsville, Kingsville, TX, ²Powderhorn WMA, Port O'Connor, TX, ³Texas A&M University Kingsville, Kingsville, TX, ⁴Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ⁵East Foundation, San Antonio, TX

ABSTRACT: MS STUDENT

Gulf cordgrass (*Spartina spartinae* [Trin.] Merr. ex Hitchc.) is a productive, warm season, perennial bunchgrass that has potential to provide valuable forage for livestock and wildlife. Mature Gulf cordgrass is often found in almost pure monoculture stands, suppressing other species; leaves and stems are coarse, and low in palatability and nutritive value. Fire removes old growth and rejuvenates aged stands, promoting the production of tender, palatable shoots, and improving overall forage quality. We applied prescribed burning in different seasons (Winter and Summer) at the pasture scale in grassland communities of coastal prairies and marshes dominated by either Gulf cordgrass or seacoast bluestem (*Schizachyrium scoparium* var. *littorale* [Nash] Bickn.). The objective was to determine the optimal season of burning to enhance forage for cattle and habitat for wildlife by rejuvenating stands of Gulf cordgrass. Results of this study show strong positive relationships between plant mortality and peak fire temperature ($p < 0.0001$), and plant mortality and duration of heat over 65°C regardless of season ($p < 0.0001$). Forage production of Gulf cordgrass for approximately 90 days following burning did not differ between four burn treatments ($F_{3,4} = 0.905$, $p = 0.51$), or season of burn ($F_{1,6} = 0.034$, $p = 0.86$). NMDS ordination analyses of biomass composition demonstrated greater fluctuation and movement between functional groups than species density did following burning. Although there was no difference in forage production between seasons, composition of FSC returned to pre-burn conditions more quickly after winter burning than summer burning. Prescribed burning in Gulf cordgrass patches allowed other species to increase in relative abundance and productivity, and enhanced the production of tender new growth, nutrition content and utilization of Gulf cordgrass and adjacent vegetation compared to non-burned treatment plots.



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SPARKS AT THE CAMPFIRE: PARTICIPANT ASPIRATIONS AND MOTIVATIONS TOWARDS FORMING THE WYOMING PRESCRIBED FIRE COUNCIL

Ryan Wilbur*, J. Derek Scasta; University of Wyoming, Laramie, WY

ABSTRACT: Ph. D STUDENT

Fire is a natural global phenomenon that can be strategically prescribed to manage landscape features and functions. However, social tolerance of prescribed fire has hindered its application due to perceived and actual risks associated with such projects. Landowners, nonprofit organizations, local, state, and federal agencies, and the public are creating collaborative institutions such as Prescribed Fire Councils (PFCs) designed to address these societal and individual concerns. Wyoming (WY) has recently formed a PFC (WY-PFC; <https://wyoextension.org/wyprescribedfire/>) making it the 36th council in the United States. In this study, I use semi-structured interviews to understand motivations for why individuals participated in the WY-PFC and what they aspired for the organization to accomplish. Findings demonstrated that interviewee's felt a lack of control over the stories expressed about prescribed fire. The general public's fear of fire was expressed as a major hurdle for the PFC to address if they want to help reestablish prescribed fire to the Wyoming landscape. Participants had a strong passion to enhance outreach efforts about prescribed fire to bolster public understanding and tolerance. Regardless of the hurdles that these participants perceived, they felt that a collaborative effort within the WY-PFC provides an interwoven network of experts and individuals to come together to expand resources and ensure a more concise narrative is told about prescribed fire utility for healthier lands and safer communities in the future.



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EFFECT OF FIRE AND SEASON OF DEFOLIATION ON TOTAL NON-STRUCTURAL CARBOHYDRATES CONCENTRATION AND SURVIVING OF PURPLE THREEAWN (*ARISTIDA PURPUREA*)

Carlos Villalobos*, Leobardo Richarte; Texas Tech University, Lubbock, TX

ABSTRACT

Purple threeawn (*Aristida purpurea*) is a native perennial grass classified as undesirable to cattle production because of its low quality. Fire is one of the management tools that has been used to improve grasslands invaded with purple threeawn. The objective of this study was to characterize the total nonstructural carbohydrates (TNC) dynamics of purple threeawn throughout the growing season and their response to clipping and fire treatments during three phenological stages. This research was conducted at the Texas Tech University Native Rangeland in Lubbock, TX. During the 2010 growing season, 90 purple threeawn plants were randomly selected regarding plant size and treated with clipping and burning. Treatments were applied to 30 plants during each phenological stage. Phenological stages were vegetative, reproductive and post-reproductive. Ten plants were clipped at each stage; ten were burned and ten more were used as control plants. Clipping treatments simulated 90% utilization while the burning treatment consisted on prescribed fire applied to plants individually. Samples were collected from basal crowns 30 and 45 days after treatments. TNC concentration measurements were performed on basal crowns using the acid hydrolysis process, then TNC concentrations were measured spectrophotometrically at 612 nm. TNC concentrations of control plants showed a constant increase from the first sampled collection in mid-July to the last collection at the end of November. Sampling time, phenological stage and defoliations type interacted ($P > 0.05$) in their effects on TNC concentrations. TNC concentrations in the basal crowns were higher ($P > 0.05$) in plants treated during the post-reproductive stage among phenological stages, on control plants between defoliation treatments and in plants sampled 45 days after treatment applications. Our results showed that threeawn TNC concentration storage period extends as far as late November. Purple threeawn TNC concentration is dynamic across the growing season and it is easily affected by common defoliation events such as burning and clipping. The results of this study can be used to identify the best season to apply to apply prescribed burning in order to control this species.



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FORB COMMUNITY RESPONSE TO INVASIVE SPECIES, GRAZING, AND PRESCRIBED BURNS IN THE PACIFIC NORTHWEST BUNCHGRASS PRAIRIE

Brogan L. Watson*¹, Lesley Morris², Scott Lukas³, Sandra J. DeBano³, Heidi Schmalz⁴; ¹Oregon State University, La Grande, OR, ²SRM, Bismarck, SD, ³Oregon State University, Hermiston, OR, ⁴The Nature Conservancy, Enterprise, OR

ABSTRACT: MS STUDENT

There is growing concern about the observed worldwide decline in native pollinator populations, particularly bees. In addition, grasslands globally are experiencing intensified degradation from agricultural development, invasive species pressure and the lack of conservation practices for pollinating species. Forbs account for the majority of plant species diversity within grassland systems and their continued decline is severely impacting pollinator communities. The study took place in Northeastern Oregon at the Zumwalt Prairie Preserve (ZPP) which is the largest remnant of the Pacific Northwest Bunchgrass Prairie. This unique landscape is essential to conserving plant and insect communities for the future. The objectives of this study were to examine how prescribed fire, invasive plant species, and livestock grazing impact forb community for native pollinators. Data was collected at the ZPP in Oregon from 2008-2018. Forb foliar cover was sampled in 2008, 2010, 2016 and 2018 in long-term monitoring plots, with prescribed burns implemented in the fall of 2006 and 2016. Overall forb cover was low across all plots and all years, forb cover decreased over time in both burned and unburned sites from 2008 to 2016. In 2018, forb cover increased slightly in unburned sites but remained the same as previous years in unburned sites. However, plots that experienced prescribed fire had the highest forb species richness. Further results will be presented based on forb foliar cover data over time and the relationship to rangeland stressors, various treatments and potential habitat for native pollinator species.



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ACCURATELY MAPPING RESIDUAL DRY MATTER (RDM) ACROSS 50,000 ACRES OF NEVADA RANGELANDS

Timothy M. Bateman^{*1}, Eric D. Sant², Gregg E. Simonds³; ¹Open Range Consulting, Logan, UT, ²Open Range Consulting, Park City, UT, ³Open Range Consulting, Park City Utah, UT

ABSTRACT

In 2018, Open Range Consulting was successful in accurately predicting Residual Dry Matter (RDM) across 50,000 acres of the Horseshoe Ranch located near Elko, Nevada. Knowing the RDM of rangelands is a key metric for integrating livestock management and conservation values. Research has shown relationships between better management of RDM and important ecological functions such as grass regeneration, soil stability, nutrient cycling, water infiltration and grass community health. Traditional methods of measuring RDM by using sample locations to clip and weigh vegetation biomass, are limiting in spatial scale and can provide difficulties when creating pasture wide management plans. Using their Earth Sensed Technology, Open Range Consulting was able to overcome this limitation by using biomass data and Landsat imagery to create a continuous RDM map of the entire Horseshoe Ranch. By withholding 10% of the data the final map produced a R^2 of 0.85. Estimating RDM across large areas can provide incredibly useful information to land managers by directing needs such as dormant season grazing of cheatgrass to reduce the risk of large fires. ORC is working towards automating this process so that RDM maps can be produced and put in the hands of resource managers in a timely and effective manner.



Poster Session Tuesday 1: Poster Pod 33, Poster 32

PLANT-BIOCRUST-FIRE INTERACTIONS ACROSS FIVE SOUTHWESTERN DESERTS

Ellie McCann^{*1}, Sasha Reed², Armin Howell², Akasha Faist³; ¹New Mexico State University, Las Cruces, NM, ²U.S. Geological Survey, Moab, UT, ³New Mexico State University, LAS CRUCES, NM

ABSTRACT: MS STUDENT

Biological soil crusts (biocrusts) are a critical component of many dryland ecosystems. Biocrust communities (consisting of lichens, mosses, cyanobacteria, bacteria, and algae) have an important impact on ecosystem processes by influencing plant germination and growth, as well as enhancing surface hydrology, soil aggregation, nutrient cycling, and resistance to erosion. While biocrusts are highly adapted to harsh dryland conditions, they are known to be susceptible to fire impacts. Climate change and non-native invasive species have shortened fire-return-intervals in many dryland systems; however, while these changes carry implications for biocrusts and ecosystem recovery, our overall understanding of these consequences remains poor. This research looks at first order fire effects on biocrusts from across the five North American deserts (Chihuahuan, Colorado Plateau, Great Basin, Mojave, and Sonoran) and examines the impact of soil heating on plant-biocrust interactions. Field collected soil samples were homogenized and half of the samples had representative biocrust communities returned to the soil surface to provide a bare soil and biocrust comparison. Half of all samples, both biocrusted and bare, were heated to simulate fire impacts. To test plant-biocrust interactions, all samples were then seeded with *Elymus elymoides*, a perennial native bunchgrass. Plant germination, leaf production, and root and shoot biomass were measured during a 100-day greenhouse study. Seedling germination rates and mean germination times were affected by the presence of biocrust, regardless of soil heating. Plant growth was also influenced by biocrust and soil heating, and the magnitude of this response varied by desert. This work demonstrates the importance of biocrust in shaping post-fire vegetation responses. It also reveals complex dynamics between biocrust, soil heating, and the abiotic parameters of different desert soils. As fire regimes continue to strengthen in many dryland systems, management will increasingly benefit from understanding these mechanisms and the role they play in ecosystem recovery.



Poster Session Tuesday 1: Poster Pod 33, Poster 33

EFFECT OF EARLY-SEASON BURNING AND GRAZING ON SUB-IRRIGATED MEADOW HAY PRODUCTION

Tara M. Harms*¹, Mitchell Stephenson²; ¹University of Nebraska-Lincoln, Lincoln, NE,
²University of Nebraska - Lincoln, Scottsbluff, NE

ABSTRACT: MS STUDENT

Sub-irrigated meadows are a valuable forage resource to ranching operations in the Nebraska Sandhills. Within a given year, these meadows can be used for hay production, grazing, or a combination of both. Buildup of standing dead and litter material from ungrazed or unhayed plant material can potentially reduce forage yield and quality. We hypothesized, that prescribed burning on sub-irrigated meadows early in the growing season, late-April to early-May, would result in the removal of standing dead and litter without decreasing total hay production later in the growing season. Research was conducted from 2017 to 2018 with treatments of a 1) spring prescribed burning, 2) mowing, and 3) a control with no early-season management. All treatments were subjected to a modified strip-strip plot design with either grazing or grazing exclusion following the burn, in May and early June. In mid-August, biomass production was collected within the plots for each year. Grazing utilization was greater on the burn (69%) than the control plots (43%), but treatment did not influence biomass production in mid-August ($P=0.32$). There was an interaction between year and grazing which occurred in May and early-June regardless of the treatment ($P < 0.01$). In 2017, biomass was 1.8 times greater on the ungrazed compared to grazed plots, but in 2018 biomass was only 1.2 times greater on the grazed compared to ungrazed plots. Our research suggests that managers of sub-irrigated meadows can burn meadows early in the season with no later loss in hay production but grazing in May and early June may decrease biomass production later in the growing season.



Poster Session Tuesday 1: Poster Pod 33, Poster 34

EXAMINING THE IMPACT OF PATCH BURNING ON LIVESTOCK GRAZING PATTERNS IN EDWARDS PLATEAU, TEXAS

Wei-qian Gao^{*1}, Jay P. Angerer², X. Ben Wu³, Douglas R. Tolleson⁴; ¹Texas A&M University, College Station, TX, ²Texas A&M AgriLife Research, Temple, TX, ³Texas A&M University, COLLEGE STATION, TX, ⁴Texas A&M University, Sonora, TX

ABSTRACT: Ph. D STUDENT

Production of sheep, goat, and cattle are major agricultural enterprises on West Texas rangelands, especially in the Edwards Plateau. In this region, the use of fire as a management tool was suppressed until recently. Although previous studies have been conducted to evaluate cattle use of burned versus unburned patches, there has been a lack of studies where combinations of livestock species grazing together on patch burned areas have been evaluated. The objective of this study is to examine grazing patterns of cattle, sheep and goat, both spatially and temporally, on areas where patch burning has been implemented. The study site is Texas A&M AgriLife Research Ranch, Martin Ranch, located in Mesquite-Oak-Savanna ecosystem in the Menard County of Texas. In February 2019, patch burns were implemented on the ranch and represented about one-seventh of the total ranch area (240 ha). After the burns, animals from the resident herd were randomly selected and GPS collars were placed on 34 goats, 33 sheep, and 8 cows to reflect the proportion of animals in the resident herd. The GPS collars were set to collect movement data every 10 minutes during a five-month period. Gates and fences for the entire ranch were opened and livestock were free to choose areas to graze. Data from the GPS's were evaluated to determine locations where the animals grazed and their preferences for different areas of the landscape. Initial observations indicate that cattle and sheep were more attracted by recent burned patches compared to goats. Livestock forage use patterns and time spent by species in the burned and unburned areas and among different vegetation land cover classes will be presented. Information from this study will assist in providing information to producers on how implementation of patch burning would influence their management of these grazing lands.



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PRIORITIZING VEGETATION MANAGEMENT PRACTICES ON PRIVATE WORKING LANDSCAPES TO REDUCE CATASTROPHIC EVENTS

Stephanie R. Larson-Praplan*¹, Van Butsic², Max Moritz³; ¹UC Agriculture and Natural Resources, Santa Rosa, CA, ²UC Berkeley, Berkeley, CA, ³UC Agriculture and Natural Resources, Santa Barbara, CA

ABSTRACT

As California policy makers continue to address the impacts of catastrophic wildfires, input from private landowners, who own the majority of California's working landscapes, is often overlooked. Collaborative management of working landscapes can be key to reducing catastrophic fires while also maintaining viable of these lands continue to provide ecosystem services from forest and rangelands. Our project brought together private landowners to evaluate the implementation of management tools on the rangelands that surround Lake Sonoma. Located in northern California, Lake Sonoma is the primary drinking water source for more than 600,000 residents of Sonoma and northern Marin Counties, California. Lake Sonoma watershed includes approximately 230 parcels and 33,500 hectares. The land is mostly privately owned and has not experienced a significant fire in many years. We engaged landowners through a dialogue-based approach, increasing landowner awareness of landscape attributes, especially those related to fire risks. Individual parcel's biophysical attributes and vegetation were analyzed using a variety of existing fire hazard maps, providing different results of fire behavior based on slope, fuels, wind speed and direction, temperature, and humidity. At educational meetings, landowners were provided reports, showing maps and tables that quantified vegetation types and hazard class, along with which management practice(s) were most appropriate for that type. A checklist assessed management practice costs, for grazing, prescribed fire, and shaded fuel breaks, assisting landowners in prioritizing practice implementation and maximizing returns on rangeland management investments. Better informed landowners have a greater chance of adopting management practices, subsequently improving rangeland resiliency and reducing fire intensity. The project methodology will be scaled from individual property owners to larger landscapes and community-owned rangelands. Scaling efforts will increase awareness on how to manage rangelands and implement appropriate practices to mitigate catastrophic fires.



Poster Session Tuesday 1: Poster Pod 33, Poster 36

LONG TERM RESPONSES OF TANGLEHEAD TO PRESCRIBED PATCH BURNING AND CATTLE GRAZING

Rider Combs^{*1}, Alfonso Ortega¹, Humberto L. Perotto², Sandra Rideout-Hanzak³, David B. Wester³, Alexandria M. DiMaggio¹, Chase H. Walther⁴; ¹Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ²Texas A&M University - Kingsville, Kingsville, TX, ³Texas A&M University Kingsville, Kingsville, TX, ⁴Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT: MS STUDENT

Tanglehead (*Heteropogon contortus*) is a native perennial bunchgrass that is found throughout south Texas. This native grass is a drought tolerant warm season grass, which has drastically increased its distribution over the past 15 years. As tanglehead matures the stems become coarse, undesirable to cattle and reduces species richness in the pasture. These monotypic stands threaten wildlife habitat and the ranching industry on south Texas rangelands. This experiment evaluates the effects of prescribe patch burning and continuous grazing on (1) the composition of a plant community previously dominated by tanglehead; and (2) pasture utilization by cattle and native wildlife. The study site is a 95.5-hectare tanglehead monoculture pasture on a private ranch in southern Jim Hogg County, Texas. Since August 2016, this pasture has been continuously grazed at a stocking rate of 0.1 AU/ha/yr. A total of six plots (approximately 7 ha) used for the study and three of the plots were burned in the November 2016. Cattle (*Bos taurus*) freely graze in either non-burned areas (control) or patch burn areas. Three exclosures were placed on each plot to measure species richness and forage percent utilization. One grazing exclosure was randomly selected in each plot and vegetation 20 meter transect was conducted off of one randomly selected corner. The sampling period has been on 35-day intervals for the past three years. Average plant species richness and percent utilization was 4.83 and 8.33 plants per 0.25 m² and 1.8% and 51.7% in the control compared to the burned plots, respectively. Plant species richness and cattle preference for tanglehead may be increased following a prescribed burn since palatability is increased. Ranchers can use this information as a management tool to increase species richness, cattle utilization of tanglehead and improve wildlife habitat.



Poster Session Tuesday 1: Poster Pod 34, Poster 37

HYDROLOGIC AND BIOLOGIC RESPONSES OF ANTHROPOGENICALLY ALTERED LENTIC SPRINGS TO RESTORATION IN THE GREAT BASIN

Leah Knighton, Steve Petersen*; Brigham Young University, Provo, UT

ABSTRACT

Water is a limited and highly valued resource in the Great Basin. Surface water sources are often small and widely spaced apart, comprising only 1-3% of the surface area of the overall landscape. Despite their small size, these springs and surrounding wet meadows have a substantial effect on the surrounding environment. In recent years, many of these springs have become dewatered due to diversions of groundwater and climatic shifts in precipitation affecting recharge. These hydrologic changes can cause a drop in the local water table that promotes a shift in the plant community from wetland-obligates to more drought-tolerant species which can result in a degraded system. As degradation progresses, springs and wet meadows lose their ability to store water. The purpose of this research was to examine the responses of both the hydrologic and biologic factors to different springbox restoration techniques. Twenty-four spring sites were chosen in the Sheldon National Wildlife Refuge in northwestern Nevada. Each site was randomly assigned one of six different treatment designs. Various biotic and abiotic variables were measured. In our results, we observed soil moisture increase over the majority of our sites. Biomass increased in four of our six treatments. All treatment types exhibited a similar effect on springs with none having a clearly more restorative effect than any others. This research suggests that springs in the Great Basin have unique characteristics and responses to restoration and may need individualized approaches. Yearly variation caused by increased precipitation may be partially responsible for changes in hydrologic and biologic aspects of springs and wet meadows. Further data collection is needed to determine the true extent of treatment and yearly effects on spring restoration. In spite of the need for individualized approaches, restoration is possible. Simple solutions may be sufficient to recover hydrologic processes that maintain ecologic resilience.



Poster Session Tuesday 1: Poster Pod 34, Poster 38

USING THE NVC TO DEVELOP FUNCTIONAL-BASED SEED MIXES FOR RESTORATION OF SAGEBRUSH HABITAT

Scott B. Franklin*¹, Gwen Schneider²; ¹University of Northern Colorado, Greeley, CO,
²Colorado State University, Fort Collins, CO

ABSTRACT

Big sagebrush ecosystems are widespread throughout the western United States and provide essential ecosystem services. Sagebrush habitat has experienced a 45% reduction in range. While restoration practitioners generally attempt to restore ecosystems to historic conditions, this is not always achievable. The use of functional types (FTs), rather than specific species, to restore ecosystem structure and function may be easier to achieve but is not well tested. We examined the variability of vegetation communities along a sagebrush elevation gradient in western Colorado. We classified 1245 plots based on species cover and aligned that classification with USNVC types. We then performed several FT analyses in PCORD with 517 plots to examine differences in functional dominants among classified groups and relationships among FTs and environment. We asked: (1) Do functional dominants differ along this elevation gradient?; and (2) can we use functional types to refine restoration protocols, such as seed mixes? Plots were classified into nine groups based on dominant species; an NMS ordination clearly discriminates groupings. The data further show a relationship with the environmental variables of temperature and variation in temperature, and elevation and moisture; an elevation gradient. When a similar analysis was conducted on a functional type matrix (including growth form, clonal organ, photosynthetic pathway and life history), distinctions among groups were not clear; the convex hulls have a great deal of overlap and the Basin Big Sagebrush community has an extremely wide distribution. However, we did find some significant differences in functional diversity and functional dispersion among groups. Mean cover of different function types suggest minor differences among groups, but worth noting when developing seed mixes. Differences in the dominance of clonal growth organs was clear, and clonal plants made up 50% -100% of the cover for nearly all groups. For sagebrush communities alone, *A. nova* sites are not even shrub-dominated, perennial and annual graminoids are more common in Wyoming Big Sagebrush than Basin Big Sagebrush, and Mountain Big Sagebrush communities seem strongly dominated by that one species.



Poster Session Tuesday 1: Poster Pod 34, Poster 39

UNDERSTORY VEGETATION RESPONSE TO THINNING PINYON-JUNIPER WOODLANDS

Yasser M. Almalki^{*1}, Alexander G. Fernald², Andres F. Cibils², Carlos G. Ochoa³, Douglas S. Cram², Robert L. Steiner²; ¹New Mexico State University, las cruces, NM, ²New Mexico State University, Las Cruces, NM, ³Oregon State University, Corvallis, OR

ABSTRACT: Ph. D STUDENT

Portions of the western United States, extending from West Texas up through southern parts of Oregon, are densely populated with piñon-juniper (PJ) woodlands. Managing tree densities could have positive ecological implications for rangeland watersheds and wildlife habitat. The objective of our study was to determine understory vegetation response to tree removal in small watershed areas. This research reports comparative data collected from six watersheds situated within New Mexico State University's Santa Fe Ranch, Santa Fe County, New Mexico, to assess herbaceous standing crop and cover over 10 years following tree removal. In 2009, six 1.00 to 1.35 ha paired PJ watersheds were selected. Juniper thinning was conducted in three watersheds (treatment watersheds, T) while the remaining three watersheds were left untreated (control watersheds, C). The variation of slopes is such that, the bottom of the valley may range from 2% to 5%, while the slopes on may vary from 20% to 50% with sandy clay loam texture. We measured understory vegetation biomass and cover in 2009 (pre-treatment), 2014, and 2019 (post-treatment) based on our hypothesis that juniper thinning would significantly increase understory biomass at the watershed scale. Total standing crop significantly increased in T compared to C in both post-treatment years (2014 and 2019). Also, in T, grass basal cover significantly increased after 10 years of treatment compared to C. Our results suggest that juniper thinning at our site in northern New Mexico can promote a 2.5-fold increase in understory grass production. Our results provide land managers critical information for actual effects of tree clearing in small watershed areas.



Poster Session Tuesday 1: Poster Pod 34, Poster 40

TOPO-EDAPHIC CONSTRAINTS ON WOODY PLANT COVER CHANGE IN A SEMI-ARID GRASSLAND

Scott A. Jones*, Steven R. Archer; University of Arizona, Tucson, AZ

ABSTRACT: Ph. D STUDENT

Many rangelands have experienced a proliferation of woody plants at the expense of grasses. Efforts to stem WPE include a variety of chemical, mechanical, and pyric brush management practices. However, results from these actions are costly and typically short-lived, necessitating re-treatment. While the WPE process and its drivers are varied, consensus is emerging that interactions among multiple factors are key. The strength of these interactions ostensibly varies depending upon local constraints imposed by landforms, soils and topography, but how these constraints influence the rate and extent of the WPE has not been well-quantified. The long-term efficacy of brush management treatments is also subject to these constraints. Thus, long-term spatial/temporal dynamics of shrub encroachment and responses to brush management are challenging to predict. We quantified long-term rates and patterns of shrub (*Prosopis velutina*) cover change across the 18,210 ha Las Cienegas National Conservation Area at ~20-year intervals between 1936 and 2017 taking into account soils, topography, and brush management history. Shrub cover increased from 1.7% in 1936 to 7.7% in 2017 across the area, but elevation, slope aspect, and soil texture substantially influenced fine-scale changes. For example, shrub cover on loamy upland/limy slopes underwent little change (from 0.3% in 1936 to 1.9% in 2017), whereas change on loamy uplands was higher (from 1.3% to 8.2%) and substantially higher on loamy bottoms (from 4.3% to 19%). Recovery of shrub cover on areas receiving brush management also varied by ecosite, with re-establishment on loamy bottoms increasing from <1% in 1975 to 22.1% in 2017 while a loamy upland treatment increased from <1% to 2.3% over the same time span. We will discuss how knowledge of fine-scale patterns of shrub encroachment and responses to brush management can be used by managers to determine when, where and how frequently to implement brush management activities.



Poster Session Tuesday 1: Poster Pod 34, Poster 41

SAGEBRUSH FIELD OF DREAMS AND DASH; EARLY STRUCTURAL ADVANTAGE OF TRANSPLANTS FOR BUILDING GREATER SAGE-GROUSE HABITAT

David A. Pyke^{*1}, Robert K. Shriver², Robert S. Arkle³, David S. Pilliod⁴, Cameron L. Aldridge⁵, Peter S. Coates⁶, Matthew J. Germino⁴, Julie A. Heinrich⁷, Mark A. Ricca⁶, Scott E. Shaff⁸; ¹US Geological Survey, Corvallis, OR, ²U.S. Geological Survey, Flagstaff, AZ, ³U.S. Geological Survey, Boise, ID, ⁴US Geological Survey, Boise, ID, ⁵Colorado State University, Fort Collins, CO, ⁶U.S. Geological Survey, Dixon, CA, ⁷Colorado State University, Natural Resources Ecology Laboratory, Fort Collins, CO, ⁸U.S. Geological Survey, Corvallis, OR

ABSTRACT

In the Great Basin USA, increasingly larger areas of big sagebrush (*Artemisia tridentata*) are being killed by wildfires driven by nonnative grasses and these losses have far outpaced rates of sagebrush recovery. Consequently, wildlife populations of sagebrush-obligate species and their habitats (e.g., Greater Sage-grouse, *Centrocercus urophasianus*) are often in decline. In addition to the establishment advantage that transplanting container-grown sagebrush provide for restoration, they also afford an initial height and canopy area advantage over seeded plants, but do they maintain this advantage over time? We examined height and canopy area of sagebrush individuals by substituting space for time at 28 seeded and 20 transplanted locations across the Great Basin using a Bayesian hierarchical regression. We tested if the initial height and canopy area advantage of planted sagebrush might translate into reaching habitat goals for Greater Sage-grouse sooner than seeded plants. Preliminary results indicate that initial height and canopy area advantages for transplanted over seeded individuals lasted for the first three years after planting, but a greater growth rate for seeded individuals allowed them to equal or surpass transplanted individuals in these measures in subsequent years. The transplant advantage disappeared by the fourth year for both canopy area and height. By the sixth year seeded plants were taller than transplanted individuals because of their greater height growth rate. Container-grown plants achieved heights suggested to meet Greater Sage-grouse management guidelines around year three, about a year before seeded plants. Densities of about 2 plants/m² and 4 to 5 years of growth were necessary to meet cover requirements for Greater Sage-grouse. Since big sagebrush often establishes poorly from seeds, planting nursery-grown sagebrush that are 1-2 years old may be the best hope for quickly achieving wildlife habitat goals after fires at least for site-level applications.



Poster Session Tuesday 1: Poster Pod 34, Poster 42

LONGTERM IMPACTS OF PINYON-JUNIPER REMOVAL ON VEGETATION AND HYDROLOGIC PROPERTIES

Cameron S. Burleson*¹, Justin C. Johnson¹, Christopher J. Williams², Frederick B. Pierson³, Viktor Polyakov⁴; ¹University of Arizona, Tucson, AZ, ²USDA - Agricultural Research Service, Boise, ID, ³Agricultural Research Service, Boise, ID, ⁴USDA - Agricultural Research Service, Tucson, AZ

ABSTRACT: UNDERGRADUATE STUDENT

Throughout the western U.S., extensive pinyon-juniper (*Pinus* spp., *Juniperus* spp.) encroachment into sagebrush (*Artemisia* spp.) shrublands has reduced sagebrush habitat and modified hydrologic function. Land managers are combating this challenge with tree removal treatments to return current woodlands to historical sagebrush shrublands. This study examines the effects of fire and mechanical tree-removal treatments on vegetation as well as the spatial patterns and persistence of litter accumulation and soil hydrologic properties along hillslopes. Experimental plots were located at three sites in the Great Basin region. Vegetation sampling was completed pre-treatment (2006) and 1, 9, and 13 years after mechanical and prescribed-fire treatments at two sites. Sampling was also conducted in a naturally burned and unburned third site two consecutive years after a wildfire (2008, 2009). In 2019, hydrologic, soil, and vegetation characteristics were measured in canopy and intercanopy microsites within all treatments at each site. All treatments were effective in reducing tree cover. Over a period of 13 years, sagebrush and perennial grass cover increased in mechanical treatments and perennial and annual grass cover increased in prescribed fire treatments. Wildfire initially reduced perennial grass cover 4-fold and removed 100% of the limited pre-fire shrub cover. Perennial grasses increased 3-fold over the 2nd year after wildfire, but shrub cover remained near 0%. In 2019, soil water repellency was observed on former and existing tree microsites in all treatment areas, but repellency adjacent to standing dead trees and stumps within burned treatment areas was weaker than in tree microsites within untreated and mechanically treated areas. With few exceptions, ground cover was generally greater in treated intercanopy areas than in untreated areas. While treatment effects vary by treatment type, the preliminary results indicated that pinyon-juniper removal treatments can increase vegetation and ground cover, reduce soil water repellency, and improve surface conditions on sagebrush rangelands.



Poster Session Tuesday 1: Poster Pod 35, Poster 43

NOT ALL FUEL REDUCTION TREATMENTS DEGRADE BIOCRUSTS: HERBICIDES SHOW POSITIVE EFFECTS ON COVER OF BIOCRUSTS

Lea A. Condon^{*1}, Margaret Gray²; ¹US Geological Survey, Corvallis, OR, ²Utah State University, Logan, UT

ABSTRACT

In response to increasing fire, fuel reduction treatments are being used to minimize fire risk. Although biocrusts are associated with reduced cover of fire-promoting, invasive grasses, the impacts of common fuel reduction treatments on possible degradation of biocrusts are poorly understood. We use data from a long-term experiment testing fuel reduction treatment on lichen and moss components of biocrusts in sagebrush steppe. Fuel reduction treatments include mowing, prescribed fire, and the use of two herbicides: one commonly used to reduce shrub cover, tebuthiron and one commonly used to combat cheatgrass, imazapic. Given the long-term nature of the dataset, we also compare estimates of biocrust cover surveyed on rainy days versus the dataset as a whole because many, but not all, researchers that study biocrusts wet the soil surface before surveying to ease in the detection of these sometimes-cryptic organisms. This dataset provides an opportunity to compare both approaches. Preliminary results demonstrate neutral to positive effects of herbicides: tebuthiron and imazapic, on both the moss and lichen components of biocrusts. Mowing and prescribed fire led to losses in cover of mosses, with the later leading to comparatively greater declines in cover (declines of 23% - 31% versus 42% - 67%). Reductions in moss cover mirrored gains in cover of bare soil, which are associated with increased risk of invasion by grasses responsible for increasing fire risk. Preliminary results also demonstrate greater differences in cover of biocrusts compared to controls when data was collected on rainy days. This approach highlights that higher cover of biocrusts is likely to be detected when the soil surface is wet. We demonstrate positive effects of the use of herbicides for reducing fuels while simultaneously maintaining or promoting biocrusts and reducing the threat of invasion by annual grasses that are responsible for increasing fire risk.



Poster Session Tuesday 1: Poster Pod 35, Poster 44

EFFECTS OF BIOCRUST DEVELOPMENT ON ESTABLISHMENT OF NATIVE PLANTS IN A SALT DESERT SYSTEM

Kari E. Veblen*¹, Merran Owen¹, Thomas A. Monaco²; ¹Utah State University, Logan, UT,
²Forage & Range Research Laboratory, Logan, UT

ABSTRACT

In salt desert shrublands of the Great Basin, exotic annual plants are displacing native species. Low productivity and recruitment in these systems limits their resilience, and active revegetation with native species is especially challenging. Two underexplored questions for re-establishing native species include: 1) the effectiveness of broadcast seeding vs transplanting of greenhouse-grown seedlings and 2) how different levels of biological soil crust development affect restoration success. In a degraded salt desert shrubland in southeastern Idaho, we experimentally tested broadcast seeding vs. spring or fall planting in areas of high vs. low crust development for three native grasses and one forb. Survival, size and reproductive success were measured over several time periods during the year following planting. Broadcast seeding largely failed across all levels of crust development and species. Survival, biomass and reproductive success of transplanted seedlings differed across species, and biological soil crust development had a significant effect on the ability of some species to survive the first summer after planting. This study demonstrates the success of transplanting as a method of native species establishment, and the benefits of targeting areas of high soil crust development for restoration plantings in a salt desert shrubland.



Poster Session Tuesday 1: Poster Pod 35, Poster 45

BIOTIC CAUSES OF SEEDLING MORTALITY FOR *ELYMUS ELYMOIDES* (RAF.) SWEZEY IN A DRILL-SEEDED RANGELAND ENVIRONMENT

Jesse R. Morris^{*1}, Steve Petersen², Matthew Madsen², Brock McMillan², Dennis Eggett², Russ Lawrence³; ¹BYU, Orem, UT, ²Brigham Young University, Provo, UT, ³Hill Air Force Base and Utah Test and Training Range, Hill Air Force Base, UT

ABSTRACT: MS STUDENT

Human activities in the Great Basin have impacted rangelands and facilitated the colonization of invasive annual grass and forb species. Generally, areas dominated by invasive annual species fail to provide high quality habitat for wildlife and increase the frequency of wildfires compared to areas dominated by native plants. Subsequently, efforts to restore degraded areas often fail. Understanding processes involved in plant establishment can improve the ability to predict the outcome of revegetation practices and create effective solutions for rangeland revegetation. The purpose of this study was to identify timing and biotic causes of plant mortality for species seeded during rangeland revegetation on the Utah Test and Training Range (UTTR) in western Utah. We placed Reconyx motion sensing trail cameras in 28 plots arranged in a randomized split-plot design with fenced and unfenced plots and seeded with two rows of *Elymus elymoides* (bottlebrush squirreltail) (Raf.) Swezey. We tracked individual seedlings and recorded their status (alive, dead, or damaged), comparing initial seedling establishment and seedling survival between fenced and unfenced plots. Seed predators reduced initial seedling establishment in unfenced plots by 4 times ($p = 0.0002$). Seedlings were 7 times more likely to survive in fenced vs. unfenced plots. Of total seedling mortality, 73.6 % of seedling death was caused by herbivory (pocket gophers, invertebrate herbivores, jackrabbits). The effects of small herbivores decreased the success of rangeland revegetation efforts, reducing native plant establishment and leaving sites vulnerable to plant invasion. Continued research should be conducted to determine the effect of herbivores on revegetation efforts at a large scale and what strategies could mitigate those effects.



Poster Session Tuesday 1: Poster Pod 35, Poster 46

COMPARING ESTABLISHMENT METHODS AMONG DIFFICULT-TO-PRODUCE NATIVE PLANT MATERIALS

Jaycie N. Arndt^{*1}, Brian A. Meador²; ¹University of Wyoming, Sheridan, WY, ²University of Wyoming, Laramie, WY

ABSTRACT: MS STUDENT

Some native species are highly desirable in reclamation and restoration settings, but seed availability is limited because the species is challenging to effectively establish, grow, harvest, clean, and condition. Additionally, propagation methods may directly impact native plant restoration efforts where original seed sources are limited. We evaluated seed increase methods of native plants sulfur-flower buckwheat (*Eriogonum umbellatum* Torr.) and desert biscuitroot (*Lomatium foeniculaceum* J.M. Coult. & Rose). Sulfur-flower buckwheat is a native, low growing, woody mat-forming perennial that is important for quail, sage-grouse, and ungulate forage and for pollinator habitat. Desert biscuitroot is a broad-leaved, herbaceous perennial of the Apiaceae. It is used for medicinal purposes and is an important forage for sage grouse. We compared establishment and survival between direct-seeding and transplanting containerized seedlings for seed production fields in northeast Wyoming. One year after planting, sulfur-flower buckwheat establishment was 71.7% \pm 21% (95% CI) with transplanting and 0.16% \pm 0.7% (95% CI) with direct seeding. Two years after planting, survival was 18.1% \pm 19.4% (95% CI) with transplanting and 10.2% \pm 1.5 (95% CI) with direct seeding. One year after planting, desert biscuitroot establishment was 18.1% \pm 19.3% (95% CI) with transplanting and a 10.2% \pm 1.5% (95% CI) with direct seeding. Two years after planting, survival was 10.1% \pm 21.2% (95% CI) with transplanting and 6.5% \pm 0.9% (95% CI) with direct seeding. Extended survival, seed production, and cost comparison analyses will be evaluated.



Poster Session Tuesday 1: Poster Pod 35, Poster 47

STRIP-SEEDING, TARGETED GRAZING, AND PRESCRIBED FIRE FOR RESTORATION AND INVASIVE SPECIES MANAGEMENT IN CALIFORNIA GRASSLANDS

Julea A. Shaw^{*1}, Elise S. Gornish², Danny J. Eastburn³, Emilio A. Laca⁴, Daniel K. Macon⁵, Kenneth W. Tate⁶, Leslie Roche⁷; ¹University of California - Davis, Davis, CA, ²University of Arizona, Tucson, AZ, ³UC Davis, Woodland, CA, ⁴University of California, Davis, Davis, CA, ⁵University of California Cooperative Extension, Auburn, CA, ⁶Plant Sciences Department, UC Davis, Davis, CA, ⁷UC Davis, Davis, CA

ABSTRACT: Ph. D STUDENT

California valley grasslands are dominated by non-native annual grasses from the Mediterranean regions of Europe. The more recent spread of highly invasive annual grasses such as medusahead (*Elymus caput-medusae*) have led to reduced forage quality and plant species diversity. Restoration and vegetation management are important tools to increase productivity and biodiversity. However, efforts to re-establish native vegetation are often hindered by the high cost of plant material and persistence of invasive species. To address this challenge, we tested the efficacy of combining strip seeding with targeted grazing and prescribed burning. Strip seeding is the seeding of desired species in horizontal patches across a landscape and relies on natural dispersal from these patches to colonize unseeded areas. Proposed benefits of this method include reduced cost and increased invasion resistance over large areas. However, we found that after five years, a legacy of initial seeding configuration remained with lower native and higher non-native abundance in unseeded strips. To reduce invasive cover and encourage dispersal of native species from seeded to unseeded strips, we implemented targeted grazing and prescribed burning treatments in a full factorial design five and six years after initial seeding. We measured post-treatment community composition and reproductive output of medusahead to determine if combining strip seeding, grazing, and burning is an effective strategy to establish native grasses and reduce invasive cover. We found that all burning and grazing treatments reduced native cover, but only treatments that included burning (with or without grazing) reduced the cover of medusahead. The combination of burning with grazing was most effective at reducing medusahead cover but included the tradeoff of reducing established perennial grasses. Further research is needed to determine if altering the timing and frequency of grazing and burning can reduce medusahead while minimizing negative impacts on native perennial grass communities.



Poster Session Tuesday 1: Poster Pod 35, Poster 48

SUCCESS OF INSTALLING NATIVE PLANT PLUGS IN CHEATGRASS (*BROMUS TECTORUM*) DOMINATED LANDSCAPES

Steven O. Link*, Gretchen Graber; Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR

ABSTRACT

An experiment was conducted to determine if it is possible to establish native plants, installed as 10 cubic inch plugs, in cheatgrass (*Bromus tectorum*) dominated locations. There was no effort to control cheatgrass. These plants were compared with plants installed in nearby bare soil (sand) locations. This work was done at the Saddle Mountain National Wildlife Refuge in southcentral Washington State. This shrub-steppe study area is very dry with annual precipitation of about 170 mm. Sixteen shrub-steppe species were compared. In the second growing season and after a fire in the summer of the first growing season Western yarrow (*Achillea millefolium*) had the highest survival of $57 \pm 5.1\%$ in cheatgrass compared with $74 \pm 5.7\%$ in bare soil. Other successful species in cheatgrass were Sandberg's bluegrass (*Poa secunda*, $52 \pm 5.7\%$), sand dropseed (*Sporobolus cryptandrus*, $27 \pm 5.2\%$), Bottlebrush squirreltail (*Elymus elymoides*, $18 \pm 6.2\%$), and orange globemallow (*Sphaeralcea munroana*, 6.3 ± 2.3). The other 11 species were not successful. We conclude that it is possible to establish some shrub-steppe species as plugs, under the conditions of the test, without using herbicides or other methods to control cheatgrass.



Poster Session Tuesday 1: Poster Pod 36, Poster 49

CONTROLLING YELLOW STARThISTLE TO ENHANCE WATER RESOURCES: RESPONSE OF MULTIPLE ECOSYSTEM SERVICES AT THE WATERSHED SCALE

Danny J. Eastburn*¹, Joseph M. DiTomaso², Michael L. Deas³, Jeff T. Laird³, Leslie Roche⁴;
¹UC Davis, Woodland, CA, ²University of California, Davis, Davis, CA, ³Watercourse
 Engineering, Inc., Davis, CA, ⁴UC Davis, Davis, CA

ABSTRACT

California is facing growing demand for water and 85% of California's surface water supply is generated, passes through, or stored in rangeland watersheds. In addition to conservation, other strategies are needed to meet urban, agricultural, and environmental water demands. A potential method to increase water yields from rangeland watersheds is the removal of dense stands of weeds, specifically Yellow starthistle (*Centaurea solstitialis*) (YST), that use more water than native or desirable annual forage species. Simultaneously, managers are increasingly expected by a diversity of stakeholders to incorporate multiple ecosystem service goals. We aim to measure the response of multiple ecosystem service outcomes to the application of herbicide at the watershed scale. Our sites consisted of four grazed annual-grassland watersheds (2 north/2 south) ranging in area from 6 to 9 acres. All watersheds were equipped with flumes, meteorological stations, and soil moisture sensors and piezometers at three landscape positions. We conducted plant community surveys using 27 (1m²) quadrats nested across 9 (10ft) transects. At multiple time steps, we sampled forage biomass and YST biomass along two transects representing all possible landscape positions. Using a UAS, we recorded thermal and multispectral imagery at each sampling event to create evapotranspiration maps using surface energy balance model. After installation of instruments in 2017 and baseline monitoring in 2018, in the winter of 2019 we applied milestone herbicide to one watershed from each block via helicopter. We found YST in the treatment watersheds, dropped from a baseline of ~40% cover across all watersheds to 0% cover in the treated. Preliminary results suggest greater soil moisture conditions and less total evapotranspiration in the treated watersheds compared to the untreated. We did not find a significant difference in annual grass cover between watersheds, however, species richness and legume cover were lower in the treated watersheds compared to untreated.



Poster Session Tuesday 1: Poster Pod 36, Poster 50

CATTLE REMOVAL IN SAGUARO NATIONAL PARK AND THE COMPOSITIONAL CHANGES FORM ASSOCIATED SUCCESSION

Ryan J. Summers*; Oregon State, Vail, AZ

ABSTRACT: MS STUDENT

In the area that is now Saguaro National Park East, grazing began in the 1880's. Because of the impact to the Saguaro cactus, ecological impacts in the park were determined to be so great that anti-grazing conservationists won a court case eliminating grazing in 1978. Surveys of ten plots began in 1978 and were replicated in 2007 and 2018 by agency personnel. The layout of plots was paired- grazing removed 1956 (control) and in 1978 (treatment). Our hypotheses were: (1) Cover and diversity would increase, (2) Shrubs would increase compared to graminoids, (3) Unpalatable species would decline, (4) Paired plots would show little compositional difference and (5) Plots burned from the 1980's would show significant difference. Canopy cover & diversity increased significantly by 2007 and expanded by 2018. Unpalatable species such as *Ericameria laricifolia* declined dramatically as well due to competition of palatable species. As was found in 2007, the 2018 analysis showed no difference quantifiably speaking between paired plots. Three out five hypotheses were confirmed, indicating differences in composition and cover were not different in burned versus unburned plots. One would surmise from the data that intensity was low and may have only hit portions of the plots-possibly concentrating on the plethora of *Prosopis velutina* that existed on these plots in 1978 but were reduced dramatically by 2007 and steady by 2018. Hypothesis (2) was proven incorrect. Shrub cover increased in 2007 and doubled by 2018, while graminoid cover increased by 2007 and dramatically by 2018. This is likely due to increasing autumn rain from tropical activity from the Pacific Ocean. Trends in this direction slightly increase in the years prior to 2007 (1996, 1998, 2000, 2003 & 2006) and dramatically increase in the years prior to 2018 (2014-2018) leading to the perennial bunchgrass explosion seen in our research.



Poster Session Tuesday 1: Poster Pod 36, Poster 51

NATIVE AND INTRODUCED SEED MIX PERFORMANCE ON CHEATGRASS RANGELANDS

Charlie D. Clements*¹, Dan Harmon²; ¹USDA, Reno, NV, ²USDA ARS, Reno, NV

ABSTRACT

Invasion of alien plant species influences many phases of wildland research in the Great Basin. The accidental introduction and subsequent invasion of cheatgrass (*Bromus tectorum* L.) onto millions of hectares of Great Basin rangelands has led to the conversion of former big sagebrush (*Artemisia tridentata* Nutt.)/bunchgrass communities to cheatgrass dominance. Cheatgrass has revolutionized secondary succession in more arid big sagebrush plant communities throughout the Great Basin by increasing the chance, rate, spread and season of wildfires. The best known method to suppress cheatgrass densities and associated fuels is through the establishment of perennial grasses. We investigated the performance of native, introduced and native/introduced perennial grass seed mixes following for two consecutive years in northern Nevada. Following weed control efforts using the pre-emergent herbicide, *Sulfometuron methyl*, we seeded native and introduced perennial grasses in seed mixes to record establishment and the ability of these seed mixes to suppress cheatgrass. Following 2-years of recording seedling emergence and establishment, we recorded 35.5 perennial grasses/m² in the introduced and native mix plots and 25.8/m² in the native/introduced plots for year-1. Year-2 resulted in 27.9 perennial grasses/m² in the introduced and native/introduced plots, while the native plot decreased to 14.0/m². Year-1 received 335.3mm of annual precipitation compared to 201.9mm in year-2. Cheatgrass densities were recorded from a low of 10.8/m² in the year-1 introduced plots to a high of 144.2/m² in the year-2 native plots. Introduced perennial grass seed mix performed the best at suppressing cheatgrass fuels from 1,352 kg/ha in control plots down to 103 kg/ha, while the native/introduced and native plots recorded 151 kg/ha and 381 kg/ha, respectively. In arid environments introduced perennial grasses and introduced/native perennial grass seed mixes consistently performed better at suppressing cheatgrass than native perennial grass seed mixes which can be attributed to more arid years than mesic years.



Poster Session Tuesday 1: Poster Pod 36, Poster 52

DOCUMENTING THE PLANT EVALUATION PROCESS FOR COMMERCIAL RELEASE PURPOSES IN WEST TEXAS

Hagen D. Meyer*¹, Colin S. Shackelford², Carlos E. Gonzalez¹; ¹Sul Ross State University, Borderlands Research Institute, Alpine, TX, ²Caesar Kleberg Wildlife Research Institute, Kingsville, TX

ABSTRACT: UNDERGRADUATE STUDENT

The need for locally adapted seed sources in West Texas is increasing as highway and pipeline right-of-ways and oil and natural gas fields continue to expand, but the region's access to commercially available, locally adapted native seed sources is limited. West Texas Native Seeds, a collaboration between the Caesar Kleberg Wildlife Research Institute and the Borderlands Research Institute, is addressing this limitation by developing regional ecotypic seed sources. The program is actively working to expand the commercial availability of West Texas-specific seed sources to consumers, thus aiding in numerous restorative projects across the region. This project serves to document the preliminary plant evaluations of the grass species, hairy grama (*Bouteloua hirsuta*) and the forb species, narrowleaf globemallow (*Sphaeralcea angustifolia*). Previously collected populations of both species were planted in a greenhouse in March of 2019. Fifty-nine accessions of hairy grama were grown, 19 of which did not have enough plants germinate and were eliminated from the evaluation. Eleven accessions of narrowleaf globemallow were grown, all of which were evaluated. The greenhouse plants were translocated to an evaluation plot south of Alpine, Texas in May of 2019. Preliminary evaluations conducted throughout the growing season were started in July and are ongoing. The evaluations are performed monthly throughout the growing season for the first year and bi-monthly during the growing season the following year. Three populations of hairy grama and two populations of narrowleaf globemallow stand out after two rounds of data collection. Data collection and seed germination testing will continue through 2020.



Poster Session Tuesday 1: Poster Pod 36, Poster 53

ECOLOGICAL RESTORATION OF NATIVE PLANT COMMUNITIES IN FORESTS AND WOODLANDS ON THE NAVAJO NATION

Bryan Neztosie*; Diné College Land Grant Office, Tsaile, AZ

ABSTRACT

The long-term goal of the proposed research project is to determine evidence of ecological restoration of native vegetation after implementing ecological restoration thinning prescriptions in dense pinyon, juniper, and ponderosa pine forest on the Navajo Nation. The objectives are 1) Increase the capacity of staff, faculty and students to participate in applied research. 2) Strengthen collaborations with research institution to improve technical support systems to implement research. 3) Research results will be shared with Navajo Nation Forestry Department, Navajo communities, Grazing Officials, Bureau of Indian Affairs Natural Resources, and land users (grazing permittees).



Poster Session Tuesday 1: Poster Pod 36, Poster 54

STRATEGIC PLACEMENT OF SALT SUPPLEMENTS TO RESTORE SHRUB-ENCROACHED PASTURES. A CASE STUDY FROM ITALIAN ALPS

Ginevra Nota*, Marco Pittarello, Michele Lonati, Simone Ravetto Enri, Davide Barberis, Giampiero Lombardi; University of Turin, Turin, Italy

ABSTRACT: Ph. D STUDENT

Socio-economic transformations occurred in Europe over the last decades led to a broad abandonment of mountain areas. Consequently, the processes of natural succession favored shrub and tree encroachment, resulting in a dramatic degradation of semi-natural grasslands. Grazing by hardy breed cattle can be a sustainable tool to counteract these processes and restore semi-natural grasslands. In this context, the AGER iGRAL project planned to assess the effectiveness of cattle management of hardy breeds for the restoration of abandoned pastures in Alpine and Mediterranean environments. The present contribution shows the preliminary results of the strategic placement of attractive salt supplements to increase the frequentation of shrub-encroached areas by livestock. The impacts of trampling and grazing on vegetation structure were evaluated in a 24-hectare pasture (Vogna Valley, North-western Italian Alps), grazed by 72 Livestock Units of Highland cattle from 18 to 26 July 2019. Three salt blocks were placed within shrub-encroached sites and offered *ad libitum* throughout the grazing period. Each salt site was paired with a control one with similar topographic and vegetation characteristics. To detect the impact on vegetation structure, shrub and herbage heights were measured within a 15-m radius around each site, before and after grazing. The average reductions of shrub and herbage heights around salt sites were 5.9 ± 0.88 and 7.8 ± 1.02 cm (mean \pm standard error), respectively, and they were significantly greater than in control sites ($p < 0.001$). These promising results support the use of salt blocks for an effective grazing management of Highland cattle in shrub-encroached pastures. In addition, they represent a kick-off outcome to address future actions within iGRAL project for the restoration of abandoned pastures.



Poster Session Tuesday 1: Poster Pod 37, Poster 55

COLLABORATIVE RECLAMATION EXPERIMENTS ON OIL AND GAS WELL PADS IN THE UINTAH BASIN: APPROACH AND EARLY RESULTS

Rebecca Mann^{*1}, David Baird², Kevin Sadlier², Rita Reisor³, Hilary Whitcomb³, Michael C. Duniway¹; ¹US Geological Survey, Moab, UT, ²Bureau of Land Management, Vernal, UT, ³US Fish and Wildlife Service, Salt Lake City, UT

ABSTRACT

Energy exploration and development occurs throughout western rangelands. Although many operators expend significant resources reclaiming disturbed areas, knowledge gaps exist regarding how to successfully and efficiently achieve reclamation success, complicated by the challenging characteristics of arid environments: unstable soils, exotic species, and low and variable precipitation. In addition, reclamation tactics and tools employed vary widely among operators and their efficacy across plant community and soil gradients has not been publicly demonstrated. The U.S. Geological Survey, Vernal Field Office of the Bureau of Land Management, and the U.S. Fish and Wildlife Service have initiated a series of replicated experiments across environmental gradients in the Uinta Basin, to generate information pertaining to what reclamation practices are effective and where. In 2018, the first study was installed in a mixed salt-desert plant community. We compared drill seeding to broadcast seeding over hummocked soil, crossed with an organic soil tackifier and an herbicide treatment. An additional smaller experiment at the same site compared a warm and dry climate-adapted seed mix to a cool & wet climate-adapted seed mix, crossed with several surface amendments: connectivity modifiers, mulch, pitting, and biochar. Data following the first growing season suggested that desirable plant establishment was favored in hummocked and broadcast seeded plots, and at the small scale by adding mulch or soil pits. The warm-dry seed mix performed better when no surface amendments were added. Three additional study sites will be installed in fall 2019, which will evaluate similar restoration tactics across additional plant community types (Wyoming big sagebrush, black sagebrush, and greasewood). This expanding network of studies will not only inform reclamation efforts in the Uinta Basin; it will provide valuable data for a wide range of restoration projects across arid rangelands in the western US.



Poster Session Tuesday 1: Poster Pod 37, Poster 56

A REVIEW OF OIL AND GAS RECLAMATION PRACTICES, MONITORING, AND STANDARDS; IMPROVING RECLAMATION SUCCESS ON WESTERN PUBLIC LANDS

Michael C. Duniway*¹, Rebecca K. Mann², Molly L. McCormick³, Patrick J. Anderson⁴, Seth Munson³, David S. Pilliod⁵, Steven E. Hanser⁶, Zachery Bowen⁷; ¹US Geological Survey, Moab, UT, ²U.S. Geological Survey, Moab, UT, ³U.S. Geological Survey, Flagstaff, AZ, ⁴U.S. Geological Survey, Fort Collins, CO, ⁵US Geological Survey, Boise, ID, ⁶U.S. Geological Survey, Reston, VA, ⁷USGS, Fort Collins, CO

ABSTRACT

Reclamation of disturbed lands following oil and gas development in the western US is complicated by dry conditions, challenging soils, and heterogeneous landscapes. The objectives of the work described here are to improve success of oil and gas reclamation on these landscapes through: (1) an analysis of existing reclamation practices, monitoring protocols, and standards; (2) an assessment of scientific information on reclamation methods and their effectiveness; and (3) development of a technical reference to inform management or policy decisions. This work is being conducted in close collaboration with Department of Interior partners and other stakeholders to ensure project deliverables meet the needs of managers, policy makers, and the public. We report here preliminary results from our detailed review of scientific literature and agency documents on the topics of reclamation practices, monitoring techniques, and standards for determining bond release for Bureau of Land Management (BLM) permitted oil and gas activities. Our review of approximately 3000 peer reviewed articles and other reports, programmatic and planning documents, and interviews with agency staff revealed several important new insights, information gaps, and science needs. We report our initial, preliminary assessment here. First, among the many relevant studies reviewed, we often found it difficult to determine under what conditions specific study results would be applicable. Second, we found that planning documents and practitioner decisions tended to rely on local knowledge networks (peers, local experts, etc.) more than external information sources, such as the scientific literature. Third, results suggest there is variability in reclamation requirements among BLM management units (state and local offices) and energy projects--particularly how reclaimed condition monitoring is done and the standards by which bond release is determined. Next steps for this work include analysis of existing data structures, convening workshops, and development of a web-based annotated bibliography and decision support tools.



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MICROTOPOGRAPHY SELECTION FOR RESEEDING TECHNIQUES USING UAVS IN THE CHIHUAHUAN DESERT, BREWSTER COUNTY, TEXAS

Carolina Medina-Nava*¹, Bonnie J. Warnock², Kevin Urbanczyk³; ¹Sustainable Ranch Management - Borderlands Research Institute - Sul Ross State University, Alpine, TX, ²Sustainable Ranch Management - Sul Ross State University, Alpine, TX, ³Rio Grande Research Center - Sul Ross State University, Alpine, TX

ABSTRACT: MS STUDENT

Understanding the fate of rainwater is critical in semi-arid and desertic systems, as water is most often the limiting factor in plant growth and distribution. Therefore, it is important to assess water availability (wetness index) in soils in a degraded state. Microtopography in the landscape can enhance germination and survival by providing soil moisture for longer periods. The goal of this project is to develop a model to select and determine microtopography using high-resolution imagery from an unmanned aerial vehicle (UAV) to then be used as potential seeding microsite, and; implement different reseeding techniques in microsites to establish native grasses in an area treated with Tebuthiuron. A high-resolution topographic map of the study area was created using a combination of low-level aerial photography (DJI Matrice 600) equipped with a multispectral camera (MicaSense RedEdge-M Camera). Flights were designed using Drone Deploy at 60.96 m with a 75% overlap. Images were processed using Agisoft Software to then obtain a digital elevation model (DEM) and an Orthoimage of the study area. To determine wetness index values and select microtopography locations, the DEM was analyzed using TauDEM (Terrain Analysis Using Digital Elevation Model) toolbox in ArcGIS. Microsite points were then ground-truthed to calibrate the model and determine its success. The results of this study will not only depict a detailed analysis of soil surface characteristics, but also a better understanding of the flow of water and deposition of sediments. This will help model which microsites are best suited for reseeding and will improve the probability of seed germination.



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RESTORATION OF NATIVE GRASSES ON ABANDONED CENTER PIVOTS IN SANDY SAGE PRAIRIE OF SOUTHWEST KANSAS

Alonso Barragan-Martinez*¹, Mitchell J. Greer²; ¹Fort Hays State University, Garden City, KS, ²Fort Hays State University, Hays, KS

ABSTRACT: MS STUDENT

Thousands of acres of native sand sage prairie in Southwest Kansas have been converted to croplands. Due to low precipitation and arid conditions, much of these croplands are irrigated by center pivots irrigation systems fed by underground aquifers. Many of these aquifers have reached levels too low for irrigation and the fields are abandoned. These lands eventually become eroded and form large moving sand dunes. Programs like the Conservation Reserve Enhancement Program (CREP) have struggled in restoring native grasslands in abandoned croplands of this area using current protocols. Determining causes for these struggles may help in restoring grasslands in the region. Possible reasons for this lack of success may have to do with water use, soil temperature and larvae insect infestation. Providing moist soil may create more suitable conditions for seed germination. Soil temperature above 65°F may also increase germination, supporting the notion that sowing is currently being done too early. Spraying insecticides a day before planting may protect new seedlings from predation. Our objective is to compare current procedures employed by CREP to new methods currently showing promise at small scales to determine if these new methods are more effective in restoration of this important ecosystem and the wildlife that use it.



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MEZAVUE™ HERBICIDE: THE NEW STANDARD IN PRICKLYPEAR CONTROL AND SO MUCH MORE

D CHAD Cummings*¹, Charles Hart², James R. Jackson³, Morgan L. Russell-Treadwell⁴, Byron Sleugh⁵; ¹Corteva Agriscience, Bonham, TX, ²Corteva Agrisciences, Abilene, TX, ³Texas A & M AgriLife Extension Service, Stephenville, TX, ⁴Texas A&M AgriLife Extension Service, San Angelo, TX, ⁵Corteva Agriscience, Indianapolis, IN

ABSTRACT

MezaVue™ herbicide is a new tool for rangeland managers in the southern US. MezaVue combines three active ingredients to bring unprecedented performance on pricklypear (*Opuntia* spp.). Its superior formulation provides faster pricklypear activity, increased uptake and faster kill than picloram alone, amazing individual plant treatment results and more consistent results in IPT, ground broadcast, and aerial broadcast applications. MezaVue has improved oak tolerance, lower use rate, lower odor, and better value than current industry standards for pricklypear control. In addition to pricklypear control in the southwestern US, MezaVue also controls a wide range of invasive and encroaching woody brush, including old man's beard (*Clematis* spp.), Queen's delight (*Stillingia texana*), broom snakeweed (*Gutierrezia sarothrae*), multiflora rose (*Rosa* spp.), and blackberry (*Rubus* spp.). Foliar individual plant treatment applications (MezaVue 1.0% v/v + MSO 1.0% v/v) control a many additional brush species, including but not limited to callery pear (*Pyrus calleryana*), ailanthus (*Ailanthus* spp.), scotch broom (*Cytisus scoparius*) and retama (*Parkinsonia aculeata*). MezaVue herbicide is the new standard in pricklypear control, but also provides excellent control of additional brush species across the southern US, giving land managers a new tool in the battle against encroaching brush.



Poster Session Tuesday 1: Poster Pod 38, Poster 62

HOTSPOTS FOR POST-FIRE SAGEBRUSH RECOVERY: BURNED AND SURVIVING INDIVIDUALS PLAY A ROLE

Robert S. Arkle^{*1}, David S. Pilliod², Matthew J. Germino², Justin L. Welty², Michelle I. Jeffries²; ¹USGS, Boise, ID, ²US Geological Survey, Boise, ID

ABSTRACT

Improving the success of post-wildfire sagebrush restoration treatments is important for habitat conservation. Past work suggests that one-year post-wildfire, sagebrush seedling establishment may be enhanced in microsites where mature sagebrush canopies burned and subsequently left behind a “fertile island”- an area of unique soil characteristics that may facilitate sagebrush establishment and inhibit invasive annuals. Further research suggests that post-treatment sagebrush populations, composed of predominantly young individuals with low survival and fecundity, are vulnerable to extirpation through a process called transient population dynamics. Conceivably, the presence of larger, fire-surviving, remnant individuals may lessen the likelihood of transient dynamic-based declines or extirpations. We sought to determine the importance of fertile island microsites and remnant individuals to sagebrush populations 1-2 years post-fire. Preliminary results from 469 plots in sites across the Great Basin suggest several important trends. First, sagebrush seedlings were uncommon, with none detected in 58% of plots. Seeded individuals were even less common. Second, remnant individuals may be important, as they were detected in 21% of plots and 49% of plots with seedlings had at least one remnant individual. Third, fertile islands were the most important microsite for sagebrush establishment, with 65% of seeded individuals being detected in these locations, a value 3.4 times greater than the next greatest microsite type (plant interspaces) despite fertile islands representing far less area than other microsite types. Finally, sagebrush was more likely to establish in locations with both remnant individuals and fertile island microsites present. Thus, the extirpation of sagebrush from an area could have important, long-term implications for seeding success following future fires if there are no mature individuals to leave behind fertile islands or serve as remnant individuals. These preliminary findings could help guide where, and how, big sagebrush is seeded in the future.



Poster Session Tuesday 1: Poster Pod 38, Poster 63

BURNING, SEEDING, AND HERBICIDE PRODUCTIVENESS IN RELATION TO RANGELAND RESTORATION IN SOUTHEASTERN NORTH DAKOTA

Jace W. Stallman¹, Breanna Kobiela², Shawn DeKeyser*²; ¹North Dakota State University, Hillsboro, ND, ²North Dakota State University, Fargo, ND

ABSTRACT: MS STUDENT

Rangelands in southeastern North Dakota often face invasion from Kentucky bluegrass (*Poa pratensis* L) and smooth brome (*Bromus inermis* Leyss). As a result of the competitive advantages of these two invasive species, native species may find increased difficulty reestablishing in rangelands. Few studies have been done that analyze the effectiveness of strategies focused on reducing competition from Kentucky bluegrass and/or smooth broom before seeding native species in southeastern North Dakota. In this study, the impacts of five restoration strategies: 1) control (no treatment used), 2) native seeds drilled into the existing conditions, 3) spring burn prior to drill seeding native species, 4) glyphosate treatment before drill seeding native species, and 5) spring burn with the addition of glyphosate both prior to drill seeding native species were used on a degraded rangeland landscape. The study site consisted of a divided pasture with one side exposed to grazing and the other side was left ungrazed. The five treatments were installed into 15 40 x 100 m plots per side of the pasture for a total of 30 plots in 2010. In 2019, vegetation sampling within each plant was conducted to find if the restoration strategies increased total and/or native C4 grass biomass, reduced Kentucky bluegrass and/or smooth brome biomass, or increased grass species richness.



Poster Session Tuesday 1: Poster Pod 38, Poster 64

ESTABLISHMENT OF NATIVE PLANTS IN SALT-IMPACTED SOIL

Abigail P. Blanchard*, Lora B. Perkins; South Dakota State University, Brookings, SD

ABSTRACT: MS STUDENT

Worldwide, approximately 900 million hectares of land are estimated to be salt-impacted, with 10.6 million hectares in the northern Great Plains (NGP). Naturally occurring salinization results when rainfall moves salts in underlying marine sediments upward through the soil profile. After evaporation, salts remain in the root zone affecting plant germination and growth. Traditional methods to remediate salt-impacted soils, including tile drains and gypsum application, are effective in the irrigated soils of the Southwestern US but detrimental in the non-irrigated soils of the NGP. To combat this issue, new remediation methods are needed. This study investigates the revegetation of eight native plant species using transplanting and seeding, with two objectives assessed: 1) determine which native species are suitable for revegetation and 2) compare whether transplanting or seeding results in better field establishment. Species (four forb and four grass) were chosen based on germination ability in salty conditions. Prior to planting, vegetation was cleared and landscape fabric was placed on the 10 x 120 m plot. Further, mechanical scarification was assessed as a treatment to improve seed performance. Transplants, scarified seeds, and control seeds (n = 2016) were randomly planted throughout the plot. For transplants, mid-season and end of season performance were assessed from plant height, number of flowering heads, and survival. Mid-season survival was almost 50% across all species. *Sporobolus airoides* had the highest survival (81.1%) followed by *Elymus trachycaulus* (75.8%) and *Pascopyrum smithii* (75.4%). Of the forbs, only *Asclepias speciosa* and *Gaillardia aristata* had survival above 30%. *S. airoides* survival increased as salinity increased, making it unique among the species. Results from this study will provide information essential for the remediation of salt-impacted soils in the NGP.



Poster Session Tuesday 1: Poster Pod 38, Poster 65

BRUSH MANAGEMENT OF A WHITETHORN ACACIA-ENCROACHED GRASSLAND ENHANCES RESOURCE-CONSERVING 'SHRUB ISLANDS'

Justin C. Johnson^{*1}, Christopher J. Williams², David P. Guertin¹, Steven R. Archer¹, Frederick B. Pierson³; ¹University of Arizona, Tucson, AZ, ²USDA - Agricultural Research Service, Boise, ID, ³Agricultural Research Service, Boise, ID

ABSTRACT: MS STUDENT

We conducted an integrated suite of measurements to quantify the ecohydrologic impacts of chemical brush management (tebuthiuron) at a shrub-encroached grassland in southeastern Arizona. We addressed two questions: Did tebuthiuron application 1) affect hillslope runoff following high-intensity rainfall?, and 2) alter bare ground connectivity and the magnitude of runoff and sediment transport? Vegetation and soil measurements were conducted in 2018 on rainfall-simulated, small- (0.5 m², n=41) and overland flow-simulated, large- (13 m², n=13) plots in a whitethorn acacia (*Vachellia constricta*) community treated with tebuthiuron (0.84 kg/ha a.i.) in 2013 and on an adjacent untreated area. The treatment successfully decreased live-shrub cover by > 99% from the untreated control to the treatment, and, consequently, increased grass cover by 383%. Importantly, vegetation and hydrologic treatment effects differed by microsites. Grass cover on skeletal-shrub microsites (75%) far exceeded that on live-shrub microsites (12%); interspace grass cover responded less markedly to herbicide treatment (25%) vs. 0% on control. Cumulative runoff from skeletal-shrub microsites during 100 and 120 mm/hr simulated rainfall were 79% and 70% lower, respectively, on the treated site, whereas cumulative runoff from the zones between shrubs were statistically comparable between treatments. Although the basal gap size distribution shifted to shorter gap lengths, rill widths, depths, and velocity during overland flow simulations were statistically comparable. We did, however, measure significantly lower runoff/sediment yields on the treated site at the highest overland flow rate (40 L/min). Our findings suggest mortality induced by tebuthiuron enhanced herbaceous cover on 'shrub islands' that in turn increased their infiltration capacity. The asymmetric runoff/sediment yield response of shrub patches vs. interspaces on treated vs. control sites leads us to hypothesize spatial heterogeneity of hydrologic properties persisted even after recruitment of grass cover. These results indicate resource-conserving patches may be more resilient to certain ecological transitions than previously suspected.



Poster Session Tuesday 1: Poster Pod 38, Poster 66

RESPONSE OF ONE INTRODUCED AND THREE NATIVE SAGEBRUSH STEPPE PLANTS TO ARBUSCULAR MYCORRHIZAL FUNGI INOCULUM

David E. Prado-Tarango^{*1}, Ricardo Mata-Gonzalez¹, Matthew G. Hovland¹, Paul Schreiner²;
¹Oregon State University, Corvallis, OR, ²USDA-ARS, Corvallis, OR

ABSTRACT: Ph. D STUDENT

Inoculation with arbuscular mycorrhizal fungi (AMF) has been recommended for rangeland restoration projects without complete understanding of the effects on individual species. To further characterize plant-mycorrhizal interactions, we evaluated the effect of a commercial AMF inoculum on a variety of plant morphological traits of *Artemisia arbuscula*, *A. nova*, *A. tridentata* ssp. *wyomingensis* and *Taeniatherum caput-medusae* during the first week's post-germination. Seedlings were harvested at 6 and 15 weeks after growing under greenhouse conditions using the following treatments: field soil (from a disturbed sagebrush grassland), inoculated field soil, inoculated autoclaved field soil, and autoclaved field soil as control. We hypothesized that mycorrhizal colonization and plant biomass will increase with the application of the commercial inoculum for plants grown in the disturbed field soil. The effects of different treatments were analyzed using a factorial ANOVA and a Tukey's Test post-hoc analysis. Application of the commercial inoculum did not significantly increase the percentage of mycorrhizal colonization after 6 weeks, as colonization was higher in plants grown in uninoculated field soil than under all other treatments. Total plant biomass of *A. nova* (harvested at six weeks) and *T. caput-medusae* (harvested at fifteen weeks) was greater when grown in inoculated autoclaved soil compared with all other treatments. Total biomass of *A. arbuscula* and *A. tridentata* ssp. *wyomingensis* was greater for plants grown in autoclaved soil without inoculation at six and fifteen weeks compared with all other treatments. Root biomass was greater for all species in autoclaved soil without inoculation compared with all other treatments. Our results suggest that the commercial mycorrhizal inoculum is not effective at the 6-week period for the species tested under greenhouse conditions in the soils used. The commercial inoculum may require additional time and/or more mature plants to be effective.



Poster Session Tuesday 1: Poster Pod 39, Poster 67

PERCEPTIONS OF WILD HORSE AND BURRO MANAGEMENT ON PUBLIC LANDS OF WESTERN US

Marissa N. Humphreys*; Oregon State University, Milwaukee, WI

ABSTRACT: MS STUDENT

For thousands of years horses have roamed the planet and while they evolved in North America, around 10-14,000 years ago they went extinct, and it wasn't until about 500 years that they returned to North America. In 1971 The Wild Free-Roaming Horse and Burro Act was signed and since then the management of free-roaming horses and burros has been a controversial topic and their management has been an uphill battle for the federal agencies that are tasked managing the almost 82,000 animals that are currently on the range and the 40,000 plus animals that are in off-range holding facilities. The federal agencies only have so many resources and tools that they can use to manage the wild horse and burros. However, often times their management practices are slowed or even stopped by advocacy groups and other stakeholders. Why though? Why are these groups pushing back against the federal agencies who are trying to manage and protect the wild free-roaming horses and burros? This project begins to explore the answer to this question by surveying advocacy groups, rescue organizations and stakeholders, and in turn hopes to provide insights and recommendations to management agencies in regards to outreach about the wild horse and burro program and the issues at hand.



Poster Session Tuesday 1: Poster Pod 39, Poster 68

EXAMINING THE EFFECTS OF MAMMALIAN HERBIVORES ON RECRUITMENT AND STAND STRUCTURE OF QUAKING ASPEN

Elizabeth Reikowski*¹, Hall Cushman²; ¹University of Nevada, Reno, Reno, CA, ²University of Nevada, Reno, Reno, NV

ABSTRACT: MS STUDENT

Quaking aspen (*Populus tremuloides*) stands support exceptionally diverse and productive understory plant communities and provide habitat for an array of wildlife species. Unfortunately, this ecologically and economically significant tree species is thought to have declined in many parts of its range in recent decades, due to both adult mortality and reductions in recruitment. Numerous site-specific studies have implicated browsing of young shoots by wild and domestic ungulates as important drivers of the reductions in aspen recruitment. However, few studies have examined the effect of mammalian herbivores on aspen recruitment across large spatial scales, where the abundance, distribution, and species of mammalian herbivores can vary strongly due to contrasting environmental conditions and management practices. We are examining the extent and severity of mammalian herbivory on aspen recruitment using a large and spatially expansive network of aspen monitoring plots in California, Nevada, Idaho, Wyoming, and Utah. Using data from the plot network we are evaluating (1) what topoclimatic, biotic, or management factors predict the severity of mammalian herbivory on aspen recruitment, (2) whether the effect of browsing by mammalian herbivores varies among juvenile trees of different size classes, and (3) whether browsing by wild and domestic ungulates is a major driver of the overall health and structure of aspen stands. This work will allow land managers to more effectively identify the conditions under which aspen may be particularly sensitive to mammalian herbivory and may require wild ungulate and/or livestock exclusion to successfully recruit the next generation of trees. Furthermore, because evidence that ungulates may drive reductions in recruitment is not a unique situation to aspen, this research will have broader implications for informing management decisions and future research in a variety of woody species that are critically important to wildlife.



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MESIC MEADOW HABITAT RESPONSES TO VARIATION IN GRAZING MANAGEMENT: BALANCING SAGE-GROUSE HABITAT WITH LIVESTOCK PRODUCTION

Kenneth J. Randall*¹, Melinda J. Ellison², Tracey N. Johnson¹; ¹University of Idaho, Moscow, ID, ²University of Idaho, Carmen, ID

ABSTRACT: MS STUDENT

Mesic meadows found in sagebrush-steppe provide a unique set of resources for wildlife habitat and livestock production. Greater sage-grouse (*Centrocercus urophasianus*, hereafter, sage-grouse), an Idaho Species of Greatest Conservation Need, rely upon these habitats during brood-rearing because they support diverse communities of forbs, an essential part of juvenile sage-grouse diets. Livestock grazing activities on mesic meadow plant communities and soils may elicit direct or indirect effects on sage-grouse populations reliant upon these communities. Understanding how livestock grazing influences key habitat features of sage-grouse brood-rearing habitat will help inform management decisions on rangelands that provide wildlife habitat and livestock production within mesic meadows. We evaluated effects of variation in intensity and timing of livestock grazing in mesic meadows on sage-grouse brood-rearing habitat. We established 15 pastures at Rinker Rock Creek Ranch in south-central Idaho and stocked them with yearling heifers to evaluate effects of short-duration grazing. We evaluated moderate (30-40%) and high (70-80%) grazing utilization in six pastures in June (16 days) and six pastures in August (16 days) (n = 3 pastures per treatment; n = 12 total). Three pastures provided controls without grazing. We measured heifer performance and plant communities before grazing (< 6 days), after (< 6 days) grazing, and at the end of September to assess vegetation regrowth. We measured heifer body weight to evaluate changes in gain across grazing treatments. We measured vegetation composition, foliar cover, the average height of vegetation by species, biomass, and soil moisture and will compare among our experimental treatments and against other sites where livestock grazing was unrestricted during the growing season. Analyses of these data will provide greater insight into the relationship between livestock grazing and food resources for sage-grouse brood-rearing. Results may be used to guide future best management practices for livestock producers utilizing mesic meadows shared with sage-grouse.



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RESPONSE OF SAGEBRUSH HABITAT CHARACTERISTICS TO FERAL HORSE GRAZING

Jacob D. Hennig*, J. Derek Scasta, Jeffrey L. Beck; University of Wyoming, Laramie, WY

ABSTRACT: Ph. D STUDENT

Following the extinction of native equid species in North America during the Pleistocene, shrubland communities existed in absence of large mammalian grazers for roughly 10 millennia. Shrublands evolved with less grazing pressure compared to grassland and savannah systems and therefore may be more susceptible to damage from introduced large grazers such as feral horses (*Equus ferus caballus*) and cattle (*Bos spp.*) Compared to cattle, feral horses are relatively unmanaged in the United States and little is known about how these animals impact fragile sagebrush (*Artemisia spp.*) systems. Sagebrush habitat is crucial to native wildlife species such as pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and greater sage-grouse (*Centrocercus urophasianus*; hereafter ‘sage-grouse’) to fulfill the food and cover requirements of these iconic species in many areas of western North America. High utilization by horses is thought to decrease sagebrush habitat quality through two mechanisms: 1) grazing that may in turn decrease native vegetation cover and height, and 2) trampling that may increase shrub fragmentation and soil penetration resistance. For sage-grouse, these impacts can translate to decreased nesting habitat, escape cover, and forage availability. Empirical examination of how feral horses affect sage-grouse habitat is lacking; however, these evaluations are crucial as the sage-grouse is an imperiled species that has been petitioned for endangered species listing under the U.S. Endangered Species Act of 1971. We set out to address this knowledge gap by measuring a suite of sagebrush habitat characteristics along a gradient of horse utilization within the Adobe Town Herd Management Area in southern Wyoming, USA in summers 2017-2019. We used spatial regression models to examine the effects of horse utilization on canopy cover of plant functional groups, grass height, and visual obstruction. Increased horse utilization was significantly correlated with increased bare ground cover; however, horse use was not significantly correlated other measured metrics. Our results show that horse utilization may have deleterious impacts on soil health, which may impact the vegetation community in the long-term.



Poster Session Tuesday 1: Poster Pod 39, Poster 71

DETERMINATION OF SPECIES AND SEX IN DEER VIA NEAR INFRARED SPECTROSCOPY OF LIVER TISSUE

Douglas R. Tolleson^{*1}, Kaylee Hollingsworth², Perry Barboza²; ¹Texas A&M University, Sonora, TX, ²Texas A&M University, College Station, TX

ABSTRACT

Near infrared reflectance spectroscopy (NIRS) has been used to determine a variety of chemical characteristics in multiple biological materials but has not been applied to a significant extent in animal tissues. Our objective was to determine the ability of NIRS of liver tissue to discriminate between species and sex in sympatric white-tailed (*Odocoileus virginianus*) and axis (*Axis axis*) deer at the Texas A&M AgriLife Sonora Research Station. During the regular Texas deer hunting season (November) of 2016, 2017, and 2018, liver samples (caudate lobe) were collected at harvest from a total of 87 animals. Samples were stored in whirl-pac bags at -20o C and later thawed to ~24o C for NIRS analysis. Spectra (400-2500 nm) were obtained on liver tissue with an ASD Field Spec using a contact probe directly through the whirl-pac sample bag. Principal component, linear discriminant analysis, and chi-square procedures were accomplished in SAS. Within 62 white-tailed deer samples, 17/22 females (77%) and 32/40 males (80%) were correctly identified. Within 63 male deer samples, 15/23 axis deer (65%) 26/40 white-tailed deer (65%) were correctly identified. When 63 male deer samples were randomly allocated to 2 groups, percent successfully identified was 10/30 for group 1 (33%) and 14/33 for group 2 (42%). There were no differences in the proportion of correct versus incorrect identifications for any of the above comparisons. Prediction of an independent validation set of adult white-tailed deer samples (n = 9 male, 9 female) resulted in 100% correct identification of species but all samples were identified as male. Preliminary results indicate that NIRS of liver tissue was successful in discriminating between species and sex in sympatric white-tailed and axis deer within a given location. Portable NIRS analysis of liver tissue may be useful as a post-mortem diagnostic technique. Further research will explore this capability.



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Poster Session Tuesday 1: Poster Pod 40, Poster 73

DISRUPTION OR DISPLACEMENT: HOW DO LIVESTOCK GUARDIAN DOGS PREVENT DEPREDAATION?

Daniel K. Macon^{*1}, David Lile², Derek W. Bailey³, Tracy Schohr⁴, Leslie Roche⁵; ¹University of California Cooperative Extension, Auburn, CA, ²UC Cooperative Extension, Susanville, CA, ³New Mexico State University, Las Cruces, NM, ⁴University of California, Quincy, CA, ⁵UC Davis, Davis, CA

ABSTRACT

Rangeland livestock operations are increasingly turning to livestock guardian dogs (LGD) to protect their herds from predators. At the same time, laws and regulations that protect predators (especially gray wolves, mountain lions, and grizzly bears) limit lethal control options for ranchers. Despite the increasing use of LGD, very little is known about the direct interactions of LGD with predators. Furthermore, little is known about the relationship between LGD and livestock behavior. Some ranchers have expressed concerns that LGD may push predators onto adjacent ranches or grazing allotments. Some wildlife agencies and environmental nonprofit organizations are concerned that LGD may impact non-target wildlife. Previous work suggests that LGD can 1) discern between threatening and nonthreatening wildlife and 2) disrupt predator behavior rather than physically displace predators to adjacent lands. We are using low-cost geographic position system (GPS) technologies, trail cameras, wildlife surveys, and structured interviews with herders and sheep operators, to evaluate LGD behavior and their interactions with predator and non-predator wildlife on a variety of rangeland production systems. In addition, we are examining the effects of breed, sex, age, and reproductive status on LGD behavior. Our preliminary results suggest that predator response to LGD (disruption versus displacement) depends on a variety of factors, including sheep management (fenced versus herded). The next step in this project will use GPS tracking to examine the spatial relationships between LGD and sheep in different landscapes and production systems, including open-range herded sheep on public land grazing allotments in the Sierra Nevada mountains, fenced sheep on annual rangelands and irrigated pastures in the Sierra foothills, and fenced sheep in short grass prairie pastures in central New Mexico.



Poster Session Tuesday 1: Poster Pod 40, Poster 74

RARAMURI CRIOLLO CATTLE AS LIVESTOCK GUARDIAN AGAINST PREDATORS

Kelly J. Koriakin*¹, Raoul K. Boughton²; ¹University of Florida, Jacksonville Beach, FL,
²University of Florida, Ona, FL

ABSTRACT: MS STUDENT

As the human population in Florida expands alongside a recovering endangered panther population, interactions between the two are increasing. Habitat necessary for continued panther recovery is mostly held by either agricultural or livestock producers and negative interactions will largely affect livestock producers in the form of depredations. There is anecdotal evidence in Colombia that San Martinero cattle integration in beef herds decreases calf depredations by jaguars, yet few studies have been conducted on this topic. We have integrated 11 Raramuri Criollo, a closely related cattle breed, with commercial beef cattle in order to assess their ability to deter negative interactions with predators in south Florida during calving in September through January. In order to capture differences in cattle behavior in the presence of a predator, we deployed a total of 20 GPS collars on Raramuri cattle and commercial beef cows that collect location at 10-minute fixes and record activity levels, in a herd of 91 cattle on 358 acres. Predator presence is monitored by a 375m grid game camera array throughout the pasture/rangeland and will also serve to examine predator avoidance of Raramuri Criollo cattle compared to commercial beef cattle. We identify if there is potential for Raramuri Criollo cattle to serve as guardian cattle for beef herds and discuss their impact on future panther conservation.



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MESOCARNIVORE OCCUPANCY IN A SAGEBRUSH-JUNIPER LANDSCAPE AND ASSOCIATED EFFECTS ON GREATER SAGE-GROUSE NEST FAILURE

Sarah E. McIntire^{*1}, Tracey N. Johnson¹, Mark A. Ricca², Peter S. Coates³; ¹University of Idaho, Moscow, ID, ²USGS-Western Ecological Research Center, Dixon, CA, ³U.S. Geological Survey, Dixon, CA

ABSTRACT: MS STUDENT

Greater sage-grouse (*Centrocercus urophasianus*, hereafter, sage-grouse) have experienced population declines and habitat loss since European settlement. Expansion of juniper trees into sagebrush steppe habitat is cited as a factor affecting population dynamics. In addition to affecting sage-grouse directly, the presence of juniper and resulting changes in landscape composition and structure may influence activity or abundance of sage-grouse predators, but little if any information exists on how the mesocarnivore (e.g., coyotes [*Canis latrans*], red foxes [*Vulpes vulpes*], and American badgers [*Taxidea taxus*]) community uses juniper-encroached landscapes. Our objectives are to 1) examine whether juniper cover is an important environmental gradient that affects mesocarnivore occupancy and 2) evaluate whether sage-grouse nests in juniper-encroached habitats are at a higher risk of being preyed on by mesocarnivores. From 2016-2019 we monitored sage-grouse nests (n=54) in the Owyhee mountains in southwestern Idaho and placed continuously recording DVR video cameras on a subset of nests (n=27) to determine nesting success and identify nest predators. In 2019 we deployed trail cameras (n= 80) throughout our study site from April–August across a gradient of juniper cover to determine occupancy rates of mesocarnivores. At sage-grouse nests we documented 30 depredation events, six of which we could identify predator species using video footage. Recorded depredation events were attributed to red foxes (n=5) and spotted skunk (*Spilogale gracilis*; n=1). Preliminary analyses of trail camera data indicated the presence of five species of mesocarnivores; coyote, red fox, striped skunk (*Mephitis mephitis*), bobcat (*Lynx rufus*), and American badger. We will present additional preliminary results from the mesocarnivore community. Understanding whether occupancy of mesocarnivores may be influenced by juniper will help inform management efforts aimed at increasing sage-grouse reproductive success and survival areas affected by juniper encroachment. Findings are preliminary and provided for timely best science.



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SMALL MAMMALS AND GRASSLAND RESTORATION: LONG TERM MONITORING OF THE STERNBERG NATURAL AREA

Hunter R. Bohn^{*1}, Mitchell J. Greer¹, Morgan A. Noland¹, Curtis J. Schmidt²; ¹Fort Hays State University, Hays, KS, ²Sternberg Museum of Natural History, Hays, KS

ABSTRACT: UNDERGRADUATE STUDENT

The Howard Reynolds Natural Area has been under restoration efforts for multiple years. Restoration of grassland areas has been a major component of the efforts, and while this 20-acre project is not much in comparison to other grasslands, it is still an important piece of the conservation puzzle. Seeding of pollinator-plots, prescribed burning, and other projects have been conducted on the site. Restoration projects like this can have effects on many species of both flora and fauna. The objective of this study is to survey the impact that these restoration efforts are having on the small mammal community. Our study design consists of four trap nights per season with three seasons per year (May, September, and November). The study site contains five transects of 20 Sherman traps placed ~10m apart. Data collection started in the summer of 2016, and trends to date show that the diversity in the study area has been altered and populations have seen both increases and declines over time. Cotton rat (*Sigmodon hispidus*) has been a prominent component of the community from the outset but has changed over time. Numbers of harvest mice (*Reithrodontomys spp.*) and deer mice (*Peromyscus spp.*) have been notable in some years and minimal in others. Other species caught on the site include house mouse (*Mus musculus*), Elliot's short-tailed shrew (*Blarina hylophaga*), and prairie vole (*Microtus ochrogaster*). Our results indicate long term monitoring is required to truly assess the impacts of restoration on the small mammal community.



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LANDCART: LANDSCAPE COVER ANALYSIS AND REPORTING TOOLS

Bo Zhou^{*1}, Michael C. Duniway², Shannon Savage³, Christopher Cole³, Sandra Litschert⁴, Gregory Okin¹; ¹UCLA, Los Angeles, CA, ²US Geological Survey, Moab, UT, ³BLM, Denver, CO, ⁴Quantum Spatial, Denver, CO

ABSTRACT

Major challenges to conservation planning on western landscapes include (1) availability of relevant high-quality field data about habitat, (2) data coverage that allows interpolation and contextualization of field data, and (3) information on how habitats change through time. In addition, there is a need for (4) consistent and thorough monitoring and management of critical wildlife corridors. In response to these challenges, the Bureau of Land Management (BLM) initiated the Assessment, Inventory, and Monitoring program (AIM) which collects data on habitat indicators relevant to broad plant and animal conservation goals. The AIM project has, and will continue to produce, an unprecedented amount of data collected with consistent methods and a statistically valid sampling framework across the lands administered by the BLM. However, remote sensing can extend the spatial and temporal context of AIM field data, increasing its usefulness to BLM management decision processes. Here, we share a new web-tool to facilitate extrapolation of AIM measurements in time and space: Landscape Cover Analysis and Reporting Tools (LandCART; www.landcart.org). LandCART generates RandomForest prediction using AIM plot observations as training data, implemented in Google Earth Engine to create 30-m spatial resolution predictions of key AIM indicators along with uncertainty metrics. A web-based tool has been developed to facilitate use by BLM staff to make AIM indicator predictions on-the-fly at any location over various periods of time (14-day, monthly, seasonally, and annually). This tool also reports spatial and temporal uncertainty associated with predictions. Improvements underway for LandCART include a reporting function that will generate the documentation needed to apply LandCART to formal decision processes and analysis tools to evaluate differences between areas of interest and trends through time. The LandCART team of researchers and agency staff have developed the webtool collaboratively, working diligently to ensure the tool meets BLM needs and is scientifically robust.



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SAMPLE SIZE FOR ACCURATE ESTIMATION OF MEAN HERBAGE MASS IN CAMPOS GRASSLANDS

Martin Do Carmo*¹, Pablo M. Soca², Geronimo A. Cardozo³; ¹Universidad de la Republica, Rocha, Uruguay, ²Universidad de la República, Paysandu, Uruguay, ³Instituto Nacional de Investigacion Agropecuaria, Treinta y Tres, Uruguay

ABSTRACT: MS STUDENT

Estimation of mean herbage mass in individual paddocks in grazing systems is important for livestock managers and researches of various disciplines. The question at sampling from paddocks is the sample size (number of samples) required for accurate estimation of mean herbage mass. The answer to this question is influenced by a number of factors relating to population characteristics (e.g., population size [paddock area] and within-population variability), sampling methods (e.g., random or systematic) and accuracy of estimation (e.g. confidence level and allowable error). The aims of this study were to i) assess the sample size needed to accurately estimate the mean herbage mass and ii) evaluate the effect of paddock area and sampling density on sample size. We used a data set consisting of 273 occasions of herbage mass sampling conducted in 26 paddocks in five sites locating from south to north and northeastern Campos grasslands of Uruguay. Herbage mass sampling followed the standard field methodology of “comparative yield method”. The data were classified by heterogeneity and paddock size within heterogeneity to perform bootstrap for each sampling event to choose the lowest sample with highest confidence from $n = 50$ to $n = 400$. Herbage heterogeneity index in the paddocks ranged from a highest level of 2.5 to a lowest level of 0.04, with the majority (61%) in low heterogeneity (≥ 0.58). As herbage heterogeneity increased, sample size required for acceptable estimation accuracy increased, while paddock area appeared not to affect the sample size. Samples with confidence greater than 90% and less than 10% error of the mean ranged from 100, for less heterogeneous sampling events, to 400 for more heterogeneous scenarios. Under high heterogeneous scenarios of herbage mass, which also cover all the situations less heterogeneous, 400 biomass observations are required for paddocks up to 100 ha.



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DETERMINING APPROPRIATE UTILIZATION MEASUREMENTS FOR MULTISCALE SPATIAL ANALYSIS OF GREATER SAGE-GROUSE HABITAT IN SOUTHERN IDAHO

Jason W. Karl¹, ALEXANDER LAURENCE-TRAYNOR*², Vincent S. Jansen³; ¹University of Idaho, Moscow, ID, ²University of Idaho, MOSCOW, ID, ³University of Idaho, Moscow, ID, ID

ABSTRACT: MS STUDENT

Intensity and timing of cattle grazing can have diverse effects on rangeland vegetation structure and composition which can influence wildlife-livestock interactions. Yet, commonly implemented methods for measuring grazing use were not designed to provide data at broad spatial and temporal scales commensurate with landscape wildlife species such as Greater Sage-grouse (*Centrocercus urophasianus*). Understanding the strengths and limitations of these different methods with respect to their precision and scalability is fundamental to effective management of multiple-use landscapes. In 2012 the University of Idaho, U.S. Fish and Wildlife Service, Bureau of Land Management and others initiated a large-scale 10-year research project investigating the effects of spring cattle grazing on the demographic traits and habitat characteristics of Greater Sage-grouse. Wildlife and vegetation data were collected at 5 study sites in central and southern Idaho comprising more than 30,000 acres of rangeland. As part of that study, grazing utilization has been measured using 5 different methods concurrently, which represent commonly accepted and widely used protocols across rangelands in the west: landscape appearance, biomass clipping from utilization cages, vegetation height/weight, percent cover of grazed plants and ocular estimates of percent forage removed. This study looked at the correspondence between these 5 methods and compared their efficacy across different scales relevant to Greater Sage-grouse life cycles. Results indicate correlation between different methods varies across spatial and temporal scales and in some cases across environmental gradients. Main drivers of non-sampling error such as inter-observer bias varied with method selection. Creating hybrid indicators from combinations of methods proved useful in minimizing error and strengthening statistical inference. Spatial analysis of these measurements with cattle telemetry data may further improve our understanding of patterns of grazing intensity across the study area. These conclusions highlight the importance of selecting appropriate monitoring methods which can provide valuable information for sustainable multiple-resource management.



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LANDPKS APP FOR PLANNING AND MONITORING OUTCOME-BASED GRAZING: NEW FEATURES

Jeffrey Herrick^{*1}, Terri Schulz², Jason Neff³, Rachel Murph⁴, Meghan Mize³, Jonathan J. Maynard⁵, Brandon T. Bestelmeyer⁶; ¹USDA-ARS Research Unit @ The Jornada, Las Cruces, NM, ²The Nature Conservancy of Colorado, Fort Collins, CO, ³University of Colorado @ Boulder, Boulder, CO, ⁴USDA-NRCS, Denver, CO, ⁵USDA-ARS, Las Cruces, NM, ⁶USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Outcome-based grazing requires (1) defining management objectives that are realistic, (2) developing and implementing a management system, and (3) monitoring results. The Land-Potential Knowledge System (LandPKS) can be used to easily and cost-effectively address the first and third requirements. The latest version includes a soil- and ecological-site identification function. This function can be used to define realistic management objectives based on both the long-term (ecological site), and current (ecological state) potential. Soil identification is based on location and improved with user inputs of soil texture (using a simple key) and color (using the phone's camera and a post-it note for calibration). A direct link provides full access to the ecological site description in EDIT. The vegetation monitoring tool is rapid (20 minutes/plot), requires only a yardstick and a pin flag, and generates the same indicators as those used by BLM in its AIM program (though at a lower level of precision). It will also include a new feature providing access to habitat information for selected species in some regions. Comparing this information with current data and the ecological site description can help decide whether it's realistic to manage for desired wildlife species. The new LandManagement module supports agronomic recordkeeping (including precipitation, tillage, fertilizer, weed control, etc.) which can also be used for planning and tracking restoration and remediation treatments. Finally, the new version includes a data privacy option. The LandPKS app is available on both iPhone and Android. More information is available at LandPotential.org.



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USING LIDAR TO ESTIMATE ABOVEGROUND GRASSLAND BIOMASS AND THE EFFECT OF GRAZING ON SPATIAL HETEROGENEITY

Vincent S. Jansen^{*1}, Crystal A. Kolden¹, Heather E. Greaves², Jan Eitel³; ¹University of Idaho, Moscow, ID, ²University of Alaska Fairbanks, Fairbanks, ID, ³University of Idaho, McCall, ID

ABSTRACT

There is a strong link between vegetation heterogeneity and biodiversity in grassland ecosystems. However, quantifying spatial patterns of key metrics, such as aboveground biomass, at landscape scales remains a challenge. This stems from difficulties in accurately estimating grassland biomass at fine scales over large areas and determining what spatial scale is most appropriate to monitor how grassland impacts (e.g., livestock grazing) affect spatial patterns of biomass (i.e., spatial heterogeneity). Here, we use lidar metrics (volume, max height, and intensity) in Random Forest models to quantify (pseudo $R^2=0.59$ and RMSD of 139.4 g m^{-2}) fine-resolution (pixel size 1.0668 m (3.5 ft)) aboveground biomass estimates across a bunchgrass prairie grassland system. To determine both the effects of grazing on the spatial heterogeneity of aboveground biomass and which pixel size is most sensitive to the effects of livestock grazing on grassland heterogeneity, we aggregated fine-resolution biomass maps to coarser pixel resolutions (3m , 5m , 8m , 20m , 30m) across 23 pastures with varying levels of grazing intensity. Following aggregation to coarser pixel resolutions, we observed that semivariogram models produced statistically different ($\alpha = 0.05$) measures of biomass heterogeneity. The range statistic was the only pasture-level semivariogram metric sensitive to grazing, and this relationship was only significant when using the finer-resolution datasets ($\sim 1\text{m}$ to 8m pixels). Our results demonstrate 1) the applicability of lidar data for quantifying biomass in short-statured grasslands, 2) that grazing in Pacific Northwest bunchgrass prairie can decrease spatial heterogeneity of aboveground biomass and 3) that fine-resolution satellite data ($<10 \text{ m}$ pixel sizes) are necessary to effectively monitor the effects of grazing on the spatial heterogeneity of vegetation biomass, an indirect metric of biodiversity at management scales (pasture sizes ranged from 40 to 745 ha) in this grassland ecosystem.



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IMPROVING A BRUSH MANAGEMENT ASSESSMENT TOOL USING DRONE TECHNOLOGY AND ENHANCED LANDSAT IMAGE PROCESSING

Chandra Holifield Collins*¹, Susan Skirvin², Jeffrey K. Gillan², Zachary Winston², Andrew Corrales², Philip Heilman³, Loretta Metz⁴; ¹USDA, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³USDA-ARS, Tucson, AZ, ⁴NRCS, Temple, TX

ABSTRACT

Woody species (brush) removal as a conservation practice is used extensively across rangelands in the western United States. The USDA-Natural Resources Conservation Service (NRCS) Conservation Effects Assessment Project on Grazing Lands (CEAP-GL) is tasked with determining how effective the practice has been; however, land managers lack a cost-effective means to conduct these assessments at the necessary spatial and temporal scales. The use of remotely sensed data is key for such assessments. Thus, the Rangeland Brush Estimation Toolbox (RaBET) was developed through a collaborative effort between USDA-NRCS CEAP-GL and the USDA-Agricultural Research Service. RaBET estimates woody canopy cover in 30m resolution temporal maps covering Major Land Resource Area (MLRA) scale landscapes--thousands to millions of hectares--to aid planning and assessment of the conservation practice. These maps are currently produced using high resolution (0.6 - 1m) National Agriculture Imagery Program (NAIP) aerial photography and medium resolution (30m) Landsat satellite imagery. Unfortunately, in the arid and semi-arid southwestern US, the resolution of NAIP imagery is too coarse to capture fine-leaved shrubby species, and low reflectance signal from small leaf area is difficult to detect with Landsat imagery. Therefore, this study investigates the use of ultra-high resolution (< 1cm) small unmanned aerial system (sUAS, drone) photography as a replacement for NAIP and explores methods to improve Landsat detection of sparse vegetation for the creation of improved RaBET woody cover maps to aid land management.



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GAUGING FLORAL RESOURCES FOR POLLINATORS USING HIGH RESOLUTION DRONE IMAGERY

Nicholas V. Anderson*¹, Steve Petersen², Val J. Anderson², Thomas Bates²; ¹Brigham Young University, Springville, UT, ²Brigham Young University, Provo, UT

ABSTRACT: MS STUDENT

Under the multiple-use management regime established in the United States for federally owned lands, government agencies have come under pressure from commercial apiaries to grant permits for the summer pasturing of honeybees on government lands. Federal agencies have struggled to integrate honeybees into their management plans and have little information to make regulations that resolve how many colonies should be allowed in a single location and at what distance sets of hives should be placed. Many conservation groups have voiced their concerns regarding the introduction of honeybees to these natural lands, as they may outcompete and displace native pollinating species. Assessing the quality of an area in regard to its floral resources, pollen and nectar, can be important when attempting to create regulations for the integration of commercial honeybee operations into a native ecosystem. Attempts are made in this study to determine flower cover using high resolution drone imagery to help assess the floral resource availability to pollinators in high elevation, tall forb communities. Roughly 700 images were captured at 23m above ground level using a drone equipped with a Sony QX1 RGB 20-megapixel camera. These images were stitched together using Pix4D resulting in a 60m diameter high-resolution mosaic of a tall forb meadow. Using the program ENVI, a supervised maximum likelihood classification was conducted to calculate the percentage of total flower cover and flower cover by color (blue, white, and yellow). A complete vegetation inventory was taken on site and the major flowers contributing to each color class were noted. An accuracy assessment was performed on the classification yielding an 89% overall accuracy and a Kappa Statistic of 0.855. With this level of accuracy, drones provide an affordable and time efficient method for the assessment of floral cover in large areas.



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SPATIAL PREDICTION OF ECOSYSTEM STATE TRANSITIONS ON THE TAOS PLATEAU

Alexandra Heller^{*1}, Nicholas Webb¹, Brandon T. Bestelmeyer², Sarah E. McCord³; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³USDA-ARS, Las Cruces, NM

ABSTRACT: MS STUDENT

Land use, climate, and landscape context jointly determine the occurrence of state transitions in terrestrial ecosystems. State-and-transition models (STM) are used to clarify the roles of drivers, and ecological sites (climodaphic land units) represent the effects of landscape context. On the Taos Plateau in northern New Mexico, uncertainty about the patterns and drivers of vegetation state transitions impedes sustainable land management. The efficacy of restoration treatments is highly variable, likely due to unrecognized variation in climate and soils. Similar challenges are ubiquitous across terrestrial ecosystems and in particular landscapes with high spatial variability in soils. We used data from federal vegetation monitoring programs and spatial, environmental, and land use data to test for the role of climate, geomorphology, soils, and land use history on restoration success on the Taos Plateau. The large dataset comprises a suite of recently-established core monitoring methods that are consistent across agencies and provide scalable estimates of resource distribution and land change trends across the western U.S. We used a suite of multivariate methods to characterize vegetation states and their relationships to environmental variables to test propositions in conceptual STMs. Preliminary analysis verified the ecological site concepts which were hypothesized for the study area. Plant functional group abundance and vegetation structure varied within ecological site based on management history, indicating that multiple vegetation states are present on the landscape and correlated with land use legacies. Differences in state changes across gradients of land use and management history inform the relative resilience of sites a spatial context. A workflow for using multivariate analysis of core methods data to inform ecological site and STM concept development, and the spatial prediction of states, is presented for use in other study areas.



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UBETUBES: A NEW RUNOFF MONITORING METHODOLOGY FOR RANGELANDS

Jeremy W. Schallner*¹, Justin C. Johnson², Christopher J. Williams³, Amy Ganguli⁴; ¹New Mexico State University, Las Cruces, NM, ²University of Arizona, Tucson, AZ, ³USDA - Agricultural Research Service, Boise, ID, ⁴NMSU, Las Cruces, NM

ABSTRACT: Ph. D STUDENT

Runoff and erosion rates are key indicators of rangeland health, where highly variable vegetation and soil patterns drive complex hillslope hydrologic processes. Currently, rainfall simulations are used to quantify hillslope runoff and erosion models, which help land managers predict runoff and erosion potential. Rainfall simulations allow for the controlled application of precipitation and measurement of the related runoff across variable landscapes but are typically time and resource intensive. Furthermore, although rainfall simulation data are readily available, measurements of hillslope runoff and erosion from actual weather events are quite limited. To address the high cost of rainfall simulations and the lack of measurements from real events, a low-cost, passive runoff monitoring methodology was evaluated for use on rangelands. We assessed this methodology utilizing “Upwelling Bernoulli Tubes” (UBeTubes) in a controlled setting to determine its potential for rangeland use. Specifically, we evaluated whether the technology was robust to high sediment concentrations typical of rangelands. Our testing coupled traditional flow measurements with those provided by the UBeTubes to evaluate efficacy under a variety of conditions expected during runoff events. Testing employed three phases and began with clean water trials, followed by water preloaded with sediment, and concluded with overland flow across a simulated hillslope. We compared measurements from both traditional methods and the UBeTubes to assess accuracy and precision. The preliminary results of the comparisons suggest that this methodology could be effective on rangelands with slight modification of the UBeTube design. We plan to expand the UBeTube testing through a small field deployment followed by an expanded deployment across multiple ecosystems. Overall, the data collected from this passive runoff monitoring methodology could potentially be used to inform continuing modeling efforts and also provide a low-cost alternative to evaluate land management decisions in the context of runoff and erosion processes.



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NUTRITIONAL DIFFERENCES OF PRONGHORN-PREFERRED FORAGE AND A CARRYING CAPACITY ESTIMATION BETWEEN THE MARATHON AND MARFA GRASSLANDS IN TRANS-PECOS, TEXAS

Katherine E. Haile*¹, Jacob C. Locke¹, Carlos E. Gonzalez¹, Thomas S. Janke¹, Louis A. Harveson¹, Shawn S. Gray²; ¹Sul Ross State University, Borderlands Research Institute, Alpine, TX, ²Texas Parks and Wildlife Department, Alpine, TX

ABSTRACT: UNDERGRADUATE STUDENT

Forbs play an essential role in the diet of pronghorn (*Antilocapra americana*) due to their higher nutritional value compared to other forages (i.e. grasses and browse). In the Trans-Pecos region of Texas, forbs comprise approximately 80% of pronghorns' forage intake. The objective of this project was to evaluate if a difference exists in the nutritional value of forbs of the same species from two different pronghorn restoration areas, the Marathon Basin and Marfa Northwest. Vegetation plots (1m²) were sampled in Marathon ($n = 50$) and Marfa ($n = 125$) during January 2019, the Cold/Dry season which is believed to be one of the most nutritionally limiting time periods of the year. These plots were located across ~21,000 ha in the Marathon Basin and ~84,000 ha in the Marfa Northwest. For this study, only forb species found in both areas ($n = 19$) were used in the comparison. After collection, the samples were dried and weighed to calculate dry matter then ground and tested for acid detergent fiber, neutral detergent fiber, and protein. The data was analyzed using an independent samples t-test to individualistically compare these three values between the species from the two restoration areas. Knowing if there is a difference in nutritional value of forb species between the two areas will help determine if one region could sustain a higher pronghorn density than the other, which may be used by Texas Parks and Wildlife Department and stakeholders as part of pronghorn restoration efforts in the Trans-Pecos.



Poster Session Tuesday 1: Poster Pod 43, Poster 91

A SYNTHETIC-CONTROL APPROACH FOR ASSESSING LANDSCAPE TREATMENT EFFECTIVENESS: PINYON-JUNIPER THINNING IN WESTERN DRYLANDS

Stephen E. Fick*¹, Michael C. Duniway¹, Travis W. Nauman², Colby Brungard³, Anna Knight¹;
¹US Geological Survey, Moab, UT, ²USGS, Moab, UT, ³New Mexico State University, Las Cruces, NM

ABSTRACT

In Western drylands, pinyon-Juniper woodlands are often cleared or thinned to improve a number of ecosystem services including livestock forage (herbaceous cover), sage-grouse habitat (sagebrush cover), and erosion reduction (reduction in bare ground cover). However, the efficacy of these large-scale treatments is seldom quantified at scale, and beneficial effects likely vary widely depending on soil and environmental setting and recent weather. Indeed, some benefits may be only temporary if treatments are on undesirable ecological trajectories. The many instances of pinyon-juniper treatments in the past three decades are thus examples of large-scale natural experiments which cumulatively may yield important ecological and management insights but suffer from insufficient monitoring data and analytical challenges related to lack of replication, randomization, and the availability of a priori controls. Analysis of such large-scale, natural experiments are common in the health and econometrics literature, where relatively sophisticated techniques have been developed to address inherent experimental limitations. Here, we apply a relatively recent technique from this literature, synthetic control, to the assess ecological trajectories of pinyon-juniper woodland thinning, as assessed by remote sensing data. We find that success varies depending on intended outcome (cover of sage, forage or bare ground), climate, and topo-edaphic properties. We also compare outcomes estimated by synthetic control to more simple comparisons and find that the synthetic control method is more robust to sources of confounding noise related to inter-annual variability and satellite imagery.



Poster Session Tuesday 1: Poster Pod 43, Poster 92

A WEB INTERFACE FOR CREATING RANDOM, SPATIALLY BALANCED LANDSCAPE MONITORING DESIGNS

Nelson G. Stauffer*; USDA-ARS, Las Cruces, NM

ABSTRACT

In the monitoring and assessment of landscapes, randomly located sampling plots are often used to minimize sampling bias and enable inference to larger landscape units. In particular, spatially balanced random designs are more robust to spatial autocorrelation and therefore produce data usable for answering multiple management questions. The Generalized Random Tessellation Stratified (GRTS) approach is one technique for creating spatially balanced random designs in natural resources and has been widely adopted by multi-scale terrestrial and aquatic monitoring programs. While the parameters for a GRTS design are relatively simple to specify with stratification polygons and per-stratum sample sizes, generating a design from those inputs has historically required the ability to code using the R package *spsurvey*. As a result, technical skills have been a bottleneck for this statistical approach in resource monitoring programs. To remove this technological barrier, we have developed a web application, the “Balanced Design Tool”, to create GRTS designs through a graphical interface. The tool prompts users to upload polygons describing their study area and stratification then to specify the number of points to draw per stratum before generating a spatially balanced design. Version 1.5, released in October 2019, added significant functionality. The point allocation process now supports three different approaches (manual, proportional by stratum area, and equally by stratum) through a more user-friendly interface. Users can now use an interactive, webmap to evaluate their designs without needing mapping software (*e.g.* ArcGIS). The final downloaded design now includes all the files (including an R script) to recreate the design and design documentation. With this tool, land managers can now create their own reproducible, spatially balanced designs to develop locally appropriate, statistically valid monitoring programs to suit a wide variety of objectives.



Poster Session Tuesday 1: Poster Pod 43, Poster 93

NDVI RELATIONSHIP OF DEPTH TO GROUNDWATER AND PRECIPITATION IN A MESIC PASTURE AREA

Lucas A. Phipps*¹, Tamzen K. Stringham¹, Devon K. Snyder²; ¹University of Nevada Reno, Reno, NV, ²University Of Nevada Reno, Reno, NV

ABSTRACT

Depth to groundwater is highly influential on plant community composition and production and can be indicative of vegetative potential for a given land unit. In 2013, 31 ground water wells were installed to monitor depth to groundwater across the recently acquired BLM land historically comprising Winters Ranch, a portion of the Washoe Valley in western Nevada. Hourly depth to water measurements were recorded since installation of the wells. The location and number of the wells across the valley allows for accurate interpolation of groundwater surfaces across the study area utilizing Kriging and other spatial interpolation methods. Ground water surfaces were interpolated across the study area and related to annual climactic trends. Landsat-8 imagery was gathered since time of its launch in 2013 and images captured during June of each year were assessed using several spectral indices. The Normalized Difference Vegetation Index, or NDVI is a common remote sensing method for assessing plant vigor and cover. Averaging June NDVI values across the study area and comparing depth to groundwater as averaged across the water year and across wells provided a strong Pearson's correlation coefficient ($r = 0.88$). Correlation between pixel values at a given well and depth to groundwater averaged across the year also provided a positive relationship an average correlation coefficient ($r = 0.65$), but only while depth to groundwater was deeper than 1 meter. June NDVI also provided a strong relationship with annual precipitation ($r = 0.74$). Given known baseline values, NDVI derived from imagery captured in June can be utilized to quickly and accurately assess depth to groundwater for non-wetland mesic areas. An assessment of scale of inference and NDVI relationships to groundwater are presented here.



Poster Session Tuesday 1: Poster Pod 43, Poster 94

SEMI-AUTOMATED TREE SEGMENTATION AND QUANTITATIVE STRUCTURE MODELS OF TREES FROM TERRESTRIAL LASER SCANNING POINT CLOUDS IN MIOMBO WOODLANDS OF THE NIASA NATIONAL RESERVE, MOZAMBIQUE

Tracy L. Shane*¹, Robert Washington-Allen¹, Natasha Ribiero², Jonathan Greenberg¹;

¹University of Nevada, Reno, Reno, NV, ²Eduardo Mondlane University, Maputo, Mozambique

ABSTRACT: Ph. D STUDENT

Participation in the United Nations Program for Reducing Emissions from Deforestation and Forest Degradation (REDD+) requires nations to monitor, report and verify changes in carbon stocks over time. In this study, we aimed to develop a semi-automated methodology for processing terrestrial laser scanning (TLS) derived point clouds. This non-destructive methodology may be used to improve carbon stock estimates and better capture changes in miombo woodlands in Niassa National Reserve, Mozambique due to disturbances such as fire, elephant grazing, and agricultural land use. Fourteen permanent 30-m diameter forest stands, that were established in 2004, were scanned during field data collection in 2015 using a Faro 3D 330x TLS. After scan registrations and denoising of the point cloud data, stem cylinders were built and diameter-at-breast height computed from the stem cylinders. Individual trees were segmented into individual point clouds using SimpleTree and then tree heights were calculated from the segmented point clouds. Quantitative Structure Models (QSMs) were computed using SimpleTree to estimate tree volume. QSM processing time ranged from two hours to 48 hours depending upon complexity of the model and the processors used. With improvements to this methodology, repeated TLS measures on the same plots should allow researchers to better track changes in carbon stocks over time.



Poster Session Tuesday 1: Poster Pod 43, Poster 95

MONITORING ACCURACY: GETTING THE RIGHT INDICATORS, IN THE RIGHT PLACES, AT THE RIGHT SCALE

Kurt O. Reinhart*, Matt Rinella, Lance T. Vermeire; USDA-ARS, Miles City, MT

ABSTRACT

Correctly assessing whether rangeland ecosystem services are stable, improving, or degrading is of global importance. In the USA, several plant and soil properties are routinely measured as part of a standardized system for assessing rangeland health. Here we evaluate the effectiveness of several plant and soil properties as indicators of soil water transport in the Northern Great Plains. First, we tested whether appreciable variation in soil water transport (infiltration) was explained by soil (e.g. soil aggregate stability, % soil carbon) and plant properties (i.e. total biomass and composition). Second, we used a meta-analysis to test the generality of the expected positive aggregate-infiltration association. Multiple regression analyses determined that variation in infiltration was best explained by plant community composition variables but not soil properties. Specifically, infiltration was positively correlated with the cover of a tap rooted forb (*Tragopogon dubius*) and negatively correlated with the cover of a fibrous- and shallow-rooted grass (*Bouteloua gracilis*). With a meta-analysis of these and other data from the Northern Great Plains, we found no general aggregate-infiltration association. Our findings counter prevailing scientific and management expectations on the functioning of key range health indicators. Meaningful indicators of soil water transport seemingly fall into two distinct classes. Bare-ground and/or litter cover are likely to explain the largest amount of variation in soil water transport ($r^2 = 0.83-0.99$). Significant albeit lower levels of variation may also be explained by the cover of key plant species ($r^2 = 0.13-0.18$) and plant biomass. We predict that soil infiltration is likely highest at sites with high levels of litter, tap rooted forbs, and plant biomass and low levels of bare ground and cover by shallow- and fibrous-rooted grasses. To maximize predictive accuracy, rangeland health assessment systems should be tailored to individual rangeland types (e.g. ecosites).



Poster Session Tuesday 1: Poster Pod 43, Poster 96

US NATIONAL VEGETATION CLASSIFICATION (NVC) - COMMUNICATION TOOL FOR ECOLOGICAL SITE WORK

Gene A. Fults*¹, Carol Spurrier²; ¹USDA NRCS, Vancouver, WA, ²US Forest Service, Washington, DC

ABSTRACT

E.W. Tisdale, SRM President, estimated there were 928 million acres of rangeland/native grazing lands in the United States in 1957. Presently, only 746 million acres remain (NRI 2015). This disappearing resource is the subject of many ecological, social services, and economic studies that require repeatable and understandable tools of inventory. The U.S. National Vegetation Classification (NVC) is a canopy-based protocol for describing the physiognomy of plant community phases within a confined area of interest. This vegetation description can help communications across boundaries of ownership, interest groups, and agencies. OMB Circular No. A-16 encourages Federal Agency employees to use/crosswalk to the NVC. The NVC Ecological Site Description opportunity makes uncommon plant assemblages easier to describe for then delineated state and transition model (STM) purposes. Generally, there will be many NVC associations that will be grouped within one Ecological Site's STM. This is important for phase-one of Ecological Site concept development within a defined area of interest. Phase-2 would begin collecting production (lbs./ac./yr.) by species and functional groups for the plant associations assigned to the ESD. Photo interpreters may also be interested in a specific photo-signature of aerial photos since canopy is used for remote sensing and map delineation.



Poster Session Tuesday 1: Poster Pod 44, Poster 97

RECONCILING SAGE GROUSE HABITAT MONITORING OUTCOMES

Mike T. Anderson*; Open Range Consulting, Salt Lake City, UT

ABSTRACT

Sage-grouse are being used as an umbrella species to manage for over 350 plant and animal species that also depend on sagebrush communities. Identifying minimum habitat requirements is particularly relevant and establishes thresholds that carry implications to Sage-grouse management. The Utah Greater Sage-Grouse Approved Resource Management Plan Amendment (ARMPA) has set habitat objectives for the Greater Sage-grouse. These objectives are illustrated as thresholds of cover for vegetation functional groups that are 'desired' by Sage-grouse. The thresholds were developed using standard Sage-grouse habitat monitoring methods, Line intercept (LI) used to address shrub cover, and modified Daubenmire for herbaceous cover. Under the Habitat Assessment framework (HAF), the BLM currently uses the Assessment Inventory Monitoring (AIM) protocol which employs Line Point intercept (LPI), to ascertain the cover of the afore mentioned vegetation functional groups. The goal of this project is to determine if the two methods yield the same outcomes. Do standard and current monitoring methods provide the same outputs for the same site?



Poster Session Tuesday 1: Poster Pod 44, Poster 98

SOIL EROSION EFFECTS UNDER CLIMATE CHANGE SCENARIOS IN NORTHERN MEXICO

Jesus A. Prieto AmparÃ¡n, Federico Villarreal Guerrero*, Alfredo Pinedo Alvarez; Universidad Autonoma de Chihuahua, Chihuahua, Mexico

ABSTRACT: Ph. D STUDENT

Climate change and land use/land cover change (LULCC) can influence susceptibility to erosion and, consequently, land degradation. Modeling LULCC allows us to understand the dynamics of the processes occurring and the main drivers of these change. The objective of this study was to analyze the effects of LULCC and climate change on soil erosion in the Conchos River Basin (CRB) in northern Mexico, located in the region of the North America's Grasslands. Future climate change in the study area was inferred using the CCSM4 climate change scenario at 2050 and 2070 under two representative concentration pathways (RCPs) 4.5 and 6.0. For the simulation of the dynamics of the future land use/land cover (LULC), a model developed in Dinamica-EGO was used, which uses stochastic models of the Markov chains, cellular automata and weights of evidence. The Revised Universal Soil Loss Equation (RUSLE) was used to estimate soil loss under the climate change and LULCC scenarios. The results show that rainfall erosion (R Factor) will increase in all RCPs scenarios. The maximum amount of R was 399.64 MJ mm ha-1h-1y-1 in 2050 under RCPs 4.5 and 431.49 MJ mm ha-1h-1y-1 under RCPs 6.0. For 2070 the maximum amount of R was 376.472 MJ mm ha-1h-1y-1 under RCPs 4.5 and 443.07 MJ mm ha-1h-1y-1 under RCPs 6.0. The modeled LULC showed that forests and grasslands are becoming agricultural land and scrublands. The change in C and R Factors accounted for most of the increase in soil erosion and sediment production in the study area during the evaluated future period reaching 491.39 t ha-1y-1 in 2070 under RCPs 6.0. Among the drivers of soil erosion, the LULC (C Factor) is where watershed managers could influence to reduce soil loss due to erosion and mitigate the negative effects of climate change.



Poster Session Tuesday 1: Poster Pod 44, Poster 99 – Poster Withdrawn

ELECTRONIC AND FIELD VERSIONS OF INTERPRETING INDICATORS OF RANGELAND HEALTH (IIRH) FORMS (VERSION 5)

Bob Gillaspay*¹, Alan Bower², Darren Pinnegar³; ¹USDA-NRCS, Davis, CA, ²USDA - NRCS, Red Bluff, CA, ³USDA - NRCS, Chico, CA

ABSTRACT

California NRCS developed an Excel spreadsheet of the forms contained in IIRH version 5. This format allows for minimizing duplicate data entries and inclusion of reference sheets, matrices, and field forms in one electronic file format. The spreadsheet can be protected to prevent inadvertent changes to rangeland health reference information. This spreadsheet could be used as a basis for the development of a rangeland health database.



Poster Session Tuesday 1: Poster Pod 44, Poster 100

ECOLOGICAL SITE GROUP DEVELOPMENT AND PREDICTIVE MAPPING FOR THE UPPER COLORADO RIVER BASIN

Samuel S. Burch^{*1}, Travis W. Nauman², Michael C. Duniway¹, Joel T. Humphries³; ¹US Geological Survey, Moab, UT, ²USGS, Moab, UT, ³Bureau of Land Management, Lakewood, CO

ABSTRACT

Ecological site descriptions (ESD) and associated soil maps have proven to be a useful tool in describing the relationship between abiotic components (soil, climate, topography) and biotic interactions and have become a “common currency” land classification system used by many federal land management agencies. However, ESDs can be difficult to apply to broader-scales due to their often high level of spatial detail, creating a need for a less complicated and data-driven mapping of soil and plant communities. Grouping ESDs that share common ecological dynamics have been proposed as one solution to this problem. In this work, we are creating ecological site groups (ESG) across Major Land Resource Areas 34A, 34B, 35, and 36. Analysis of various digitally-available field collected soil and vegetation data, established state-and-transition models, and structured expert feedback are being employed to develop these new ESGs to provide a framework for a new classification system that is both practical and quantitative. The new groups consolidate roughly 480 ESDs into 21 distinct ESGs. Using a predictive machine learning approach relating observation-based soil survey databases (NASIS/SSURGO, AIM) and available environmental raster data (topography, climate, geology, and satellite imagery) from multiple sources, a field-scale (30-meter) map with pixel-by-pixel uncertainty estimates was produced. These ESGs can provide users with a practical description of the environmental interactions and possible alternate states to facilitate effective future land management decisions.



Poster Session Tuesday 1: Poster Pod 44, Poster 101

RANGELAND MANAGEMENT POLICY EFFECTS ON RIPARIAN VEGETATION

Wayne Smith*¹, Anne Blackwood²; ¹Open Range Consulting, Smithfield, UT, ²Open Range Consulting, Island Park, ID

ABSTRACT: UNDERGRADUATE STUDENT

In a multi-use system, it can be difficult to understand the effect of management policies on a landscape. Disturbances; like livestock grazing, recreational activities and wildlife management all have varying degrees of effect across the landscape. The diffuse nature of these disturbances and their repeated use over decades make it difficult to determine the effectiveness of management policy. Satellite imagery was used to quantify vegetation changes in riparian areas over a 30-year period. Riparian areas were selected, and images with those areas were reclassified to quantify vegetation types. The change was measured over time by vegetation type since management policy was implemented. This technique of measure change across the landscape provides a more accurate account of how the landscape is changing compared to sampling. With this technique we are able to provide land managers a better understand of how management policy is altering the landscape.



Poster Session Tuesday 1: Poster Pod 44, Poster 102

USES AND APPLICATIONS OF VERSION 5 OF THE INTERPRETING INDICATORS OF RANGELAND HEALTH TECHNICAL REFERENCE

Mike L. Pellant*; BLM, Boise, ID

ABSTRACT

Version 5 of the Interagency Interpreting Indicators of Rangeland Health technical reference has been extensively field tested over the past three years and is now available. This version replaces the 2005 Version 4 and is the latest revision of the protocol was initiated in 1994. IIRH is a largely qualitative technique that uses 17 indicators that collectively provide a point in time assessment of three attributes of rangeland health: 1) soil/site stability, 2) hydrologic function, and 3) biotic integrity. IIRH has been used extensively by the Bureau of Land Management to assist in determining if Standards for Rangeland Health are being met on grazing allotments. The National Resources Conservation Service utilizes IIRH as part of its National Resource Inventory on non-federal lands and to assist in the ranch planning process. IIRH has proved to be an excellent communication tool and has been modified to prioritize restoration and invasive species management planning. International applications continue to increase as the value of this qualitative protocol to provide initial information on rangeland health is recognized.



Poster Session Tuesday 1: Poster Pod 45, Poster 103

UNCOVERING TRAITS AND RECOVERING GRASSLANDS: A FUNCTIONAL ASSESSMENT OF OIL AND GAS WELL PAD RECLAMATION

Randi C. Lupardus*¹, Anne C. McIntosh²; ¹University of Alberta, Edmonton, AB, ²University of Alberta, Augustana Faculty, Camrose, AB

ABSTRACT

The use of plant functional traits in reclamation assessments may guide the interpretation of variability in both plant community composition and its functional recovery. We compared plant functional traits and soil properties across 18 grassland sites certified reclaimed from former oil and natural gas well pads in southern Alberta (Canada) of two age classes, young (reclaimed/abandoned 8-10 years) and old (17-30 years), to that of proximate reference native grassland sites. We found that reclamation was not yet able to alleviate the legacy effects of industrial disturbance on soil properties (pH, bulk density, organic carbon and electrical conductivity) of old or young well pads and that the effects were more severe on old well pads. Compared with reclaimed well pads, reference sites contained a higher prevalence of short native species that preferred xeric conditions, had semi-abundant seed production and large seed weight. Young well pads included higher prevalence of species preferring hydric conditions, of therophytes, geophytes and of species with low dispersal capacity, whereas old well pads included more introduced species and a higher prevalence of species dispersed by animals, preferring mesic conditions, and high seed production. Old reclaimed well pads had lower trait functional diversity (FDQ) than young well pads and reference sites. Although both old and young reclaimed sites were statistically different from reference sites in terms of FDQ and community weighted means, young well pads, reclaimed under more recent reclamation criteria, shared more traits with reference sites and appear to be converging towards more similar trait composition to reference conditions. Using a trait-based approach as an indicator of recovery, we were able to develop a mechanistic understanding of biological and edaphic filters influencing community assembly on reclaimed sites. These results can inform future best practices for oil and gas reclamation activities.



Poster Session Tuesday 1: Poster Pod 45, Poster 104

BIOASSAYS: THE ROLE OF SEED BANK MONITORING IN RANGE MANAGEMENT

Dan Harmon^{*1}, Charlie Clements², Mark Freese³; ¹USDA ARS, Reno, NV, ²USDA-ARS, Reno, NV, ³Nevada Dept of Wildlife, Reno, NV

ABSTRACT

Managing the vast acreage of rangelands in the arid western United States, has become one of the great environmental challenges of the 21st century. The complexity of land stewardship requires a multitude of management actions and the cooperation and collaboration of multiple entities. One very important aspect to a good management plan is monitoring. Monitoring includes outcomes of management actions such as timing and intensity of use as well as range improvement practices. Standardized monitoring protocol such as Assessment, Inventory, and Monitoring (AIM) have become universally used to make rangeland management decisions. While this protocol includes virtually every aspect of vegetation and soil stability characterization, seed bank estimates are not included. Seed banks represent one of the best predictors of future site potential and plant community condition and function. While resources such as Ecological Site Descriptions (ESD) and State and Transition models are often used to predict the best range improvement practices for a site, especially after a fire event, they are often landscape generalizations and may not represent the best assessment at the specific site level. Determining the level of cheatgrass competition seeded species will encounter the initial seedling establishment year is critical to make seed mix and rate decisions. We find that fall bioassay seed bank measurements are the best method to determine the level of competition seeded species will face. We will present various bioassay techniques we use to measure seedbanks in research and management activities. Data from our multiple research projects that use bioassays to measure seedbanks will be presented for reference. Bioassay seed bank results from herbicide treatments, soil nitrogen manipulations as well as perennial grass-cheatgrass suppression zones will be presented. Seed bank bioassays are a very efficient and effective tool to monitor and predict future cheatgrass populations to ensure the best range improvement practices.



Poster Session Tuesday 1: Poster Pod 45, Poster 105

IMPOUNDMENT SALINITY IN NORTHWEST SOUTH DAKOTA

Patrick Kozak^{*1}, Lisa Kunza², Kurt Chowanski¹, Dan Heglund²; ¹South Dakota School of Mines and Technology, Rapid City, SD, ²South Dakota School of Mines and Technology, Rapid City, SD

ABSTRACT: Ph. D STUDENT

Salinity impacts water availability and quality for wildlife and livestock in the western United States. In northwestern South Dakota, impoundments are the primary water source for livestock and may impact water availability and quality in riparian corridors used by wildlife such as the Greater Sage-Grouse (*Centrocercus urophasianus*). Impoundment salinity influences water availability and quality, and in areas with limited surface water resources it can be a concern for resource managers. To characterize spatial patterns in salinity, we measured conductivity in water and soil at 160 impoundments across 14 HUC12's totaling 1,184 square kilometers (292,580 acres) in Butte and Harding Counties in northwest South Dakota during the summer of 2019. We evaluated how the impoundment size, spatial distribution across the HUC 12, type (reservoir or dugout), impoundment drainage area, and soil salinity impacted each impoundment. Sampled impoundment conductivities ranging from 101 $\mu\text{S cm}^{-1}$ to 3,247 $\mu\text{S cm}^{-1}$ across the study area. Initial results suggest that soil salinity and impoundment drainage area impact impoundment salinity across all HUC12's. Characterizing spatial variability in rangeland salinity in northwest South Dakota will help rangeland managers make decisions in the context of broader landscape-scale processes and changes across the region.



Poster Session Tuesday 1: Poster Pod 45, Poster 106

IMPACTS OF COMMERCIAL HONEYBEES ON NATIVE BUTTERFLIES IN HIGH-ELEVATION MEADOWS IN UTAH.

Jacqueline E. Kunzelman^{*1}, Nicholas V. Anderson², Steve Petersen³, Robert Johnson⁴, Val J. Anderson³; ¹Brigham Young University, Scottsdale, AZ, ²Brigham Young University, Springville, UT, ³Brigham Young University, Provo, UT, ⁴Stanley L. Welsh Herbarium, Brigham Young University, Provo, UT

ABSTRACT: UNDERGRADUATE STUDENT

Under the multiple use management regime in the United States, beekeepers are continually filing for government permits to use natural lands as summer pasture for honeybees. Utilizing natural landscapes in high mountain ranges may help strengthen honeybee colonies, as this natural setting is generally void of chemical pollutants and pesticides that are found in agricultural and urban settings. However, the introduction of a competitive species could impact the native species occupying these landscapes. While honeybees and butterflies have different life histories, behavior, and foraging strategies, they compete for the same nectar resources. Few, if any, studies have focused on the potential population effects of commercial honeybees on native butterfly abundance and diversity. This study attempts to observe this impact using a paired before-after control-impact (BACI) design. In 2017 and 2018, Malaise trap samples were collected weekly through the months of July and August in two similar areas, each containing nine malaise trap sites for replication. In 2017, samples were taken to analyze trends within the pollinating communities. In 2018, honeybees were introduced to only one of the two areas and a change in trends between the two areas was assessed. Contrary to the original hypothesis, the resulting observation was an overall significant increase in the mean butterfly abundance in the impact areas after honeybees were introduced, while control areas remained relatively stable. Several potential theories are 1) Honeybees are deterring a natural predator/competitor of butterflies that previously limited population growth. 2) Honeybees are consuming resources regularly used by butterflies which extends the foraging time and consequent capture rates of butterflies. 3) Environmental factors were inconsistent between control and impact areas, biasing capture rates. This ongoing research will help determine the suitability of high mountain ranges for the summer pasturing of honeybees and the population impacts on native pollinators.



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