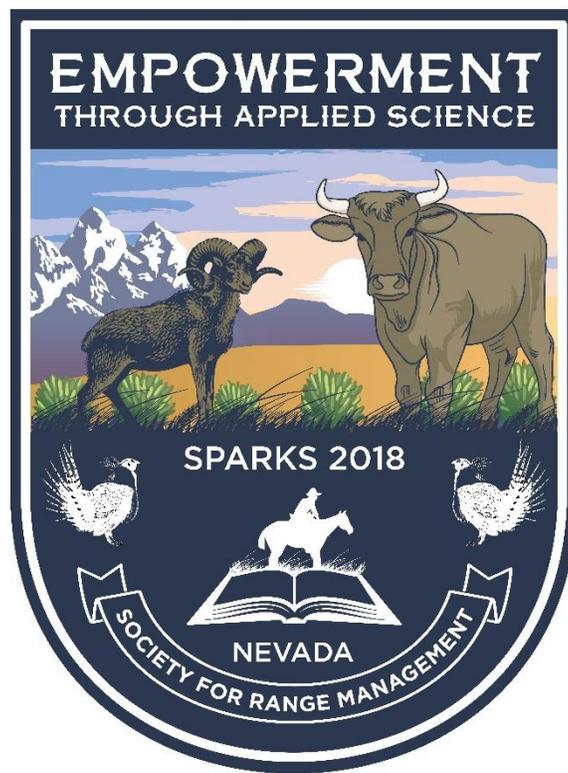


**Abstract Proceedings of the
71st SRM Annual Meeting, Technical Training
and Trade Show**

Empowerment through Applied Science

Jan. 28 to Feb. 2, 2018 - Nugget Hotel, Sparks, NV



BRAND CREATION FOR A PRESCRIBED FIRE CULTURE &NDASH; UTILIZING KEY SOCIAL MEDIA PARAMETERS. Lars Coleman*¹, J. Kelly Hoffman¹, Thomas McDaniel¹, R. Patrick Bixler², Urs P. Kreuter¹, Morgan Russell³; ¹Texas A&M University, College Station, TX, ²University of Texas, Austin, TX, ³Texas A&M Agrilife Extension, San Angelo, TX

ABSTRACT

There is much information about the safe application and ecological benefits of prescribed fire as a rangeland management tool. Accordingly, many federal and state agencies, private entities, and landowner representative associations promote the use of prescribed fire and provide information, training and/or equipment to enhance its safe use. However, there is still widespread public resistance to the broad scale use of this management tool. Social media provide a valuable outlet for positive information about prescribed fire to a broader audience. However, social media are underutilized to bridge the gap between current decision makers and potential prescribed fire users.

Given the rising age demographic of farmers and ranchers across the rangeland of the USA, a new generation of decision makers on these lands is inevitable. The shift to a younger demographic will result in greater use by land managers of social media sites. Building a foundation for information sharing for this group is critical for three reasons. First, there is a need to ensure greater access to information by a newer generation. Second, effective mentorship requires information utilization across multiple media platforms as a supplement to in person discussions. Third, information needs to be shared further through easier means.

Interviews were conducted for landowner representative associations and government agency employees about their opinions of prescribed fire and the use of information about this tool. While increasing interest in disseminating more information about prescribed fire to potential users was identified, there is concern that such information is not being targeted effectively. Information about social media approaches to sharing information about prescribed fire will be presented.

ABSTRACT

Abstract:

The *Managing Species at Risk - Policies and Tools* workshop was sponsored by Environment and Climate Change Canada to discuss current knowledge and management of species at risk (SAR) on the Canadian Prairies.

The workshop focused on two broad areas. One addressed the opportunities in developing sustainable approaches to managing species at risk (SAR) and their needs. This included presentations on the use of tools such as modifying range health assessments, developing beneficial management practices and taking an ecosystem/multi-species approach. The use of citizen science was also explored.

The second area focused on the use of policies to lower the risk for ranchers protecting SAR habitat through conservation/management agreements, incentives such as payment for ecological services and providing additional management information through existing agricultural programs such as the provincial environmental farm plans (EFP).

The following is a summary of themes found in the presentations and discussions following the workshop. This presentation will elaborate on the project approaches and themes.

Primary themes

One size does not fit all. Respect the individuality of each agricultural operation.

Take a multiple species approach.

Getting more information into hands of producers is a good thing

Make the programs voluntary

Management changes are sometimes minimal cost

Economic viability of the operation must be considered.

Consistent long-term funding is necessary to make the programs operational

Strong participation from agricultural organizations is important

The first seven presentations featured projects currently underway under the Species at Risk Partnerships on Agricultural Lands (SARPAL) fund of Environment and Climate Change Canada. The SARPAL initiative is intended to promote voluntary (i.e. non-regulatory) protection of individuals, residences, and/or critical habitat located on commercial agricultural lands, through a partnership approach.

CHILDREN OF EJIDATARIOS WILLINGNESS TO ESTABLISH HOME GARDENS FOR SOCIAL-ECONOMIC IMPROVEMENT IN SONORA, MEXICO. Martha H. Martin Rivera*¹, Maribel Montoya-Juarez¹, Fernando A. Ibarra-Flores¹, Salomon Moreno Medina¹, George A. Rasmussen²; ¹University of Sonora, Santa Ana, Mexico, ²Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

Home garden is crucial for urban survival of many people in northwestern Mexico. Attributes include bringing family members together; production of fresh food, and the potential to meet economic, social, ecological sustainability and spaces for cultural, gender and social stability. The study was conducted at the preliminary school Vicente Guerrero at Ejido Santa Martha aiming to monitor producers' young sons' perception about the implementation of home gardens as means of food production, to promote family unity and as economic input. Surveys were randomly applied to thirty-eight 9 to 11 years old children of ejidatarios (shareholder on common land) during the summer of 2016. Results show that 95% of the children agree to participate in the establishment of home gardens in their school or house. Sixty five percent of surveyors said that during free time they help in home duties. Why to plant vegetables and fruits, 44% said for more plants for eating, 28% to spend less money buying vegetables and fruits. All them agree in having their own home garden and at least 78% of them were willing to spend 2-3 hours a week along with their family taking care of plants. Surveyors agree (65%) to have a necessity of having 20-100 pesos a week for fun. Sixty percent of the students say that they spend free time watching Tv, playing with an electrical devise such computer, tablet or phone. What they like to buy with the money earned in the home gardens: 60% answer that any small farm animal such as chickens, rabbits, ducks and geese; 40% answered that they were willing buying some school supplies such backpacks, notebooks and pencils as well as clothes, shoes and toys. We conclude that home gardens may play an important role in increasing their income, promoting family integration and future economic improvement.

A SYSTEMATIC REVIEW OF US RANGELAND SOCIAL SCIENCE

. Jasmine E. Bruno*¹, Elena Dosamantes¹, Maria Fernandez-Gimenez¹, Kevin Jablonski¹, Hailey Wilmer²; ¹Colorado State University, Fort Collins, CO, ²USDA-Northern Plains Climate Hub, Fort Collins, CO

ABSTRACT

Rangeland science aims to create knowledge to sustain rangeland social-ecological systems over the long term. Range science has made substantial progress on understanding ecological dynamics of rangeland systems and the management practices that sustain them, and these findings have been systematically reviewed and synthesized in various venues. The social factors (e.g. demographics, social norms and networks, institutions, culture, economic incentives) that determine whether sustainable management is implemented have received less attention in the US, and existing research on rancher behavior has not been systematically reviewed and synthesized. We present preliminary findings of a review of US rangeland social science related to rancher decision making. Our overarching goal is to clarify what we know about rancher decision-making and to highlight key evidence gaps and research needs. Key questions guiding our review include: What methods have been used to examine rancher decision-making, and where have they been applied? How have social differences such as race, ethnicity, gender, and class been addressed in the rangeland decision-making literature? What practices/interventions/predictors and outcome/response variables have been considered? What has been the impact of practices/interventions/predictors on various outcomes, and across what timescale? Is there evidence that past rangeland social science has been applied to the design of subsequent education, outreach, policy development or program implementation?

PARTNERS ARE THE KEY TO SUCCESS ON PUBLIC LANDS. Laura K. Snell¹, Jenny Jayo*², Jaycee Decker²; ¹University of California, Alturas, CA, ²United States Forest Service, Alturas, CA

ABSTRACT

Modoc County California lies in the northeast corner of the California bordering Oregon and Nevada. Public land encompasses nearly 70% of the county and 61% of the county is managed by the United States Forest Service as the Modoc National Forest. The Modoc National Forest is a diverse forest with timber, recreation, grazing, obsidian mining, wildlife, and wild horses. Management and restoration of these large expanses of federal land impacts all the residents of Modoc County and has created a unique relationship between the Modoc National Forest and local stakeholder groups. We will share several success stories where diverse groups have worked together on the Modoc National Forest to manage the landscape for multi-use and developed strong networks for success.

INTERNATIONAL COOPERATIVE DEVELOPMENT OF TECHNIQUES FOR SUSTAINABILITY WHEN MANAGING AND RESTORING DEGRADED RANGELANDS

. Tlektes Yespolov¹, Marat Beksultanov², Stefan Strohmeier³, Mira Haddad³, Mark A. Weltz*⁴, Sayjro K. Nouwakpo⁵, Kenneth Spaeth⁶, Ian Burns⁷, Jason Nesbit⁴; ¹Kazakh National Agrarian University, Almaty, Kazakhstan, ²AgriTech Hub Kazakhstan, Almaty, Kazakhstan, ³International Center for Agriculture Research in the Dry Areas, Amman, Jordan, ⁴USDA ARS, Reno, NV, ⁵University of Nevada - Reno, Reno, NV, ⁶USDA Natural Resources Conservation Service, Ft. Worth, TX, ⁷USDA ARS, Tucson, AZ

ABSTRACT

In the United States, 36% of the land is rangeland with 25% of it privately owned and vulnerable to accelerated soil loss. Soil erosion from mismanagement, desertification, and drought affect more than 50% of Asia and 70% of Middle Eastern rangelands. Soil erosion prone rangelands often have decreased vegetation cover, changes in vegetation composition, and altered hydrologic cycle with subsequent loss of productivity and livestock forage availability. While land managers cannot control climate, they can continuously apply and modify management practices to increase ecological potential of a site and promote initiatives for more resilient rangelands. For many Asian and Middle Eastern countries, preventing soil erosion and desertification while mitigating the effects of drought are pre-requisites for economic growth and food security. United States Department of Agriculture (USDA) scientists are working with Kazakh National Agrarian University in Kazakhstan and the International Center for Agricultural Research in the Dry Areas (ICARDA), in Jordan to develop a multiphase approach to validate and deploy various rangeland assessment technologies. The multiphase approach combines use of onsite rangeland assessments, drone and satellite imagery, and natural resource support systems to identify areas with accelerated soil erosion. Once areas of concern are identified, alternative scenarios for arresting soil erosion and rehabilitating the area can be evaluated using the Rangeland Hydrology and Erosion Model (RHEM) and the KINEROS2 watershed model to prioritize and optimize restoration. Typical rangeland assessments for Kazakhstan, Jordan, and the western United States are presented along with discussion of how this approach can be used to inform resource managers to make decisions that increases stability and promotes sustainability of rangelands. Increasing sustainable rangeland management practices and building resiliency to drought across Asia, the Middle East, and the United States, can have a positive economic and environmental impact from a localized to global scale.

MANAGING FOR ECOSYSTEM AND LIVELIHOOD RESILIENCE: A STATEWIDE VULNERABILITY ASSESSMENT FOR THE COLORADO BLM

. Karin Decker¹, Michelle Fink¹, Lee Grunau¹, Corrie N. Knapp*², Shannon McNeeley¹, Renee J. Rondeau³, Tyler Beeton¹, Trevor Even¹, John Gioia², Julia Nave², Bruce Rittenhouse⁴; ¹Colorado State University, Fort Collins, CO, ²Western State Colorado University, Gunnison, CO, ³Colorado State University, Hesperus, CO, ⁴Bureau of Land Management, Denver, CO

ABSTRACT

Increased variability and novel climate regimes challenge the Bureau of Land Management's (BLM) ability to effectively manage for multiple use and ecosystem function. In this poster, we present an interdisciplinary and cross-institutional effort to assess ecological and social vulnerability on BLM lands in Colorado. The ecological vulnerability assessment utilized climate change scenarios, niche modeling, and a literature review to understand the vulnerability of species and ecosystems to climate change. The social vulnerability assessment conducted a grey literature review to understand how the BLM was currently integrating climate change in their planning efforts, and paired a statewide indicators approach with case studies to explore livelihood vulnerability to climate change. By looking at both ecological and social vulnerability, this assessment provides a framework to prioritize management actions for species, ecosystems and livelihoods. The patterns of vulnerability revealed in this assessment will help managers to make informed decisions to increase the resilience of ecosystems and the livelihoods that depend on them.

ECO-ECONOMIC IMPACTS OF DIVERGENT CONSERVATION PARADIGMS IN GRAZED LANDSCAPES. Grace E. Woodmansee*¹, Tina L. Saitone¹, John M. Harper², Kenneth W. Tate³, Leslie Roche⁴; ¹UC Davis, Davis, CA, ²University of California, Ukiah, CA, ³University of California, Davis, Davis, CA, ⁴University of California, Davis, CA

ABSTRACT

Grazing lands across the Globe provide essential habitat for sensitive species. Balancing habitat conservation with the infrastructure needs of a growing population is a central challenge facing planners, conservationists, agriculturalists, and policy makers. Differing paradigms among and within conservation/regulatory entities often results in divergent management strategies on mitigation parcels nested within agricultural landscapes. We are investigating the ecological and economic impacts of alternative conservation strategies for a 2,000 acre wetland mitigation for highway construction on grazing lands in northern California. Ecosystems services addressed in the mitigation strategy include clean water, habitat for sensitive plants and fisheries, and native plant diversity. There are two extreme conservation paradigms evident in the Little Lake Valley Mitigation Plan. The “Tradeoff Paradigm” assumes in-place agricultural activities pose an immediate risk to conservation objectives, and agricultural production must be eliminated or species will be lost. The “Synergy Paradigm” assumes that, given the desired ecological attributes already exist on site in the presence of long-term agricultural management, agricultural production and mitigation can be compatible in new conservation grazing strategies. Potentially, the conservation benefits are dependent upon the agricultural activities. The tradeoff and synergy paradigms have been applied to approximately 500 and 1500 acres, respectively in the Little Lake Valley Mitigation Plan. Compared to pre-mitigation grazing management for optimum agricultural production, we are assessing the ecological and economic impacts of 1) complete removal of grazing (tradeoff paradigm); and 2) grazing management focused on conservation objectives (synergy paradigm). We will present preliminary ecological and economic results from this assessment.

COLLABORATION BREEDS SUCCESS AND EXCELLENT RANGELAND STEWARDSHIP ON THIS NORTHWESTERN ARIZONA RANCH

. Ariana I. Gloria*¹, Andrew Brischke²; ¹University of Arizona Cooperative Extension, Kingman, AZ, ²University of Arizona, Kingman, AZ

ABSTRACT

This study highlights one of the many successful and progressive ranching operations and the people on the land who are doing the work in Arizona. In 1993, Anita Waite and Sherwood Koehn moved from their alfalfa farm in the Central Valley of California to try their hands at ranching in northwestern Arizona. The Cane Springs Ranch, located on the eastern slopes of the Hualapai Mountains, encompasses about 70,000 acres with a checkerboard of Federal, State and private land. These two ranchers understand the importance of collaboration and sound natural resource management. Their collaboration with numerous Federal and State agencies, non-governmental organizations and The University of Arizona Cooperative Extension resulted in an invaluable cooperative management plan, a land exchange in order to keep this prime rangeland from being developed, and countless range improvements beneficial to the health of the land, wildlife and public land users. Despite long-term drought conditions since 1993, monitoring data suggest the plant community has improved. During this same time period, management changed from yearlong grazing to a deferred grazing system. This study explores and details historic and current grazing management practices, collaborative projects that have been completed since 1993, and plant community improvements as evidenced through repeat photography and long-term vegetative trend data. Looking forward, one of the foremost conservation challenges this ranch faces is the invasion of Lehman's lovegrass.

NARROWING THE GAP: DOCUMENTING DECISION CALENDARS TO INCREASE SERVICE PROVIDERS' LITERACY OF WORKING LANDS. Windy K. Kelley*¹, Jeremiah Vardiman², Hannah Swanbom³; ¹University of Wyoming Extension & USDA Northern Plains Climate Hub, Pinedale, WY, ²University of Wyoming Extension, Powell, WY, ³University of Wyoming Extension, Casper, WY

ABSTRACT

Agricultural producers and land managers have decision and operational implementation calendars – some of which are written; however, many of these calendars are subconsciously shared orally from one generation to another. These calendars are instrumental in the success of the management of working lands – especially when one considers inter and intra annual weather variability and extreme events.

However, many service providers of weather and climate forecasts, and other relevant information used by working land managers to make informed decisions are several generations removed from agricultural production and land management. Therefore, the service providers are unaware of when working land managers make and implement decisions, and what information is needed to make informed decisions.

There is a need to document when different types of working land managers are making and implementing decisions, and conditions they consider when making these decisions – directly or indirectly related to weather and climate. Additionally, there is a need to share these decision calendars with service providers to increase their literacy of *working lands*. In theory, increasing the literacy of service providers will result in more timely delivery of relevant information enabling working land managers to adapt their decision-making and implementation, which would result in more resilient working lands.

We are starting to document decision calendars in several locations in Wyoming and Colorado through workshops with *working land managers*. We will assess the received information and then explore how to share the decision calendars with service providers in a useful and useable format.

WHEN RANCHERS DON'T KNOW WHAT TO DO: CARE AND RANGELAND MANAGEMENT DECISION-MAKING UNDER UNCERTAINTY

. Hailey Wilmer*; USDA-Northern Plains Climate Hub, Fort Collins, CO

ABSTRACT

This poster asks: how do ranchers know what to do when they are faced with a decision under high levels of complexity and uncertainty? In the semi-arid Western Great Plains of North America, rancher decisions have implications for rangeland ecosystems and for livelihoods. Adaptive management research has largely ignored the emotional geographies and ethical frameworks that enable decision-making in surprising or highly variable situations. I propose adding the conceptual lens of *ethics of care* to the adaptive management research toolbox enables a more complete exploration of this phenomenon. I evaluated repeated interviews with ranchers in the western Great Plains to a) compare decision-making under relatively certain and uncertain conditions and b) to explore how ethical frameworks helped ranchers identify and prioritize management actions. I describe how traditional ranching practices relate to justice-based ethics in more certain conditions, while care-based ethics are useful in new and uncertain decisions. Rancher practices of care also reveal three themes: 1) care depends on ranchers feeling some level of control in complex systems; 2) ranchers' stewardship ethic prioritizes care for situated livelihoods (those tied to specific places and contexts); and 3) care ethics lead to a "managing for the middle" paradigm (e.g. conservative, static stocking rates and homogenous cattle distribution) because care is associated with limiting both economic risk and exploitation of rangeland resources. I consider how this analysis of care ethics and critical gaps in rancher justifications for management decisions enhances existing economic and sociological theories of rancher decision-making processes. I conclude by arguing that efforts to promote management for heterogeneity on rangelands through the restoration of processes like fire and prairie dog populations should consider both the economic and ethical considerations of ranch managers.

INTRODUCING VERSION 5 OF INTERPRETING INDICATORS OF RANGELAND HEALTH. Mike Pellant*¹, Patrick Shaver², David A. Pyke³, Jeffrey Herrick⁴, Fee Busby⁵, Gregg Riegel⁶, Nika Lepak⁷, David Toledo⁸, Beth A. Newingham⁹, Emily Kachergis¹⁰; ¹BLM (retired), Boise, ID, ²NRCS (retired), Monmouth, OR, ³U.S. Geological Survey, Corvallis, OR, ⁴USDA ARS, Las Cruces, NM, ⁵Utah State University, Logan, UT, ⁶USFS, Bend, OR, ⁷BLM, Boise, ID, ⁸USDA-ARS, Bismarck, ND, ⁹USDA-ARS, Reno, NV, ¹⁰BLM, Denver, CO

ABSTRACT

Interpreting Indicators of Rangeland Health was initiated in 1994 as a qualitative, rapid assessment technique to evaluate rangeland health. Seventeen field indicators are used to rate three attributes of rangeland health: 1) soil/site stability, 2) hydrologic function, and 3) biotic integrity. The published versions of this protocol are version 3 (2000) and version 4 (2005). Version 5 represents a continuing effort by an interagency cadre to improve the use of and consistency of results when using this protocol. The revision improves the development or modification of reference sheets and clarifies that the reference for conducting evaluations is the *natural range of variability* within the natural disturbance regime of the reference state. More emphasis is also placed on the functional/structural worksheet in conducting evaluations. This revision also supports linking qualitative and quantitative measurements, where quantitative measurements may also be used for baseline monitoring. A provisional copy of version 5 will be posted online and field-tested in 2018. Input from field tests will be incorporated into the published technical reference available in early 2019.

GUIDE TO CO-DEVELOPING DROUGHT PREPARATION PLANS FOR LIVESTOCK
GRAZING ON SOUTHWEST NATIONAL FORESTS. Kelsey L. Hawkes, Mitch McClaran*,
Michael A. Crimmins; University of Arizona, Tucson, AZ

ABSTRACT

The purpose of this *Guide* is to assist Southwest Region 3 Forest Service managers and livestock grazing permittees to work together to co-develop and implement a Drought Preparation Plan for a national forest livestock grazing permit. A Drought Preparation Plan identifies strategic, proactive livestock management practices that can be implemented ahead of time in order to increase management flexibility to respond and cope with possible future drought conditions. Planning ahead is essential because: 1) Region 3 Policy defines drought as a Standardized Precipitation Index value of minus 1 or lower (i.e. drought) which occurs on average 1 in 6 years, and; 2) new practices on national forests must first be approved by through the National Environmental Policy Act (NEPA) review process, which can often take several years to complete. This *Guide* uses a series of 6 simple worksheets to walk the two parties through a scenario planning process to: 1) understand drought impacts and assess their current and desired level of preparedness; 2) identify issues with preparation; 3) co-develop and prioritize proactive practices to resolve those issues, and 4) prepare to navigate through the NEPA review. The two parties are expected to then: implement NEPA-compliant, proactive practices before the next drought; select from a greater number of management options when responding to drought; then reassess drought impacts and preparation needs. Working together has the benefits of a shared vision and expectations, improved trust, co-learning, and more efficient management. The *Guide* is one output from a project funded by the National Oceanic and Atmospheric Administration Sectoral Applications Research Program (2014-2017) where researchers and extension professionals from the University of Arizona worked together with Forest Service managers and livestock grazing permittees from the Tonto National Forest to explore drought-related challenges to operating and administering livestock grazing permits in national forests.

MULTISAR &NDASH; EMPOWERING LANDOWNERS TO CONSERVE HABITAT FOR SPECIES AT RISK

. Lee Moltzahn*; Alberta Conservation Association, Lethbridge, AB

ABSTRACT

Applying Proven Strategies to Develop a Customized Management Plan for Producers in Southern Alberta, Canada

MULTISAR is a multi-partner program that collaborates to conserve species at risk through voluntary habitat stewardship, while maintaining viable ranching operations in Alberta's native grasslands. Our primary partners are landholders, the Prairie Conservation Forum, Alberta Conservation Association, Alberta Environment and Parks, Cows and Fish, Canadian Cattlemen's Association, Canadian Round table for Sustainable Beef, and Alberta Beef Producers (sit on Advisory Team). Funding for MULTISAR is also provided by Environment Canada.

MULTISAR provides tools for landholders interested in conserving species at risk. A Habitat Conservation Strategy (HCS) is a detailed, in-depth and free customized ranch plan that balances healthy rangelands with quality wildlife habitat through grazing recommendations and habitat improvements. The process starts with a collaborative agreement between the landholder and MULTISAR and includes detailed wildlife surveys, range inventories, riparian health assessments, and information gathering on current management practices and ranch history. We start this process by overlaying a biophysical grassland dataset on the property. The Grassland Vegetation Inventory (GVI) is a comprehensive GIS product that represents Alberta's new vegetation inventory for the Grassland Natural Region of the province. GVI is comprised of ecological range sites based on soils information for areas of native vegetation and general land use for areas of non-native vegetation (i.e. agricultural, industrial, and residential developments). The GVI polygons form the basis on which all the ground surveys are built upon.

The results of the surveys conducted by Biologists, Agrologists, and Riparian Specialists are analyzed and compared with landowner knowledge to create a management plan unique to the property. In consultation with the landowner, recommendations are made that would empower them to maintain and/or enhance native grasslands and habitat that support species at risk.

YAVAPAI COUNTY NATIVE AND NATURALIZED PLANTS: A DATABASE FOR PLANT ENTHUSIASTS. Jeff W. Schalau*¹, Sue Smith²; ¹University of Arizona Cooperative Extension, Prescott, AZ, ²Yavapai County Master Gardener, Prescott, AZ

ABSTRACT

Yavapai County Native and Naturalized Plants (YCNPNP, <http://cals.arizona.edu/yavapaiplants>) is a web-based plant database designed to assist everyday people in identifying native plants of Arizona's Central Highlands Transition Zone. The website uses non-technical language instead of botanical terms, and features photographs showing plants at various times of year to capture seasonal differences in appearance. The YCNPNP search function provides users a variety of searchable fields. Known data field information is entered and results return a series of thumbnail pictures to help narrow the search. Once a thumbnail is selected a variety of photos of that species are displayed allowing users to match the plant they saw in the field with the photo. Detailed descriptions of each plant are also included. In September 2017, the YCNPNP database included 786 plants (13 cacti, 507 forbs, 127 grasses, 65 shrubs, 65 trees, 6 succulents, and 3 vines). Yavapai County Master Gardener volunteer and native plant enthusiast, Sue Smith, is a retired web programmer and leads the project. Thirteen other Master Gardener volunteers and professionals have contributed photographs and populated the plant descriptions. At its launch in 2010, the YCNPNP website had 75 plants and over 100 photos. The website is used by multiple educational institutions, agencies, and non-profit organizations and received 103,905 pageviews in 2016 (from Google Analytics). Yavapai County Master Gardeners continue adding plant photos and descriptions to the YCNPNP database. Several requests for use of YCNPNP photos are received each year. These are granted if the intended use is for educational purposes.

SAN FRANCISCO GOLD MINE IS TRAINING SOCIETY FOR RANGE RESOURCES CONSERVATION IN CENTRAL SONORA MEXICO. Salomon Moreno Medina*¹, Teodoro Ramos Estrada¹, Martha H. Martin Rivera¹, Fernando A. Ibarra-Flores¹, Fernando Jr. A. Ibarra-Martin¹, George A. Rasmussen², Rafael Retes Lopez³; ¹University of Sonora, Santa Ana, Mexico, ²Texas A&M University-Kingsville, Kingsville, TX, ³University of Sonora, Hermosillo, Mexico

ABSTRACT

Gold mining is an important activity for rural workers in Northwestern Sonora, Mexico. Mining is one of the top ten occupations with the greatest number of employees and income, but no data is available indicating what workers think about mining activities impact on the regions natural resources (rangelands and water). This study was conducted during 2014 in Estacion Llano Sonora, Mexico located at the San Francisco Mine. The objective was to understand what employees think about mining and its impact on society and surrounding natural resources. Three hundred surveys were sent to employees selected at random from the official list of the local mine. The number of surveys where determined to provide a 95% of confidence ($P < 0.05$). Data obtained suggests that: Fifty five percent of the workers are 31 to 50 years old and employment from the mine was the main source of income in 68% of the household. The average income they get from the mine varies from \$4,000 to \$12,000.00 pesos a month. Income from other employment made up from \$2,000 to \$3,200 a month. All mine employees surveyed agreed that natural resources could be used for a livelihood, responding to: 26% water, 17% soils, 17% plants, 14% animals, 14% wood and charcoal and 12% seeds and fruits. Eighty percent of the workers received some type of natural resource training from the mine. Seventy percent recognize the company has invested money and efforts to train employees and their family members in range management for natural resource conservation. Examples of training they cited in the survey included water harvesting and conservation along with seed harvesting for range improvement practices, proper grazing strategies for cattle and reforestation. In conclusion, the training provided by the mine has improved the awareness of the local people for proper natural resource management.

EJIDATARIOS WILLINGNESS TO ESTABLISH HOME GARDENS FOR SOCIAL AND ECONOMIC IMPROVEMENT IN SANTAANA, SONORA, MEXICO. Fernando A. Ibarra-Flores*¹, Maribel Montoya-Juarez¹, Martha H. Martin Rivera¹, Salomon Moreno Medina¹, George A. Rasmussen², Rafael Retes Lopez³; ¹University of Sonora, Santa Ana, Mexico, ²Texas A&M University-Kingsville, Kingsville, TX, ³University of Sonora, Hermosillo, Mexico

ABSTRACT

The economy of most ejidatarios in northern Mexico are struggling due to economic and social problems. As incomes decline more pressure is usually put on the land leading to overuse of their range resources. This study was conducted at Ejido Santa Ana Viejo and Santa Martha aiming to monitor producers' perception about the implementation of home gardens as means of food production, to promote family unity and to increase family income. Surveys were randomly applied to one hundred and ten ejidatarios during the summer of 2016. Descriptive statistics were the means for data analysis. Results show that 95% of small (cattle) farmers agreed to establish home gardens within their fields (60% men vs 40% women). Women showed the greater interest in participating in this project. Mothers believe that growing vegetables like tomatoes, chili, squash, carrots, onions, potatoes, radishes, okra and others in their backyards could reduce from 30 to 75% their expenditure in the purchase of these products. They believe that if three members of the family invested two hours of labor per day in this endeavor, it would suffice to accomplish their goals. About 95% of surveyors underlined the low participation of children and teenagers in farming operation. They believe that excessive use of cell phones and tablets plus the time they spend in school, are affecting family behavior and every day it becomes more difficult to involve them in farming activities such as milking, cheese production, planting and irrigating forage feeds for grazing animals. Ninety five percent of the surveyors view this project as an ideal alternative to bring the family back together. We conclude that home gardens may provide an alternative income source to increase household stability. In addition, parents felt it could, promote family integration and in the future, better their social rangeland management.

EVOLUTION OF THE DIFFICULTY DEGREE OF THE SRM INTERNATIONAL RANGE PLANT IDENTIFICATION CONTEST

. Juan M. Martínez-Reyna*; Universidad Autónoma Agraria Antonio Narro, Saltillo, Coahuila, Mexico

ABSTRACT

The degree of difficulty of the Range Plant Identification Contest has varied over time. To show its evolution a scatter plot with the scores of the first three places per team was elaborated. Data were not complete for all years. For the period 1955-1980 data were obtained for 10 years and for the period 1981 to 2016 data were available for 34 years. There are three distinct stages marked by the years 1983 and 1999. In the stage of 1955 to 1982 the first three places had very similar scores and a reduced degree of dispersion is shown. The first place mean score was 97.89% and the difference between the first and third place means was 2.16 percentage points. In the second stage from 1983 to 1996, scores were reduced, the first place mean score decreased to 95.69%, which is very similar to the third place mean score in the previous stage. The difference between the first and third place mean score increased to 4.66 percentage points. Finally, in the stage from 1999 to 2016 there was a great reduction in the means and a greater dispersion of the grades was shown. The mean of the first place score, 91.99%, was very similar to that of the third place score of the second stage. The difference between first and third place, which was 8.43 percentage points, increased considerably when compared to those obtained in the previous stages. After analyzing the graph and observing the trend lines it becomes evident that the contest has increased its difficulty over time. This increase has been because of the changes on the Contest Rules as well as by the increase of more challenging specimens such as seedlings and barks

COMPARING DIFFERENT SMALL UNMANNED AERIAL SYSTEMS (SUAS) FOR RANGELAND MANAGEMENT. . Steve Petersen, Teresa Gomez, Grayson Morgan*, Ryan Jensen; Brigham Young University, Provo, UT

ABSTRACT

Small unmanned aerial systems (sUAS) have proven useful to identify and map vegetation species. Scientists and rangeland managers have access to a range of sUAS vehicles and sensors for quantifying rangeland environments. This purpose of this study was to compare two sUAS, the DJI Phantom 4 with a Sentera Single Sensor NDVI camera and the 3DR Solo Quadcopter with Sony QX-1 RGB and NIR cameras, to determine which provides the most accurate data used in creating orthomosaic images. These images can then be processed to discriminate vegetation life forms (grasses, forbs, shrubs), individual plant species, or surface attributes (density, cover, percent bare-ground, litter). Image data were acquired over basin and range sites just west of Elko, Nevada. Flight missions were flown at 100ft above ground level using automated flight paths, and individual images were processed into an orthomosaic using Pix4D software. Processing the Phantom 4 data was more automated than processing 3DR Solo Data, reducing the number of steps and overall time required to complete the process. However, preliminary analysis suggests that there may be more spectral detail in the data acquired by the SONY QX-1 cameras flown on the 3DR Solo sUAS. E-cognition object-based image analysis was conducted on images from both sensors, and compared with spectral classification techniques. Preliminary results suggests the both platforms are effective in acquiring large datasets that can be processed into orthomosaics preparatory to additional image classification. With well-designed geolocation abilities, data collection and initial processing is simplified for images collected by the DJI Phantom 4. Therefore, while the DJI Phantom 4 provides easy and rapid image processing and analysis, the 3DR Solo provides high quality images in relation to spectral analysis. This information can help managers determine which drone will provide the most useful platform and products considering the type of monitoring or range assessment desired.

SAMPLING PERIOD LENGTH NEEDED TO CHARACTERIZE CATTLE TERRAIN USE ON RUGGED RANGELAND

. Margaret R. Gannon*¹, Tatjana J. Mercado¹, Derek W. Bailey¹, Milton G. Thomas², Scott E. Speidel², Richard M. Enns²; ¹New Mexico State University, Las Cruces, NM, ²Colorado State University, Fort Collins, CO

ABSTRACT

Terrain use and grazing distribution traits in cattle are difficult to evaluate because movement patterns are temporally variable due to ever changing climatic and forage conditions. Ongoing research suggests that terrain-use phenotypes can be inherited and potentially used in beef cattle genetic improvement programs. Terrain use can be monitored with GPS collars, but the length of tracking is constrained by battery life and on-site management plans. Cattle tracking studies have varied from days to months. The objective of this study was to determine if shorter, 30- to 60-day, sampling durations were as effective as a 3 month tracking periods for characterizing slope and elevation use, and vertical and horizontal distance traveled from water of individual cows. Fifteen Limousin cows from a herd of 250 cows were tracked at 15-minute intervals for 92 days during late winter and early spring in a 9,065 ha pasture that included both gentle and rugged terrain. Terrain use during 30- and 60-day periods at the beginning and end of the tracking were compared to the full 92-day period. Slope, elevation, and vertical and horizontal distance from water from the full sample period were regressed on values from the shorter data subsets and correlations were calculated between sampling periods for each pair of terrain use metrics. The 60-day periods showed strong agreement with the full 92-day period with correlation coefficients varying from 0.90 to 0.97 ($P < 0.05$). Correlations between 30-day periods and the 92-day period varied from 0.30 ($P > 0.05$) for distance to water during the early period to 0.90 to 0.93 ($P < 0.05$) for all traits during the late 30-day period. These preliminary analyses suggest that 2-month tracking periods are equivalent to 3-month tracking periods for identifying differences in terrain use among beef cows.

A COLLABORATIVE APPROACH TO AIM IMPLEMENTATION ACROSS THE WEST

. Paul Hood¹, Corey Lange¹, Sylvia Leal¹, Kaitlin Lubetkin², Madison Most¹, Cassandra Rivas*¹;
¹Great Basin Institute, Reno, NV, ²Great Basin Institute, Boise, ID

ABSTRACT

The Great Basin Institute (GBI), in partnership with the Bureau of Land Management (BLM), has implemented the Assessment, Inventory, and Monitoring (AIM) strategy to conduct ecological assessments of rangelands across the West. In 2011, this partnership began in Nevada and has since grown to include partnerships with Washington, Oregon, California, Idaho, Wyoming, and Utah. GBI-coordinated field crews work closely with BLM field and district offices to respond to needs of each BLM jurisdiction while maintaining consistency across states in terms of field protocols, study design, site selection, and data management. This approach has allowed collection of standardized data to inform land management concerns at multiple scales, ranging from local to west-wide. To ensure data integrity, GBI has developed a rigorous quality assurance and quality control methodology, which includes standardized supplemental training and use of a custom database application requiring crews to work closely with a data specialist. Moreover, final reports that include methodology and summary statistics provide an additional product to aid the BLM in land management decisions. GBI's standardized approach to AIM protocol implementation produces consistent, comparable, and scalable rangeland data to characterize and monitor ecological trends. High quality data resulting from GBI/BLM AIM partnerships inform management decisions such as livestock grazing permit renewals and sage-grouse habitat conservation.

INTEGRATING CLIMATE DATA WITH RANGELAND MONITORING USING
MYRAINGELOG. Ashley L. Hall*; University of Arizona, yuma, AZ

ABSTRACT

Precipitation is both highly spatially and temporally variable in Arizona, which adds a major challenge to decision-making for livestock allotments. MyRAINgeLog allows users to not only log precipitation observations but also track if the observation is above or below average for a specific time period and location. This information is critical to interpreting on the ground conditions and puts small-scale observations into a larger climatological context. At two allotments in central Arizona, long-term precipitation data entered into MyRAINgeLog and paired with rangeland monitoring data. Information on the amount and timing of precipitation can be an important piece of the puzzle when interpreting changes in vegetation from year to year. After several years, an underlying relationship between vegetation changes and precipitation at each ranch will become more apparent. Understanding these fluctuations can help adapt management in years of drought. Ranchers can anticipate how vegetation might change with a decrease in precipitation based on prior years and adapt their management efforts. MyRAINgeLog combined with rangeland monitoring data, repeat photography, and records about management actions provide multiple tools for ranchers in developing an allotment specific drought management plan.

EFFECTIVE GRAZING USE MONITORING FOR PUBLIC LAND MEADOWS AND RIPARIAN AREAS

. David Lile*¹, Laura K. Snell², Kenneth W. Tate³, Danny J. Eastburn⁴, Grace E. Woodmansee⁵, Neil McDougald⁶, Leslie Roche⁷; ¹UCCE, Susanville, CA, ²University of California, Alturas, CA, ³University of California, Davis, Davis, CA, ⁴University of California - Davis, Davis, CA, ⁵UC Davis, Davis, CA, ⁶UC Cooperative Extension, Madera, CA, ⁷University of California, Davis, CA

ABSTRACT

Mountain meadows and riparian areas provide essential summer forage for ranching operations in much of the west, but such areas also provide many other critical resources and ecosystem services. As such grazing use intensity on riparian areas remains a controversial issue particularly on public land grazing permits. Grazing monitoring programs are designed to help managers 1) assess the effectiveness of riparian grazing strategies; 2) adaptively manage grazing at the allotment or sub-allotment scale; and 3) demonstrate resource management outcomes to public stakeholders. While monitoring data is a valuable management tool, available staff and funding resources can be limited. To optimize the quality and quantity of grazing utilization data we seek to develop a template for monitoring riparian area grazing use on public lands. We present results from two years of data from a collaborative monitoring program involving the University, the Forest Service and stakeholders. A total of 74 study sites have been established on six National Forests and 34 different grazing allotments in California. Mean vegetative production of enrolled study sites was considerably higher in 2016 (3760 kg/ha) compared to 2015 (2776 kg/ha), while mean grazing intensity was only slightly greater in 2015. We compare and discuss metrics related to common grazing standards including herbaceous utilization, browsing of woody vegetation, streambank stubble height, streambank disturbance (trampling), as well as livestock fecal load density. From the first to the second field season, mean length of time to collect end of season grazing use data decreased from 37 minutes to 25 minutes per site, perhaps signaling improved efficiency with greater experience in the protocol. Our results help guide public land managers and grazing permittees in the development of effective grazing use monitoring programs and understanding of grazing data.

RIPARIAN HEALTH ASSESSMENT: AN AWARENESS BUILDING AND RESTORATION MONITORING TOOL. Jennifer Caudron*¹, Carolyn Ross², Ross Adams³; ¹Alberta Riparian Habitat Management Society "Cows and Fish", Edmonton, AB, ²Alberta Riparian Habitat Management Society "Cows and Fish", Red Deer, AB, ³Alberta Riparian Habitat Management Society "Cows and Fish", Lethbridge, AB

ABSTRACT

Poster Title: Riparian Health Assessment: An Awareness Building and Restoration Monitoring Tool

Poster Authors: Jennifer Caudron, Carolyn Ross, Ross Adams: Alberta Riparian Habitat Management Society (Cows and Fish)

Poster Dimensions: 48"x45"

Poster Abstract: Riparian areas account for as little as 2% of the settled portion of Alberta's landscape, but they provide essential ecological functions, including water storage, forage production and critical habitat for two thirds of wildlife species, including threatened and endangered species. Healthy functioning riparian areas offer resiliency, ecological services and stability. There are several tools that are useful for evaluating restoration success in disturbed uplands, but restoration monitoring tools for streams and wetlands tend to be focused more on avoidance of wet areas or compensation for environmental damages when wetlands are disturbed. For the past two decades, Cows and Fish has led and championed the use of Riparian Health Assessment tools to help land managers, landowners, livestock producers and others to improve riparian health and mitigate and reduce the negative impacts of land use on watersheds. However, we increasingly find that the tool is also useful for planning and monitoring restoration of natural and human-caused disturbances affecting streams and wetlands. The riparian health assessment promotes understanding of the ecological elements and functions that must be recovered to successfully restore riparian areas, and provides a set of metrics based on scientific parameters that are useful in evaluating whether restoration efforts have been successful at achieving a healthy, functioning riparian area.

The poster will demonstrate the riparian health assessment tool and provide specific illustrations and examples of how the tool can be used to plan and evaluate restoration of riparian habitat, while at the same time creating a common language between technical experts, land managers and land practitioners.

IMPLEMENTING A MONITORING WEEK FOR CORONADO NATIONAL FOREST AND THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION. Kade P. Willardson*¹, Andrew Brischke², James Heitholt³; ¹University of Arizona, St. George, UT, ²University of Arizona, Kingman, AZ, ³USDA Forest Service, Tucson, AZ

ABSTRACT

In 2007, the Coronado National Forest (CNF) in southeastern Arizona was facing major NEPA deadlines and was lacking sufficient supporting data. The CNF had the innovative idea of implementing “Monitoring Week.” Monitoring Week was so successful they have continued to have one every year since then with the exception of 2014 due to the government furlough. Monitoring Week is moved from district to district depending on where the highest priority needs are. In 2017, the University of Arizona Cooperative Extension Rangeland Monitoring Program held their own monitoring week in Yuma Arizona for the Bureau of Land Management trend sites. Because of the success they experienced, they have plans to expand Monitoring Week in their area. Monitoring Weeks have been found to be highly successful because of the large amount of work that can be completed in just four or five days. Typically, 12 to 20 people are involved and usually divided into teams of three people. Because of the efficiency of camping or boarding close to the sites, 30 to 40 sites can be sampled throughout the week. Almost reaching the yearly monitoring goals for a single district on CNF. Another benefit of having a monitoring week is getting range and other inter-disciplinary professionals together in a central location. Invitations are sent out to ranchers, wildlife biologists, soil scientists, and hydrologists. This gives time to discuss concerns that they might have at the regional, forest, or district level. It brings together people from other areas as a team instead of just being counterparts in another district. Lastly, Monitoring Week is a lot of fun and a highlight of the year for many of us!

DEVELOPING A YEAR-ROUND OBJECTIVE MEASURE OF COLORADO RANGELAND NUTRIENT COMPOSITION

. Caitlin D. Horne*¹, Ryan D. Rhoades², Jason K. Ahola¹, Terry J. Engle¹, Joe E. Brummer¹, Paul Meiman¹, Justin D. Derner³; ¹Colorado State University, Fort Collins, CO, ²Colorado State University, Fort Collins, CO, ³USDA-ARS, Cheyenne, WY

ABSTRACT

A goal for any rangeland grazing operation is to attain an appropriate balance among available forage resources, where forage nutrient composition and supplementation (i.e. if needed) meets the daily nutritional requirements of livestock. To accomplish this on a short-term basis, the producer needs to have current information about the nutrient content of the forage. There is no comprehensive, quantitative seasonal description of rangeland forage quality available for Colorado. Therefore, the objective of this project is to field-test a sampling and analysis protocol to estimate variability in seasonal rangeland forage nutrient composition over spatial scales. Four geographically diverse locations in Colorado were chosen for this pilot project. Monthly forage samples are collected for approximately one year to capture seasonal variation in quality. Forage samples are collected at each location via clipping (n=12) and grab sampling (n=3) techniques. All forage collected within a hoop (0.5 m diameter) is combined into a single composite sample. Ocular estimates of foliar cover (%) for different types of vegetation, litter, bare ground, and live or dead forage are recorded before forage is clipped. Phenological stage for each vegetation type is recorded. Forage quality will be assessed based on levels of crude protein (CP), total digestible nutrients (TDN), acid detergent fiber (ADF), neutral detergent fiber (NDF) and minerals. This data will then be used to develop near infrared spectroscopy equations for rapid assessment of the remaining samples. Once this sampling protocol is validated, it will be used to construct a more comprehensive state-wide study. Pilot survey results will highlight the importance of site-specific forage analysis to develop more cost-effective supplementation programs. Results will strengthen producer knowledge and the value of range beef cow nutrition management recommendations in Colorado.

MONITORING AND RECOVERY OF *SILENE SPALDINGII* AT FAIRCHILD AIR FORCE BASE

. Julie L. Conley*¹, Michael A. Gregg¹, Kelsey Prickett²; ¹USFWS, Burbank, WA, ²BFI Native Seeds, Inc., Moses Lake, WA

ABSTRACT

The southern portion of Fairchild Air Force Base (AFB) in Spokane County, Washington contains “biscuit-swale” topographic features and vernal pools. Some of the “biscuits” (soil mounds) provide habitat for the threatened species, Spalding’s catchfly (*Silene spaldingii*) (SISP), first discovered there in 1994. From 2014-2017 the Land Management Research Demonstration (LMRD) team from Mid-Columbia River National Wildlife Refuge Complex, has monitored this SISP population, comprised of 8 flower clusters on less than 18 acres. The number of plants detected has increased each year with 67 individuals found in 2014 and 134 in 2017- the bulk of the increases coming from just 3 of the 8 clusters. We observed that mounds with fewer or no SISP have a higher percent cover of noxious weeds. In 2015 we partnered with Washington State University Extension to release and monitor *Chrysolina hyperici* beetles for the control of St. John’s Wort (*Hypericum perforatum*). In 2016 we selected several soil mounds with no SISP detected in 5-10 years for restoration and SISP augmentation. Small plots approximately 40 meters square were hand-cleared of noxious weeds in June, August, and November of 2016, and native grass seed was hand broadcast, raked and foot-packed in November. SISP seeds from the 6 clusters with detected plants in August 2016 were collected and provided to BFI Native Seeds Inc. The seeds underwent cold stratification over winter, germinated in March 2017 and were transplanted into 20cm deep plugs. The plugs are now rosettes with healthy root systems entering dormancy and ready for out planting along with native forb and grass plugs in October 2017. LMRD plans to monitor survival for several years (SISP can be dormant for 1-3 years) and use lessons learned to continue and expand SISP recovery efforts at Fairchild AFB.

EXPLORING THE JORDANIANS' RANGELAND STATUS TRANSITION: MERGING THE RESTORATION EXPERIMENT WITH MODELING.

. Mira Haddad¹, Stefan Strohmeier¹, Job de Vries², Sayjro K. Nouwakpo*³, Osama Al-Hamdan⁴, Mark A. Weltz⁵; ¹International Center for Agriculture Research in the Dry Areas, Amman, Jordan, ²Utrecht University, Utrecht, Netherlands, ³University of Nevada - Reno, Reno, NV, ⁴Texas A&M University, College Station, TX, ⁵USDA ARS, Reno, NV

ABSTRACT

Due to recurring droughts and severe overgrazing, Jordan's dry rangelands are exceptionally prone to degradation. Establishing both restoration and sustainable rangeland management practices are crucial to reverse the negative impacts on soil stability, biotic integrity, and hydrological function of the ecosystem; however, a primary estimate of baseline water and sediment fluxes is essential to properly identify ecological potential for a sustainable transition from degraded to a more productive re-vegetated landscape. In Jordan, application of mechanized micro-Water Harvesting (WH) for an out-planting of native shrub seedlings is a widely applied restoration approach; thus, supporting the development of shrub communities forming islands within the previously ploughed micro-pits on degraded and hard-crusts lands. In this study, the Rangeland Hydrology and Erosion Model (RHEM) was used to explore three different rangeland states and their implications on water and soil fluxes: i) the purported historical vegetation and baseline of site condition using peer reviewed literature, testimonies provided by scientists, and citizen science provided data, ii) the actual land degradation status, and iii) micro-Water Harvesting equilibrium restored site scenarios based on field monitoring and modeling. A rangeland experimental site near Amman, Jordan, provided diverse monitoring data for subsequent validation by modeling. RHEM was applied to conduct 1) a long-term state and transition assessment for hill slope scenarios (i-iii), and 2) an event based on spatially distributed watershed models that provided different scenarios which suggested various landscape response patterns. The spatial-temporal assessment of water and sediment transport at baseline, and on degraded and restored rangelands in Jordan sheds light on the sustainability of sites restored with the micro-WH approach and assessment of future applications of restoration to approximate resilient equilibrium water and soil dynamics.

CONTRASTING ECOLOGICAL SITE CONCEPT DEVELOPMENT METHODS USING SSURGO DATA AND A REMOTE CATENA APPROACH

. Michael R. Higgins*¹, Jon Gustafson² ¹USDA, Templeton, CA, ²USDA, Davis, CA

ABSTRACT

A provisional ecological site is a conceptual grouping of soil map unit components within a major land resource area (MLRA) based on the similarities in response to management. Under the USDA-NRCS National Instruction, “Ecological Site Inventory and Ecological Site Description” one of the protocols for developing pESD’s includes defining soil properties to separate ecological sites. The National Instruction implements a 5-year initiative where all existing products, along with Soil Survey, should be utilized to the fullest extent possible in developing priorities and allocating resources. A catena method and product was developed to identify major patterns within the soil survey as supported by associated datasets.

Purpose of developing Catena’s:

- Identify patterns we cannot detect relying on SSURGO data alone
- Capture what we know about the landscape
- Develop hypotheses regarding observed patterns and ask questions to address gaps
- Communicate with and debate others seeking explanations based on evidence and logic of scale

In Soil Survey Region 2, MLRA 18, we contrasted a catena approach with SSURGO map unit data. Relying on the existing SSURGO data, we determined that within the context of the specific soil survey, the map unit model hypothesizes that patterns of soil differences for the Coarsegold soil series are not influenced by aspect on slopes from 45-75%. Based on our remote catena observations, we developed an alternative hypothesis that patterns in vegetation potential are related to aspect within the same slope range of the Coarsegold series. Through this approach, our team confirmed that our remote catena method captures two ecological site concepts that can be used to justify creation of a new Coarsegold soil phase specifically for the north facing slopes of the map unit of concern.

CONCEPTUALIZING PLANT ASSOCIATIONS AND ECOLOGICAL SITES FOR USE IN WATERSHED ANALYSES ON THE KAZAKHSTAN PLAINS.

. Tlektes Yespolov¹, Marat Beksultanov², Kenneth Spaeth*³, Mark A. Weltz⁴, Ian Burns⁵, Jason Nesbit⁴; ¹Kazakh National Agrarian University, Almaty, Kazakhstan, ²AgriTech Hub Kazakhstan, Almaty, Kazakhstan, ³USDA Natural Resources Conservation Service, Ft. Worth, TX, ⁴USDA ARS, Reno, NV, ⁵USDA ARS, Tucson, AZ

ABSTRACT

Kazakhstan, situated in the center of the Euro-Asia continent, is the largest country in Central Asia and the ninth largest country in the world (7.0 million km²). Kazakhstan extends about 3,000 km from the Caspian Sea in the West to the Altai Mountains in the East, and 1,600 km from the Tien-Shan Mountains in the South to the western-Siberian lowland in the North. On the Kazakhstan Plains, the following four main ecoregions exist: steppe (25%), semi desert (25%), desert regions (40%), and mountainous (7%). Rangeland watershed dynamics are modeled using tools such as the Automated Geospatial Watershed Assessment (AGWA) model, a GIS-based hydrologic assessment tool that contains the Rangeland Hydrology and Erosion Model (RHEM), and a vegetation type classification system with defined plant growth lifeforms at various resolution levels (i.e., rangeland vegetation types and rangeland plant/soil associations). For detailed analyses of the sustainability of a site, an equivalent corresponding system in congruence with the Ecological Site classification system used by United States Department of Agriculture is required. A vegetation/soil site reconnaissance survey was conducted in the grassland steppe between Almaty and Astana, Kazakhstan in the summer of 2017. A conceptual vegetation classification system for watershed model parameterization was developed using aggregated soil and vegetation associations. This allows for first order evaluation of risk for accelerated soil erosion and sustainability to be defined for broad regions of Kazakhstan. For detailed analysis of risk to sustainability at the ranch to pasture level, specific data from hillslopes of concern are required. Evaluation of this approach will be presented along with required next steps in the process to implement systematic rangeland assessments for Kazakhstan.

STATE-AND-TRANSITION MODELS: A TOOL FOR BUSH ENCROACHMENT MANAGEMENT ON TROPICAL RANGELAND

. Sandra A. Santos*¹, Dylan M. Young², Humberto P. Baldivieso³; ¹Embrapa, Corumbá, Brazil, ²University of Leeds, Leeds, England, ³Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

Tropical rangelands are composed of heterogeneous landscape mosaics associated with soil properties, topography and climates with highly variable primary productivity and species composition controlled mainly by seasonal precipitation that can be influenced by natural (e.g. flooding, wildfire) or human (e.g. fire, grazing) disturbance regimes at multiple scales resulting in three broad habitat configurations: savanna grassland, savanna shrublands and savanna woodlands. The encroaching woody species by the proliferation of indigenous woody species on savanna grassland leading to a decline in biodiversity and grazing capacity of both wild and domestic herbivores. The purpose of this research is to characterize influences of increasing *Byrsnonima. cydoniifolia* on vegetation structure in the sandy Pantanal habitats and to identify and predict states and thresholds using state-and-transition models (STM). In order to develop the STM, we measured vegetation structure and diversity in areas invaded by *B. cydoniifolia*, and used these values to determine the presence of thresholds for the development of conceptual STM. Three states (reference, invasive and degraded) were identified for savanna woodland, savanna shrublands, savanna grassland and wetland ponds vegetation types. Significant breakpoints values for *B. cydoniifolia* density and Pielou's evenness index were identified in savanna woodland and savanna shrublands (421 and 649 stems ha⁻¹ respectively). Our results suggest that the expansion of *B. cydoniifolia* and subsequent switch to an alternative state, is a process driven mainly by climatic conditions rather than overgrazing. This finding has significant implications for the management and conservation of the Pantanal grazing areas in light of predicted climate change

GRASSLAND-SHRUBLAND STATE TRANSITIONS IN ARID RANGELANDS:
COMPETITION MATTERS. Nathan A. Pierce*¹, Steven Archer², Brandon T. Bestelmeyer³;
¹University of Arizona, Tucson, AZ, ²The University of Arizona, Tucson, AZ, ³USDA-ARS
Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Background: State transition from grassland to shrubland is synonymous with desertification in many arid rangeland systems. Traditional desertification models emphasize abiotic feedbacks that modify the physical environment in ways that promote shrub proliferation and impede grass survival. Inherent in this perspective is the assumption that biotic interactions between grasses and shrubs have little bearing on state transition dynamics. Furthermore, the extent to which density-dependent interactions among shrubs might determine the magnitude and pattern of their cover is unknown. We addressed these assumptions and knowledge gaps over 4 years using selective removal experiments. ***Shrub-on-Grass Interactions:*** Grass ANPP responded positively to shrub removal in all years, but more so in years with above-average rainfall and in plots with high shrub abundance. Grass allocation to vegetative reproduction and grass patch area also increased when shrub neighbors were removed. These results demonstrate that biotic interference by shrubs upon grasses can reinforce and magnify abiotic feedbacks during grassland–shrubland transitions. ***Grass-on-Shrub Interactions:*** In years with above-average growing season precipitation, ANPP of small shrubs increased when grasses were removed, a result not evident in dry years or in larger shrubs. Grasses may therefore slow the rate at which shrubs attain a physical stature that can modify the physical environment in self-promoting ways. ***Shrub-Shrub Interactions:*** Intraspecific interactions between shrubs were not evident in any year, supporting the assumption that abiotic variables rather than competitive interactions constrain maximum shrub cover. **Summary:** Results from these field experiments provide insights on how shrub-grass interactions amplify or dampen the abiotic drivers of desertification, help explain how woody plants can continue to proliferate despite low or reduced livestock grazing pressure, and generate hypotheses that can help us refine experiments to address the mechanisms of belowground competition at play where grasses and shrubs co-occur in arid ecosystems.

USE OF A FUNCTIONAL INDEX AS ALTERNATIVE TO SIMILARITY INDEX FOR SORTING DATA LOCATIONS INTO A STM.

. Gene A. Fults*; USDA NRCS, Vancouver, WA

ABSTRACT

Locations with post-Reference vegetation occurring on a single Ecological Site presented here was collected over a 10 year period and in a prescribed manner. The data created the questions: What species are dominant in the vegetation database of today? In which ecological State should the locations be placed? What State or Threshold between States could be described by measuring natural variation at the 19 locations? To answer these questions an importance rank (Functionality Index) was calculated for all species encountered from the 19 locations. To calculate the Functionality Index, the heaviest, tallest, longest foliar cover and associated constancy of appearance within each protocol was factored by-species with an added value if the species is listed on the Ecological Site Description. The Very Shallow ecological site in Washington revealed a 15% difference of location's placement in State and Transition Model between the alternative Functionality Index and the standard Similarity Index. Ratio of ESD species to total species per location is also a valid consideration to sort location data sets. The weight based Similarity Index was re-calculated for accuracy but no errors in reconstruction were found. An alternative is needed for some databases since Similarity Index is limited by spatial heterogeneity or too few standardized quadrat placements.

RESILIENCE AND RESISTANCE OF SAGEBRUSH STEPPE COMMUNITIES ARE ASSOCIATED WITH SOIL TEMPERATURE AND WATER AVAILABILITY

. Bruce A. Roundy*¹, Jeanne Chambers², David A. Pyke³, Rick Miller⁴, Robin Tausch², Gene Schupp⁵, Ben Rau⁶, Trevor Gruell¹; ¹Brigham Young University, Provo, UT, ²USDA Forest Service, Reno, NV, ³U.S. Geological Survey, Corvallis, OR, ⁴Oregon State University, Corvallis, OR, ⁵Utah State University, Logan, UT, ⁶USDA Forest Service, Brevard, NC

ABSTRACT

Fuel control treatments are implemented in sagebrush (*Artemisia* L.) steppe communities to reduce severe wildfire, and to enhance ecosystem function and wildlife habitat. Resilience of sagebrush steppe communities after fuel control treatments or other disturbances is dependent on resistance to cheatgrass (*Bromus tectorum* L.). High cover of cheatgrass after treatments puts the system at risk of passing through a biotic threshold of increased fire frequency and continued cheatgrass dominance. Sagebrush steppe resilience in part depends on perennial herbaceous cover to resist cheatgrass. Higher resilience and resistance of sagebrush steppe systems has been associated with a cooler and wetter soil climate which supports higher perennial herbaceous cover compared to warmer and drier conditions that support cheatgrass. We tested effects of treatments on soil temperature and soil water availability and plant cover on six sagebrush sites lacking tree expansion and 11 sites with tree expansion. We measured soil temperatures and soil water potentials at 13-30, and 50 cm from 2011 through spring of 2016 and related them to cover of perennial herbs and cheatgrass 6 years post treatment (2011-2012) for most sites. Prescribed fire slightly increased soil temperatures, and increased cheatgrass cover on most sites. Mechanical treatments increased soil water availability and increased perennial herbaceous cover. However, both soil and vegetation responses varied more among sites than among treatments. Non-metric dimensional scaling ordination and decision tree partition analysis indicated that sites with warmer and wetter falls had highest cover of cheatgrass. Sites with wetter winters and early springs had higher cover of perennial herbs. Our concurrent measurement of soil climate and vegetation cover variables on similar treatments across a wide array of sites supports the idea that cooler and wetter sites are most resilient and resistant to cheatgrass, while warmer and drier sites are least resistant.

FILLING IN THE GAPS: MANAGING AND INTERPRETING SITE-SPECIFIC PRECIPITATION OBSERVATIONS WITH THE MYRAINGE LOG TOOL. Michael A. Crimmins, Mitch McClaran*, Kelsey L. Hawkes; University of Arizona, Tucson, AZ

ABSTRACT

It is common on rangelands to have large gaps of distance between “official” rain gauges and gaps of time (up to 365 days) between measurements. Those gaps make it difficult for managers to understand the impact of precipitation on rangeland resources and the response of those resources to management. We developed the web-based *myRAINge Log* (<https://myraingelog.arizona.edu>) to help managers and ranchers organize and interpret their precipitation observations and fill those gaps. We reference measures to the SPI, Standardized Precipitation Index because 1) it is widely used to represent drought severity, 2) a minus 1 SPI (12-month window) triggers on-site evaluations for all livestock grazing allotments in Region 3 of the National Forest system, and 3) it provides a likelihood-based reference for current conditions. We rely on data from the PRISM gridded climate dataset (~4km, 1981-2016) to provide the interpolation-based estimate of amount and timing of precipitation.

For data entry, *myRAINge Log* allows the user to 1) establish an infinite number gauges across the conterminous U.S., 2) enter precipitation values up to 1-y apart, and 3) enter photographs and field notes for each measurement date. For interpretation, *myRAINge Log* allows users to 1) select the time period for representing the accumulation of precipitation, 2) examine the amount of precipitation recorded in the gauge at that location, 3) compare the amount of recorded precipitation to the PRISM-based estimate of precipitation, and 4) compare the amount precipitation to the SPI values of probability.

Since deployment in June 2017, users in Arizona report benefits of comparing actual measures to vegetation abundance, and the Forest Service minus 1 SPI “drought policy”. In addition, users found benefit in understanding the frequency of precipitation events between measurements, and the projection of precipitation that occurred since the last measure and the current day.

TALKING ABOUT DROUGHT: SPI EXPLORER TOOL BUILDS A COMMON LANGUAGE. Mitch McClaran*, Michael A. Crimmins, Kelsey L. Hawkes; University of Arizona, Tucson, AZ

ABSTRACT

Collaborations should be more effective if groups share a common language to describe the topic of their joint efforts. This common language may be most critical when the collaborators have different priorities, and have been adversaries. We developed the on-line *SPI Explorer Tool* to build a common language about drought among the Tonto National Forest rangeland managers, ranchers with permits for livestock grazing in the Tonto, and the University of Arizona faculty and staff convening workshops about increasing preparation for drought. We focused on SPI, Standardized Precipitation Index because a minus 1 SPI (12-month window) triggers on-site evaluations of conditions for all livestock grazing allotments in Region 3 of the National Forest system.

The *Tool* (<https://uaclimateextension.shinyapps.io/SPItool/>) builds a precipitation history since 1895 for any user-selected location in the U.S. based on the 4km-grid estimates in PRISM (Parameter-elevation Relationships on Independent Slopes Model). Outputs include 1) annual precipitation and temperature history, 2) SPI values for 1 to 48 month windows of record, including a multi-scale plot reporting 1 to 48 month windows simultaneously, 3) the amount of precipitation and departure from average associated with each SPI value, and 4) conditional probability of future conditions given current conditions which is based on the historic record rather than forecasts (this was especially effective at stimulating increased drought preparation).

Workshop evaluations and post-Workshop surveys and interviews suggest that the *Tool* helped develop a 1) better understanding of drought information (97% of workshop participants reported greatly or moderately improved understanding), 2) common language for discussing drought (common theme in open-ended responses was “drought information tools provided a common framework that allows us to be on the same page so we can make decisions together”, and 3) better working relationship between Forest managers and permittees (66% of Workshop participants agree, only 42% of non-participant ranchers agree).

UTILIZING THE AGRICULTURAL RANGELAND EROSION AND SALINITY DATABASE TO ENHANCE ECOLOGICAL SITE DESCRIPTIONS WITH HYDROLOGIC INFORMATION.

. Gary Frasier*¹, Mark A. Weltz², Jason Nesbit², Kenneth McGwire³, Timothy J. Jones², Mariel Boldis⁴, Kenneth Spaeth⁵, Dana Larsen⁶; ¹USDA ARS Retired/Collaborator, Loveland, CO, ²USDA ARS, Reno, NV, ³Desert Research Institute, Reno, NV, ⁴University of Nevada, Reno, Reno, NV, ⁵USDA Natural Resources Conservation Service, Ft. Worth, TX, ⁶USDA Natural Resources Conservation Service, Fort Worth, TX

ABSTRACT

An Ecological Site Description (ESD) is a distinct land area described with specific soil and physical characteristics that are products of landform, topography, climate, and elevation which will support an association of plant species. Federal, state and private land managers use ESD's to help identify ecological potential of a site for specific plant community state and transition responses. The current hydrological information in ESD's is incomplete or lacking. Providing a hydrologic assessment to complement existing Ecological Site Description information of soils, vegetation, climate, and management options will provide land managers a new tool to understand soil-vegetation-erosion-management interactions and responses to conservation practices. A new database, the Agricultural Rangeland Erosion and Salinity Database (ARES), hosted by the USDA National Agricultural Library can be used to assist in developing inputs and validating outputs for models such as the Rangeland Hydrology Erosion Model (RHEM). The outputs from RHEM provides information to assess risks of unsustainable erosion and potential effects from management actions that result in changes in plant lifeform, foliar and ground cover. This information is necessary to create site-specific hydrological assessments to enhance ESD's which will provide critical hydrologic information on runoff/erosion potential as a function of the plant community. The RHEM outputs provides potential runoff and soil erosion by ecological state and provides estimates from various conservation practices as part of the hydrologic assessment. Utilizing the hydrologic assessment will provide the user the ability to develop sustainable, long term land management monitoring plans. An example of a typical hydrologic assessment for the Shortgrass Prairie ecosystem based on data collected from the USDA-ARS Central Plains Experimental Range near Nunn, Colorado, is presented along with discussion of how it can be used to make informed management decisions with targeted objectives to increase land use sustainability of Shortgrass Prairie plant communities.

RANGELAND BRUSH ESTIMATION TOOLBOX (RABET): A METHOD FOR QUANTIFYING WOODY COVER ON WESTERN GRAZING LANDS. Chandra Holifield Collins*¹, Susan Skirvin², Mark Kautz¹, Loretta Metz³; ¹USDA-Agricultural Research Service, Tucson, AZ, ²University of Arizona, Tucson, AZ, ³USDA-Natural Resources Conservation Service, Temple, TX

ABSTRACT

The USDA-Natural Resources Conservation Service (NRCS) has allocated extensive resources for brush management (removal) as a conservation practice to control woody species encroachment on rangelands. The NRCS Conservation Effects Assessment Project on Grazing Lands (CEAP-GL) has been tasked with determining how effective the practice has been, however, conservationists and land managers lack a cost-effective means to conduct these assessments at the necessary spatial and temporal scales. An ArcGIS-based decision support tool was developed through a collaboration with NRCS CEAP-GL and the USDA-Agricultural Research Service. The toolbox uses a remote sensing-based approach combining no-cost, high resolution National Agriculture Imagery Program (NAIP) aerial photography and medium resolution Landsat satellite imagery to produce large-area temporal maps of woody canopy cover. This operational product will allow land managers and NRCS to assess spatial and temporal changes in woody vegetation over large heterogeneous landscapes, and provide them with a tool to assess where the greatest need for treatment exists.

PERSISTENT ECOSYSTEM PROBLEMS AND THE NEED FOR RESILIENT
MANAGEMENT SYSTEMS. Chad S. Boyd*; USDA-ARS, Burns, OR

ABSTRACT

The concept of resilience is often used as a modifier for describing the capacity of an ecological entity to recover from disturbance factors. The notion of resilience, however, is not inexorably tied to ecology, but is instead, a system level concept that is independent of subject, and can be molded across space and time. Following that logic, we can use resilience as a construct for measuring the capacity of natural resource management systems to be successful over time within dynamic social, ecological, and political contexts. In sagebrush steppe ecosystems, the need for resilient natural resources management systems has increased dramatically in recent decades, and will likely continue to increase into the foreseeable future. This is due to the fact that major management issues, such as exotic annual grass invasion and altered fire regimes, represent problems that are not just complex, but also persistent. Purposefully building resilient management systems is a complex undertaking with many dimensions. While such an endeavor is daunting, we suggest that a good starting point would be to explore existing efforts to design long-term natural resources management systems. In this symposium, we will examine important social, ecological, and regulatory elements of one such effort in southeast Oregon, the Harney County Candidate Conservation Agreement with Assurances for Greater Sage-Grouse. CCAAs are long-term, voluntary agreements between the US Fish and Wildlife Service and non-federal landowners to beneficially manage habitat threats facing candidate wildlife species in exchange for a reduced regulatory burden should the species be listed under provisions of the Endangered Species Act. We will use this case study to illustrate critical elements necessary for resilient management systems. Our aim is not to be prescriptive, but instead to suggest an experienced-based operational framework that can be generalized for use in a variety of sociological and ecological contexts.

USING MENTAL MODELS TO ARTICULATE AN ECOSYSTEM-BASED VISION FOR GREATER SAGE-GROUSE HABITAT MANAGEMENT. Dustin Johnson*¹, Chad Boyd²; ¹Oregon State University, Burns, OR, ²USDA - ARS, Burns, OR

ABSTRACT

The western portion of the sagebrush steppe is characterized by complex landownership patterns with mixes of federal, private, and to a lesser extent state-owned lands. Conservation of greater sage-grouse habitat within this region requires engagement and agreement on a strategy from a diversity of stakeholders, given the large areas of intact habitat needed to support viable populations of this species. Habitat conservation must also play out in sagebrush landscapes that face complex and persistent ecosystem threats such as wildfire, invasive annual grasses, and conifer encroachment, which further highlight the importance of effective collaboration and resiliency of conservation effort among a diverse set of stakeholders. Such ecosystem-based conservation efforts can be challenging because stakeholders are likely to have widely varying opinions and values associated with both the nature of habitat and the environmental and management factors which influence change. Therefore, these efforts require a common and foundational understanding of habitat properties and ecological drivers of change that stakeholders can use to build a conservation vision of current conditions, desired conditions, and a strategy for achieving desired conditions. As such, we have found the importance of simple mental models that possess these qualities increases for issues such as ecosystem-based wildlife conservation. Mental models allow us to understand, communicate, structure, and simplify highly complex reality. We found that when people have a common point of reference for understanding a problem it is much easier to productively discuss and ultimately agree upon options for dealing with the problem.

BALANCING SPECIES-SPECIFIC REGULATORY IMPERATIVES WITH MANAGEMENT OF PERSISTENT ECOSYSTEM PROBLEMS. paul henson*; U.S. Fish and Wildlife Service, Portland, OR

ABSTRACT

The Endangered Species Act of 1973 (ESA) is once again the subject of heated political debate. Critics call it a failure because it has not led to the recovery of very many listed species. Proponents claim the opposite, noting that the ESA has prevented the extinction of 99 percent of listed species. My view, based on many years of implementing the ESA as a field biologist working throughout the West, is squarely in the middle: the ESA continues to enable some of the most important and positive conservation outcomes in the U.S., but implementation could be improved to accomplish more conservation with less unintended consequences. There are significant areas where the ESA falls short of its potential and where its effectiveness could be improved. For example, the ESA can create perverse disincentives to conservation for large segments of the American public. It sometimes alienates or antagonizes important constituencies who would otherwise support its goals and intent and who are critical to conservation, such as many family farmers and ranchers. The question is: can the ESA be strategically tailored to these circumstances, or is America's most powerful environmental statute mostly a blunt regulatory instrument? We used the inherent flexibility in the ESA during the greater sage grouse (GSG) listing process to reduce conservation disincentives within the ranching community of eastern Oregon and to support nonregulatory alternatives to an ESA listing of the GSG. Our guiding principles included: (1) maximize positive net conservation outcomes for GSG, (2) keeping ranchers ranching is good for longterm, landscape-level conservation, and (3) help landowners view the GSG on their ranches as an *asset* rather than a *liability*. This paper describes the rationale, process, and outcomes of this strategy, and how this approach may be applied to other conservation challenges where the ESA interfaces with private landowners.

CHALLENGES OF CREATING WIN-WIN CONSERVATION FOR GREATER SAGE-GROUSE AND LANDOWNERS AT A LOCAL SCALE. Angela Sitz*; U.S. Fish and Wildlife Service, Bend, OR

ABSTRACT

In 2011 the Fish and Wildlife Service (Service) was approached by a diverse group of stakeholders to discuss the development of a Candidate Conservation Agreement (CCA) with Assurances for greater sage-grouse in Harney County, Oregon. Over the next 3 years the Service participated in a unique collaborative process and overcame many obstacles to develop a CCA that was immediately replicated and adopted by the remaining six sage-grouse counties in Oregon. During these negotiations there were often points of disagreement, these disagreements were overcome by finding common ground and compromising on the decision. Some of these disagreements included the type and level of inventory and monitoring that would be required in the agreement, issues surrounding predation, and simply having a common understanding the primary threats to sage-grouse. This collaborative effort not only led to the development of six similar agreements it also built relationships between a unique set of partners that has resulted in many other successful conservation and research efforts.

LANDOWNER TRUST, AND THE ROLE OF THE SOIL AND WATER CONSERVATION DISTRICTS IN ENABLING AND IMPLEMENTING GREATER SAGE-GROUSE HABITAT CONSERVATION

. Marty K. Suter-Goold*; Harney Soil & Water Conservation District, Burns, OR

ABSTRACT

Management of threatened or imperiled species on private land is a complex subject. Successful management of these species requires establishing and maintaining trust with private landowners. Trust is a combination of an emotional and logical act, and requires time and patience to create. The Soil & Water Conservation Districts (SWCDs) in Oregon developed relationships and trust between private landowners and federal agencies to establish 30-year Candidate Conservation Agreements with Assurances (CCAA) for greater sage grouse (GSG) conservation. In addition to decreasing the likelihood of a GSG listing, CCAA management plans were developed to address impediments to practical implementation and to ensure that western rangelands and generational ranches maintained ecological and economic viability. The process utilized in Oregon may have application to GSG across western rangelands. In this presentation, I will guide the audience through the complexities of landowner engagement and trust, and the roles and responsibilities of the parties involved in enabling and implementing GSG agreements.

A PRIVATE LANDS PERSPECTIVE ON THE HARNEY COUNTY GREATER SAGE-GROUSE CCAA . Andrew Shields*; Roaring Springs Ranch, Frenchglen, OR

ABSTRACT

Roaring Springs Ranch is a cow-calf operation in southeast Oregon operating on over 1 million acres. The ranch works toward maintaining healthy wildlife populations and range conditions while utilizing excess forage for beef production. The ranch has a strong history of active management, implementing projects including landscape-scale juniper cutting and prescribed burning, riparian restoration, collaboration with the scientific community on many range and wildlife research projects, and participation in candidate conservation agreements with assurances (CCAA). Enrolling in a CCAA gives private landowners opportunities to be proactive in conservation work and to receive benefits for good stewardship. However, tradeoffs include privacy concerns and potential financial costs. The ranch enrolled in the Harney County Sage-Grouse CCAA in 2015 despite potential tradeoffs. Realized benefits, examples of conservation actions taken, and long term goals relating to this CCAA will be discussed. The ranch's enrollment in this CCAA has thus far been beneficial for the ranch and for the conservation of sage-grouse in this area.

COLLABORATION: WHAT IS IT AND HOW DO YOU MAKE IT WORK? . Brenda S. Smith*; High Desert Partnership, Burns, OR

ABSTRACT

Addressing persistent and complex ecosystems problems to restore landscape resilience requires good science but must also consider the complexities of management and the people involved in decision-making. Collaboration is a word that is used generously and defined loosely in recent years but is recognized as a growing trend. Agencies, including regulatory agencies, conservation groups, landowners and communities continue to seek out a participatory approach to solving complex issues. Collaboration comes with a host of expectations that include reducing delays in restoring ecosystem health, shoring-up rural economies and communities. The promise of collaboration has funders increasingly interested in funding partnerships that are high-performing and address landscape scale issues that cross management boundaries. In our experiences, we believe engaging in a collaborative, solutions-oriented process with relevant stakeholders is the only viable and lasting means to address contemporary natural resource, social and economic issues facing communities.

It is difficult to put criteria around what makes partnerships high-performing but one key is effective collaboration. Collaborative partnerships require substantial upfront social capital to build relationships. Additionally, resources are needed to support the process such as building relationships, facilitation and communications. The High Desert Partnership is an organization that has pioneered successful collaborative initiatives in Harney County for over 10 years by advocating for a process where solutions are economically, socially, and ecologically sound and are developed by all stakeholders. We have found there is no one recipe to make a collaboration work. However, there are some guiding principles that have emerged across several very different collaborative efforts in our region. Principles include, neutral party guiding the process, groups must be empowered to make decisions and shared understanding of the problem. As collaboration continues to expand as a process to solve natural resource issues there is interest in understanding the shared qualities that ensure success.

PUTTING IT ALL TOGETHER: CRITICAL ELEMENTS THAT BUILD RESILIENCY IN MANAGEMENT SYSTEMS. Jay Kerby*; The Nature Conservancy, Burns, OR

ABSTRACT

Successful development and implementation and persistence of the Oregon sage-grouse CCAA program depended on numerous sociological and ecological factors, many of which are translatable to other complex natural resource management challenges. The pending (at the time) decision on whether to grant threatened or endangered status to the Greater Sage-Grouse in 2015 stimulated a critical mass of diverse stakeholders, including local, state and federal officials and scientists, private landowners, and non-governmental organizations, to engage proactively in advance of the listing decision. Commitment to participate, despite very high uncertainty about the eventual outcomes, did not wane throughout a >3-year development phase, as public employees were empowered to participate by their supervisors and private individuals donated thousands of hours of time and travel. This diverse coalition forced participants to wrestle with critical questions necessary to advance, such as how to integrate rigorous science necessary to grapple with complex ecological questions into a management framework that addresses sage-grouse habitat needs and facilitates communication and trust with wary landowners. Initial implementation of the Oregon CCAA management framework was empowered by several policy actions, adequate agency funding and staff support, and high landowner participation in enrollment. The framework is also being bolstered by adoption into related programs, such as the State of Oregon's Habitat Quantification Calculator for planning and mitigation in Sage-Grouse habitat and use by BLM for project prioritization and planning in several districts. Additional programmatic needs for persistence include continuing education for new participants as principle authors retire or relocate and collaborative processes for potential unforeseen disputes. Successful adaptive management, as some initial on-the-ground actions fail to address complex ecological threats, such as invasive annual grasses, will be paramount and most effective if the diverse coalition that built this management framework continue to be fully engaged.

CHALLENGES IN RESTORING AND REHABILITATING ARID LANDS. Jay Davison*;
Univ. NV Cooperative Extension, Fallon, NV

ABSTRACT

Most of Nevada and large portions of the western United States can be classified as arid. Arid lands are defined in numerous ways but most agree that lands experiencing less than ten inches of annual precipitation are considered arid. In Nevada, vast areas receive less than six inches of precipitation annually. When arid lands experience other disturbances such as wildfire, vehicle traffic or mining natural revegetation is very slow to occur. Farming in these areas is only possible with irrigation and when irrigation water is withdrawn and used for other purposes natural revegetation has again proven to be extremely slow to non-existent. Because natural revegetation is so slow, to occur, efforts to supplement this process are ongoing throughout the West. However, impediments to successfully reestablishing vegetation in these areas include; the lack of natural precipitation, altered/poor soil conditions, lack of adapted plant materials, wind erosion, competition from exotic and/or native seed species, unrealistic expectations or desires of the interested public and low economic values associated with these sites.

ESTABLISHMENT OF NATIVE AND INTRODUCED PERENNIAL GRASS SPECIES IN RANGELAND SEEDING. Kevin B. Jensen*¹, Craig Rigby², Blair L. Waldron², Tom Jones²; ¹Forage and Range Research Lab, Logan, UT, ²USDA-ARS, Logan, UT

ABSTRACT

Large-scale conversion of western US rangelands from a diverse, healthy, perennial plant-dominated ecosystem such as the lower-elevation Basin and Wyoming big sagebrush rangelands to invasive annual grasses, particularly cheatgrass and medusahead has increased wildfire frequency and size, loss of soil structure, increased soil erosion, and reduced watershed function, biological diversity and shortened fire return intervals. Experiments were conducted at four semiarid rangeland locations in Idaho (1), Wyoming (1), and Utah (2) addressing seedling establishment and plant persistence of 14 perennial cool-season grass species in cheatgrass dominated environments. Establishment of the improved native grasses, bottlebrush squirreltail, bluebunch, slender, and Snake River wheatgrasses, across locations were similar in plants m⁻² to crested and Siberian wheatgrasses. Only western wheatgrass had significantly fewer plants m⁻² than crested and Siberian wheatgrass. Seedling density of native grass cultivars similar to Hycrest II crested and Vavilov II Siberian wheatgrasses were bottlebrush squirreltail (cv. Toe Jam Creek and Fish creek), bluebunch wheatgrass (cv. P_7 and Goldar), slender wheatgrass (cv. FirstStrike, Revenue, and San Luis), Snake River wheatgrass (cv. Secar and Discovery), basin wildrye (cv. Trailhead II, Trailhead, and Continental), Thickspike wheatgrass (cv. Bannock, Sodar, Schwendimar, and Bannock II), and Indian ricegrass (cv. White River and Rimrock). Native grasses similar to crested wheatgrass in plant density after 5 years were western wheatgrass, Snake River wheatgrass, and thickspike wheatgrass. Rhizomatous species western wheatgrass and thickspike wheatgrass increased in plant density over time. From this data, there appears to be adequate plant density in native grasses to establish and compete with cheatgrass.

FORAGE KOCHIA: NEW DEVELOPMENTS AND OPPORTUNITIES FOR
REHABILITATION OF GREAT BASIN RANGELANDS. Blair L. Waldron*; USDA-ARS,
Logan, UT

ABSTRACT

Forage kochia (*Bassia prostrata*, synonym=*Kochia prostrata*), a perennial, semi-shrub adapted to the semiarid rangelands of the western USA, is one of few species that can establish on degraded rangelands, compete against annual weeds, and be used in greenstrips to stop wildfires. Forage kochia's grazing potential primarily includes extending grazing into the fall by maintaining high CP (> 7%), and increased carrying capacity and improved cattle health. This presentation reviews recent research, further highlighting the potential of forage kochia to rehabilitate and improve Great Basin rangelands. First, 'Snowstorm' forage kochia, was released by the USDA-ARS, and provides ranchers and land managers a new, taller, more productive, more nutritious cultivar capable of further increasing carrying capacity and nutritive value of rangelands, including where snow cover had limited forage kochia use in the past. Second, Gardner's saltbush ecosystems are increasingly being invaded by halogeton (*Halogeton glomeratus*), an annual halophyte that increases soil surface salinity and reduces plant biodiversity. A study in the Flaming Gorge National Recreation Area evaluated the potential for rehabilitating halogeton-dominated Gardner's saltbush ecosystems with forage kochia. Forage kochia established, persisted, and reduced halogeton frequency by 52% within two years. Results indicate that forage kochia provides an opportunity for rehabilitation of halogeton-invaded, saline rangelands. Third, highly erodible farm acres coming out of Conservation Reserve Program (CRP) contracts could remain in perennial species and be used for fall and winter grazing if wheatgrass monocultures could be interseeded with nutritious forage species. An on-farm study evaluated the success of interseeding forage kochia into established wheatgrass stands, and measured the effect on forage mass, forage nutritive value, and economic return. Forage kochia successfully established, improved nutritive value, and increased stocking rates for fall grazing, resulting in economic value that was greater than previous CRP contracts.

REVEGETATION OF EXOTIC ANNUAL GRASS-INVADDED RANGELANDS.

. Kirk W. Davies*¹, Chad Boyd², Dustin Johnson³, Aleta Nafus⁴; ¹USDA - Agricultural Research Service, Burns, OR, ²USDA - ARS, Burns, OR, ³Oregon State University, Burns, OR, ⁴BLM, Las Vegas, NV

ABSTRACT

Revegetation of exotic annual grass-invaded rangelands is challenging with high rates of failure. Successful revegetation starts with effective control of exotic annuals. Effective control may require integrated treatments. Following control, high establishment of perennial vegetation is critical to limiting re-invasion by exotic annuals. However, establishment of perennial vegetation can be low, especially with native species. Introduced perennial bunchgrasses establish more reliably and compete better with exotic annuals than native bunchgrasses on drier sites. However, on cooler and wetter sites or with above average precipitation, native perennial vegetation may establishment in high enough numbers to limit exotic annual grasses. New technologies may improve revegetation success. For example, activated carbon pellets can be used to protect seeds incorporated within from pre-emergent herbicide damage. This allows desired species to be seeded at the same time exotic annuals are controlled with pre-emergent herbicides. Successful revegetation of exotic annual grass-invaded rangelands will require continued research to provide longer-term control of annuals and improve the establishment of seeded vegetation.

SHRUB ISLAND ESTABLISHMENT INNOVATION: SACRIFICING A FEW SAGEBRUSH TO PLANT MANY.

. Kent McAdoo*¹, Kirk W. Davies²; ¹University of Nevada Cooperative Extension, Elko, NV, ²USDA - Agricultural Research Service, Burns, OR

ABSTRACT

Several studies have indicated unreliable or sporadic establishment of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) using conventional seeding methods. The primary objective of this study is to evaluate the fall placement of sacrificed sagebrush plants in recently burned areas. The harvested sagebrush could serve both as snow catchments and seed source as the seeds dehisce, with the accumulating dead leaves potentially providing litter/mulch that could also enhance germination by increasing soil moisture. We established treatments within three newly burned sites in northern Nevada, 30 to 60 km apart and having variable elevation, topography, and soils. We used a randomized block study design, with five blocks at each site. Within each block, three 15-m² plots were randomly selected for either cut-shrub placement, broadcast seeding, or no treatment. At each of the cut-shrub plots, we placed Wyoming big sagebrush stems (harvested just before seed-ripe in November 2016). Seeded plots were hand-broadcast with seed zone-adapted sagebrush seed to simulate conventional broadcast-seeding practice. First year results showed that sagebrush seedling survival in cut-shrub plots, though quite variable, was significantly higher ($p < 0.05$) at each of the sites than in the broadcast-seeded plots. In May, some cut-shrub plots had a “carpet” of sagebrush within 0.5 m of the cut sagebrush, but by October, natural thinning had reduced survivors by approximately 50%. Although more natural thinning is anticipated, the October aggregate survival density mean for cut-shrub plots (5.7/m²) was still two orders of magnitude higher than that for broadcast-seeded plots. Precipitation was higher than normal during this first year of study. For comparison, we will establish additional plots in at least three new wildfire sites during November 2017. Preliminary results indicate potential utility of this technique where establishing sagebrush islands could serve as a seed source for successional recovery of critical sites over time.

REHABILITATION OF GREAT BASIN RANGELANDS: AN INTEGRATED APPROACH.
Charlie D. Clements*¹, Dan N. Harmon², Robert Blank²; ¹USDA, Reno, NV, ²USDA-ARS,
Reno, NV

ABSTRACT

Disturbed rangelands present significant challenges to resource managers and land owners. In the Great Basin, exotic annual grasses have truncated secondary succession by outcompeting native perennial species for limited moisture and nutrients. An integrated approach to successfully control such invasive exotic annuals as cheatgrass can significantly improve rehabilitation efforts. By allowing on-the-ground conditions to dictate a specific or combination of a wide array of tools available, successful rehabilitation practices can be achieved on these disturbed rangelands. The use of plant materials that have the inherent potential to germinate, emerge and establish in specific soil types, precipitation zones and in the face of inter-specific species competition is critical in any rehabilitation effort. Proper weed control practices such as mechanical or chemical (herbicides) are very critical when dealing with cheatgrass rangelands as these weed control treatments can decrease cheatgrass densities by as much as 98%. This level of weed control practice improves the seedling success and establishment by increasing available soil moisture by more than 40%. Since cheatgrass outcompetes native perennials at the seedling stage, this increase in perennial seedling survivability and establishment aids in future cheatgrass suppression and associated fuels. With each passing wildfire season more and more wildlife and grazing resources are burned due to fuels associated with cheatgrass. The effective use of weed control practices and seeding of proper plant materials and rates will allow actions personnel on-the-ground to successfully rehabilitate and improve wildlife and grazing resources.

RANGELAND FIRE PROTECTION ASSOCIATIONS, A "ALL HANDS, ALL LANDS"
PARTNER. Steve V. Acarregui*; Bureau of Land Management, Boise, ID

ABSTRACT

Presentation Title: Rangeland Fire Protection Associations, A “All Hands, All The development of Rangeland Fire Protection Associations (RFPAs) creates a legitimate avenue for private landowners to participate in wildland fire suppression operations with other local, State and Federal agencies. Private landowners, particularly grazing permittees, have a substantial interest in providing fire protection on unprotected private lands and suppression assistance on adjacent State and Federal lands. This level of collaboration requires the removal of certain barriers and the creation of key critical success factors. RFPAs are created when a State establishes statute that allows for their formation, area landowners then create a board of directors, meet established minimum requirements, take wildland fire training, and sign agreements with adjoining agencies. The partnership with RFPAs has become a force multiplier in the arena of wildland fire suppression. Valued relationships have been built between local, State and Federal partners, coupled with enhanced capability and capacity, and increased safety and effectiveness of an integrated response. RFPAs enhance our national effort to build a complete and coordinated approach to wildland fire, and they are an example of the National Cohesive Wildland Fire Management Strategy in action.

CHALLENGES AND ACCOMPLISHMENTS: PRESCRIBED BURN ASSOCIATIONS OF THE GREAT PLAINS

. Brian Teeter*; Pheasants Forever, Schuyler, NE

ABSTRACT

Prescribed burn associations are built on a concept of neighbors helping neighbors conduct prescribed burns through shared resources, energy, and time within local or regional geographic areas. The Great Plains has experienced great interest in these associations and we share some challenges associated with forming and sustaining them while relishing in their successes. We look at the four main challenges we have identified when starting a prescribed burn association; (1) people, (2) training, (3) equipment, and (4) laws and regulations. The first thing we look at is the willingness of local landowners and stakeholders to support these associations. Lacking support from the community is most often the reason for PBA failing to get off the ground. We then will look at access to training; classroom and live experience. During the early stages of PBA's forming there is a great need for not only information in the classroom but more importantly live fire experience. The third major challenge is access to equipment. While many farmers and ranchers have access to some equipment used on the fire line, specialized equipment is often needed and can be expensive. The final challenge are laws and regulations which are often the most difficult to overcome, but I argue that with the support of the community these can also be overcome.

Despite these challenges, prescribed burn associations across the Great Plains have continued to form and prosper with great success. While we often measure success in terms of the acres we burn because it is tangible, I argue that the greatest measure of success cannot be immediately measured as it is the change in the culture and attitude of prescribed fire on local, state, and regional level over time that should be our measure of success. Examples of successful prescribed burn associations and programs will be highlighted.

CALIFORNIA'S FIRST STEPS IN PRESCRIBED BURN ASSOCIATIONS.

. Jeff Stackhouse¹, Lenya N. Quinn-Davidson*²; ¹UCCE, Eureka, CA, ²University of CA Cooperative Extension, Eureka, CA

ABSTRACT

In California, some of the most valued landscapes are the ones that humans have actively managed with fire: grasslands, woodlands, pine forests. Unfortunately, across much of the state, humans have lost their connections with fire; the fear of liability, the perceived complexity of permits and regulations, and the generational and cultural gaps in fire experience have virtually eliminated fire from the toolbox for most landowners.

In recent history, CAL FIRE has been the leader in private lands burning. In the 1980s, their Vegetation Management Program (VMP) was responsible for 30,000-65,000 acres of prescribed burning every year, but in recent decades, those numbers have consistently fallen short of 10,000 acres a year—a drop in the bucket given the habitat and fuels issues that face California. CAL FIRE is currently revamping and reinvesting in the VMP, but it's become clear that other pathways are needed for landowners to reclaim fire as the important tool that it is.

One of the most promising models of landowner-led burning is the prescribed burn association (PBA) model, through which landowners and other interested partners can work together to burn each other's properties. In 2015, there were 62 PBAs, almost all of which were in the Great Plains and Texas. The PBA model has spread into parts of the Southeast, too, but these types of efforts have been noticeably absent in the West.

Over the last year, the PBA model has gained traction in Humboldt County, CA. University of CA Cooperative Extension advisors have worked with landowners, non-governmental organizations, volunteer fire departments, and others to host workshops and trainings and increase the capacity for landowner-led burning, and the formation of California's first PBA is anticipated in 2018.

RELATING BURN SEVERITY WITH ECOLOGICAL EFFECTS AT HIGH-ELEVATIONS
WITHIN THE BEAVER CREEK AND BROADWAY WILDFIRES. Bryn D. Marah*, John D.
Scasta; University of Wyoming, Laramie, WY

ABSTRACT

Fire is an ecological and social feature that varies across dominant vegetation types, environmental drivers, and social dynamics. Evidence suggests that future fire regimes may include more frequent and intense fires. Moreover, federal agencies are increasingly aware of the need to strategically allow fire to function while continuing to protect life and property. The Medicine Bow-Routt National Forest in Colorado and Wyoming experienced several fires in the year of 2016 including the Beaver Creek Fire (Colorado and Wyoming) and Broadway Fire (Wyoming). The Beaver Creek Fire was highly complex due to the overlap of jurisdictional boundaries, surface ownership, fire weather, acres burned, and cost of the incident. An analysis of burn severity related to soil and vegetation effects is underway in order to assess ecological responses to wildland fire events in the Rocky Mountains with altered lodgepole pine (*Pinus contorta*) and subalpine fir (*Abies lasiocarpa*) fuel types. We are analyzing ecological responses to wildfire events that have exhibited unusual fire behavior which is likely due to beetle kill epidemics, a century of active wildfire suppression, and global climate change. These results will be important in their application to incident and post-burn management for the future. This study is underway in collaboration with the United States Forest Service, University of Wyoming, and Southern Rockies Fire Science Network. Two years of post-fire results and implications of the project will be shared during the discussion.

LAKEVIEW PILOT PROJECT: A COLLABORATIVE APPROACH TO BLM LAND HEALTH EVALUATION PROCESS IN OREGON. Molly Anthony*; Bureau of Land Management, Portland, OR

ABSTRACT

In 2016, the Bureau of Land Management (BLM), Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and Agricultural Research Service (ARS) proposed a pilot study, in cooperation with a BLM grazing permittee on the Lakeview District in Oregon, to explore the applicability and utility of incorporating the Oregon threats-based State and Transition Model (STM) Framework into a BLM Rangeland Health Assessment and Evaluation. The Oregon STM Framework is comprised of threat-based ecological models and was developed over the last 5 years by the ARS and Oregon State University. These models were developed to simplify and structure conversations about the primary threats to sagebrush steppe communities and associated potential management responses, and facilitate monitoring of key habitat features at various scales of management. In a Rangeland Health Assessment, BLM gathers, synthesizes, and interprets inventory information on indicators of land health measured in designated assessment areas. Information from this assessment is evaluated along with other available data, including the Oregon STM ecological states map, and the Sage-Grouse Habitat Assessment Framework multi-scale suitability ratings to determine if the Standards and Guidelines for Rangeland Health are being attained. The objective of this pilot project was to determine the proper use of multiple sources of information and synergies among these information sources in completion of BLM's evaluation of the Land Health Standards. The collaborative approach to this pilot project was critical to providing a common set of tools to more easily and clearly communicate the assessments and evaluations, and application of tools with stakeholders and agency partners.

TARGETED GRAZING FUEL BREAKS. Chris J. Mitchell¹, Hanes Holman*²; ¹BLM, Elko, NV, ²Elko Land and Livestock Company, Elko, NV

ABSTRACT

Targeted grazing and minimal mechanical treatment will be used to strategically reduce fuel loads on degraded sagebrush steppe now dominated by annual invasive grasses. Treatment areas have been identified within four allotments in the Tuscarora Field Office: the Hadley, Carlin Field, T Lazy S, and Blue Basin Treatment Areas. Current permittees would be asked to implement fuel treatment actions as part of a strategic, landscape effort to protect and conserve sagebrush-steppe habitats. Priority Habitat Management Areas (PHMAs) exist on the leeward side of the grazing treatments, and would be at reduced risk of wildland fire spread when objectives are met in the proposed treatment areas. Free Use Permits would be issued to the current permittees on Hadley, Carlin Field, T Lazy S, and Blue Basin for periodic biologic treatment of annual fine fuels.

OUTCOME BASED GRAZING AUTHORIZATIONS DEMONSTRATION PROJECTS.
Richard Mayberry*; USDI Bureau of Land Management, Gettysburg, PA

ABSTRACT

The presentation will identify and describe the processes for developing and implementing Outcome Based Grazing Authorizations. Following a description of the concept, information regarding the process that was used to cooperatively develop a strategy and guidance for implementing demonstration projects will be provided. The presentation will address the expectations for developing the authorizations in consultation and coordination with BLM grazing permit holders, state agencies and interested parties. Partnerships for developing monitoring plans and exercising grazing management options will be discussed.

INCREASING FLEXIBILITY, ADAPTABILITY AND ACCOUNTABILITY THROUGH THE COLLABORATIVE DEVELOPMENT OF AN OUTCOME-BASED GRAZING PERMIT: WINECUP-GAMBLE RANCH, NEVADA. James Rogers*; Winecup-Gamble Ranch, Montello, NV

ABSTRACT

This presentation will highlight the Winecup-Gamble Ranch (Montello, NV) as an example of a collaborative, outcome-based grazing (OBG) term permit renewal process that is currently underway.

The Winecup has been engaged in various collaborative efforts focused on identifying opportunities for public land grazing allotments to be managed more holistically and locally for many years. Most recently, they have been an active member of the Results Oriented Grazing for Ecological Resilience (ROGER) group; a newly formed, rancher-led collaborative group focused on expanding grazing flexibility and adaptability to achieve specific ecological and ranch sustainability objectives. One option currently being pursued by ROGER is the development of OBG permits (i.e., Winecup), and a commitment to share successes/lessons learned with a wider audience.

The Winecup operates on approximately 1 million acres in a checkerboard arrangement (390,000 acres private and 558,000 acres BLM). The ranch currently enjoys quite a bit of flexibility within their existing permit, which has substantially contributed to their success. The goal for developing an OBG term permit is to ensure that existing flexibility in terms of seasons of use, livestock numbers, and the ability to implement needed range improvements is maintained and enhanced; while at the same time ensuring accountability through the development of a robust planning, monitoring and adaptive management strategy.

The intent is to map the allotment using remote sensing, threat-based modeling and vegetation mapping (in addition to standard BLM data) to help identify current conditions and threats, and develop ecological objectives; consider the various management tools available to meet stated objectives; determine appropriate thresholds and responses to drive management actions predicated on established rangeland management principles/practices; and design a monitoring plan that provides timely, cost effective, and relevant feedback at an appropriate scale to guide adaptive management. This entire process is embedded within an ongoing collaborative effort.

UTILIZING DISTURBANCE RESPONSE GROUPS AND STATE-AND-TRANSITION MODELS IN GRAZING PERMIT RENEWALS

. Maria M. Ryan*; BLM, Ely, NV

ABSTRACT

The BLM has been utilizing Ecological Site Descriptions (ESD) to monitor grazing allotments for decades. The recent update of the ESDs in Nevada that include the new State-and-Transition Models (STM) are particularly well developed and accurate in describing eastern Great Basin ecological site dynamics. The BLM is using the new ESDs with STMs on grazing allotments to set objectives and determine if they are being met. Standard BLM protocols to measure community function include the Assessment, Inventory and Monitoring (AIM) protocols and others to understand current states and phases of the major ecological sites with an allotment. STMs in Nevada are sufficiently detailed so that they provide the ability to determine if the proposed grazing action under a 10 year permit renewal will continue to meet or make progress toward meeting objectives. BLM grazing allotments in eastern Nevada are large (generally > 15,000 acres) and when combined with other allotments for the grazing permit renewal, analysis using ecological sites can be too small-scale. Smaller allotments can use ESDs where larger allotments or groups of allotments require a large-scale tool for analysis. Disturbance Response Groups (DRG) can be used on very large grazing allotments or groups of allotments, as DRGs combine ecological sites that respond similarly to disturbance and are more appropriate for large-scale analysis. The current ESDs and DRGs provide an increased level of information to better inform land management decisions that link community function, ecological resilience and resistance to invasive species.

IMPORTANCE OF STMS FOR BLM-NV MANAGEMENT

. Sarah E. Peterson*; Bureau of Land Management, Reno, NV

ABSTRACT

In Nevada, the Bureau of Land Management (BLM) manages over 48 million acres throughout the State. In order to achieve BLM's multiple-use and sustained yield mission, a thorough understanding of the complex and diverse landscapes the agency manages is necessary. Increasing threats, such as wildland fire and invasive species, coupled with altered site conditions across much of the State, exacerbates the management complexity of these landscapes. BLM-NV has partnered with the USDA-Natural Resources Conservation Service and the University of Nevada-Reno to develop state and transition models that land managers and technical specialists can use to identify current site conditions, potential thresholds that could result in altered site conditions, and possible pathways for restoration. These models have proven to be effective tools for identifying changes needed in management activities and for restoration options across Nevada's vast landscapes.

UTILIZING DISTURBANCE RESPONSE GROUPS IN FUELS MANAGEMENT
PLANNING AND POST FUELS REMOVAL MONITORING. Cody Coombs*¹, Tamzen
Stringham²; ¹Bureau of Land Management, Ely, NV, ²University of Nevada Reno, Reno, NV

ABSTRACT

State-and-Transition Models (STM) describe how an ecological site responds to various treatments and disturbances. STM can be used to select appropriate objectives and treatments for fuels and vegetation management projects. Disturbance Response Groups (DRG) are a series of ecological sites that respond similarly to disturbance and treatment. When planning at landscape scales, DRG, in association with STM can help plan treatments and predict their outcomes over larger areas. The BLM, NRCS, and the University of Nevada, Reno have developed STM for much of eastern Nevada. Examples of planning, implementation and monitoring will be presented showing how to integrate STM and DRG into fuels and habitat management planning.

UTILIZING DISTURBANCE RESPONSE GROUPS FOR POST-FIRE REHABILITATION
PLANNING. Keith D. Barker*; Carson City District, Carson City, NV

ABSTRACT

The BLM Carson City District is in the implementation phase of a landscape level habitat resiliency, health and restoration project in the Desatoya mountain range in both Churchill and Lander counties, Nevada. Within the project area, up to 32,000 acres of vegetation treatments will be implemented over a 10 year period. The purpose of the project is to improve availability, quantity, and quality of sagebrush, woodland, and wet meadow/riparian habitats that multiple wildlife species, wild horses, and livestock depend on. How do you establish a base line vegetation community layer, adaptively manage treatment implementation over the life of the project, and define success after project completion? This presentation will identify the process used to develop treatment specifications and prioritize areas for treatment based on the existing vegetation communities using current ecological site descriptions and the development of disturbance response groups for the project area.

DEVELOPMENT OF DISTURBANCE RESPONSE GROUPS. Devon K. Snyder*¹, Tamzen K. Stringham², Patti Novak-Echenique³; ¹University of Nevada Reno, Reno, NV, ²Univ. Nevada Reno, Reno, NV, ³USDA-NRCS, Reno, NV

ABSTRACT

Ecological site descriptions are increasingly being used by land managers to develop monitoring plans, design post-fire rehabilitation plans, and restore wildlife habitat. We have developed a system of grouping ecological sites that enhances the utility of ecological sites at larger spatial scales and improves the ability to make ecological inferences between and among individual ecological sites. A Disturbance Response Group (DRG) is a collection of ecological sites within a Major Land Resource Area that respond similarly to disturbance. Group membership is initially determined by dominant vegetation, soils and mean annual precipitation range and then is refined further by the disturbance ecology of the Reference plant community in combination with environmental variables. Because the DRG process incorporates ecological dynamics from the start, sites within a DRG have similar state-and-transition models. This expedites the field verification and model-building process for multiple ecological sites. DRGS can be joined to existing soil maps in a GIS using the NRCS Gridded Soil Survey Geographic (gSSURGO) database; in Nevada the resulting DRG maps have been utilized for stratification of monitoring points and for fire rehabilitation. An intended byproduct of the DRG process is the enhancement of users' ability to understand the underlying processes behind the ecological site concepts through consolidation of models and ecological site mapping.

UTILIZING DISTURBANCE RESPONSE GROUPS TO EXPEDITE STATE-AND-TRANSITION MODELS FOR MANAGEMENT. Tamzen K. Stringham*¹, Devon K. Snyder², Patti Novak-Echenique³; ¹Univ. Nevada Reno, Reno, NV, ²University of Nevada Reno, Reno, NV, ³USDA-NRCS, Reno, NV

ABSTRACT

Disturbance Response Groups (DRGs) are used to scale up ecological sites by grouping ecological sites based on abiotic and biotic similarities and disturbance ecology of the Reference plant community. The disturbance response focus in group building facilitates the development of a modal state-and-transition model (STM) for the DRG that is refined through field investigations and for each individual member or ecological site contained in the DRG. This method of STM development and refinement provides an expedited, scientifically sound process for creating robust, field tested, conceptual STMs that can be up-scaled to the DRG level or down-scaled to individual ecological sites. Furthermore, the process follows guidance provided by the USDA, NRCS National Ecological Site Handbook (2014) and subsequent Title 306 National Instructions (2015) for STM development for Provisional Ecological Sites. This methodology has successfully completed Disturbance Response Groups in Nevada for MLRA 23, 24, 25, 26, 27, 28A, 28B and 29 and on Oregon's Crooked River Grasslands (MLRA B10). State-and-transition models are available for the Crooked River Grasslands and MLRA 24, 25, 28A, and 28B with draft models available for MLRA 23 within Nevada.

USING DISTURBANCE RESPONSE GROUPS AND STATE AND TRANSITION MODELS
TO ASSESS RISK OF NON-NATIVE INVASION AND OPTIONS FOR RESTORATION.

Steven D. Gibson*; U.S. Forest Service, Prineville, OR

ABSTRACT

The Crooked River National Grassland (CRNG) has a long history of a level of intensive management and associated environmental conditions which are typical of National Grasslands but which are uncharacteristic of the majority of National Forest System (NFS) lands. Since federal acquisition of these lands in the early to mid 30's the administrative federal agencies have attempted to stabilize, rehabilitate and/or restore the system processes and functions on these lands, while, "...promot[ing] development of grassland agriculture and sustained yield management ..." (36 CFR213.1, (c)). On the CRNG many management activities have been employed over the years in order to accomplish these goals. During the past forty years many of these CRNG management activities have been aimed at the control of the density and distribution of western juniper on this landscape. During this same time period the spread and establishment of medusa head rye has increased dramatically often in association with implemented western juniper control practices. In consultation with Dr. Tamzen Stringham and in cooperation with the Natural Conservation Service, National Forest/Grassland personnel have conducted intensive Ecological Site data collection in order to refine STMs and disturbance response groupings, and are utilizing these products to inform management decisions and better predict outcomes of management actions intended for landscape restoration particularly in relation to non-native invasive grasses.

USING DISTURBANCE RESPONSE GROUPS AND ECOSITES TO DELINEATE
SAMPLING UNITS WITHIN NEVADA'S CONSERVATION CREDIT SYSTEM.
Katie Andrie*, Kathleen Petter; Sagebrush Ecosystem Technical Team, Carson City, NV

ABSTRACT

Nevada is diverse in its ecosystems and industries. Mining, ranching and agriculture, energy development and manufacturing are all vital to Nevada's economy, but we also need to protect our heritage, natural landscapes, and wildlife that make Nevada unique. With this in mind, Nevada's Sagebrush Ecosystem Program has developed the Conservation Credit System (CCS), a new approach to compensatory mitigation that allows anthropogenic impacts such as mines, roads, energy development and transmission lines to be developed within greater sage-grouse (GRSG) habitats while ensuring that those impacts are mitigated to achieve an overall conservation gain for GRSG habitats. The CCS uses science-based, quantitative assessments to calculate direct and indirect impacts to GRSG habitats (debits). Credits are quantified using a similar process as that used to determine debits, and are generated through habitat preservation, enhancement, and restoration. Vegetative sampling is an essential component in determining habitat quality for GRSG and quantifying credit obligation and credit generation; however, it can be challenging to define seemingly homogeneous areas of vegetation to adequately capture cover, forbs, and invasive grasses, among others, on projects of varying sizes across the state. Ultimately, Disturbance Response Groups (DRGs) and Ecological sites have helped solve this dilemma by serving as the starting point for map unit delineation by vegetation, precipitation, and soil types. Careful evaluation from other sources including aerial imagery is still recommended in order to capture additional variables prior to map unit finalization, and ultimately, on-the-ground sampling. DRGs serve as the desired tool to anchor map unit formation and ensure the level of consistency necessary for the system to allow for better outcomes for CCS users and ultimately, the GRSG and its habitat.

HOW MOISTURE GRADIENTS AFFECT RESTORATION OF NATIVE GRASSLANDS IN ALBERTA

. Darin E. Sherritt*; Tannas Conservation Services, St Albert, AB

ABSTRACT

Within the province of Alberta, moisture availability whether from summer rain or winter snows, is one of the main drivers for determining grassland plant communities. Moisture is also critically important to the success or failure in the attempts to restore these grasslands following various types of disturbances. While increased moisture means more above ground biomass production, a correlation between increased moisture and successful restoration hasn't followed the same trend. On native rangeland in Alberta, generally the drier the site is, the greater the likelihood of success at native species restoration. However, being too dry also creates restoration difficulties. Given that, there may be an optimum range of site moisture that's leads to a greater restoration success rate. A number of factors are thought to contribute to this, but one of the dominant factors is that native species are better able to compete under stressed growing conditions. This presentation will examine both successes and failures of native grassland restoration within environments with varying moisture levels and evaluate the some of the factors leading to this higher success rate on drier sites.

ISHRUB RESTORATION IN THE NORTHERN GREAT PLAINS. Matthew J. Rinella*¹, Jeremy J. James², Erin Espeland³; ¹USDA-ARS, Miles City, MT, ²Center Director, Browns Valley, CA, ³USDA Agricultural Research Service, Sidney, MT

ABSTRACT

Using seeding to restore degraded rangelands of the northern Great Plains is a major challenge. Often, seeded species fail to establish and areas remain/become dominated by downy brome and other unwanted plants. Even where some seeded species establish, species diversity is typically low, and big sagebrush and other shrub are nearly nonexistent. We gathered vegetation data on >350 seeded fields on nine strip coal mines in Wyoming and Montana and then paired these vegetation data with management (e.g. seeding rate) and environmental (e.g. 1st growing season precipitation) data in order to better understand factors regulating seeding outcomes. We found seeding aggressive, cool-season grasses, such as western wheatgrass and green needlegrass, reduced annual weed cover. These grasses became similarly abundant whether sown at low or high rates, so low rates could likely be safely used to reduce seed costs. More importantly, reducing grass seed rates reduced the onset of intense grass competition and thereby increased cover of shrubs, the plants most difficult to restore to our system. Grass competition had the potential to be so intense that seeded shrubs established at higher densities in *dryer*-than-average years, presumably because dry conditions reduced seeded grass establishment and competition. These results point to cost-effective management strategies that could be used to improve restoration outcomes in mixed grass prairie. In addition to our large-scale observational study, we briefly discuss a study strategically using seed mix diversity to buffer seeding outcomes against weather variation.

INTEGRATED MANAGEMENT PRACTICES FOR NATIVE GRASSLAND RESTORATION IN MEDITERRANEAN CALIFORNIA

. Julea A. Shaw*¹, Elise Gornish², Danny J. Eastburn¹, Emilio Laca³, Daniel K. Macon⁴, Kenneth W. Tate⁵, Leslie Roche⁶; ¹University of California - Davis, Davis, CA, ²University of Arizona Cooperative Extension, Tucson, AZ, ³UC Davis, Davis, CA, ⁴UCCE - Placer/Nevada/Sutter/Yuba, Auburn, CA, ⁵University of California, Davis, Davis, CA, ⁶University of California, Davis, CA

ABSTRACT

California is characterized by a Mediterranean climate, with moderately wet winters and dry summers, that creates unique challenges for vegetation management. In particular, exotic annual plants from Mediterranean regions of Europe are adept at quickly taking advantage of rain, making them strong competitors against native perennial bunchgrasses. Exotic annual grasses now dominate most California grasslands, fundamentally altering the ecosystem and reducing forage quality. Restoration and vegetation management are important for reestablishing the economic and ecological value of rangelands. However, restoration efforts often have low success due to high cost and persistence of highly competitive invasive plants. To address these challenges, we are testing an integrated management approach incorporating low-cost spatially-patterned seeding with targeted grazing and burning. Spatially-patterned seeding of desired plant species (i.e. “strip seeding”) has been suggested to reduce revegetation costs up to 66%. However, little research has been done on the effectiveness of strip seeding. In Fall 2012, we seeded fields with native perennial bunchgrasses in different strip widths (seeding coverage from 0%-100%). In the springs of 2016 and 2017 we measured community diversity and abundance across transects in the middle and edges of seeded and unseeded strips. We used PERMANOVA to understand how strip size affected community dynamics across the seeded strips. We found that native species successfully established in all seeded strips and conferred some degree of invasion resistance, but that unseeded strips were dominated by invasive species regardless of strip size. Therefore, to reduce invasive cover and encourage dispersal of native species from seeded to unseeded strips, we implemented grazing and burning treatments in Spring 2017. We will measure post-treatment community composition and reproductive output of a common invasive grass, *Elymus caput-medusae* (medusahead), to determine if combining strip seeding, grazing, and burning is an effective strategy to establish native grasses and reduce invasive cover.

UNPACKING SEED REGENERATION FOR RESTORATION IN AUSTRALIAN DRYLANDS: COMPLEX INTERACTIONS BETWEEN SPECIES, MOISTURE AVAILABILITY, AND SOIL TYPE

. Todd E. Erickson*¹, John M. Dwyer², Jeremy J. James³, Olga A. Kildisheva⁴, Shane R. Turner⁵, Miriam Muñoz-Rojas⁵, David J. Merritt⁶; ¹Project Manager, Restoration Seedbank Initiative, Perth, Australia, ²Research Fellow, St Lucia, Australia, ³Center Director, Browns Valley, CA, ⁴PhD Candidate, Crawley, Australia, ⁵Research Fellow, Crawley, Australia, ⁶Senior Research Scientist, Kings Park, Australia

ABSTRACT

Plant regeneration in degraded landscapes is critical to temper the on-going impact of human disturbance. Yet for many species required for large-scale restoration in biodiverse drylands, initiating their establishment via seed is challenging. More often than not, clear protocols to consider and manage seed germination and establishment requirements are lacking. Important establishment barriers include narrow ‘environmental envelopes’ that limit plant recruitment to rare periods of high, and consistent rainfall, and a reduced water holding capacity in soils impacted by human activities (e.g. reconstructed soil profiles). Cumulatively, these impediments prevent practitioners from reliably establishing a wide and representative array of native plants species from seeds.

Seed-based restoration projects in the hot deserts of northwest Western Australia are no different. In the mining sector for instance, restoration seeding efforts that contained high-diversity seed mixes have seen complete germination failures, largely as a result of seed dormancy. Recent research shows that pre-sowing seed treatments can increase germination capacity and widen the germination envelope when specific cleaning methods and dormancy-alleviation treatments are applied.

This presentation will highlight three key aspects of how we approach seed-based restoration that will improve the likelihood of plant establishment in dryland systems: (1) categorisation of the seed dormancy class that regulates germination; (2) identification of the underlying mechanisms that lead to the relief of dormancy and the development of reliable seed pre-treatments; and, (3) novel seed enhancement technologies (i.e. seeding priming, coating and pelleting) to maximise germination capacity under various seeding scenarios. Data from a large, purpose-built rain exclusion shelter will be used to demonstrate how we model seed germination, emergence, and early seedling survival across 20 different soil and rainfall scenarios.

RANGELAND RESTORATION FOR HIROLA, THE WORLD'S MOST ENDANGERED ANTELOPE.

. Ali H. ABDULLAHI*¹, Lauren Porensky², Kari E. Veblen¹; ¹Utah State University, Logan, UT, ²USDA-ARS, Fort Collins, CO

ABSTRACT

Rangeland restoration can improve habitat for threatened species such as the hirola antelope (*Beatragus hunteri*) that inhabit savannas of eastern Kenya. However, restoration success likely varies across soil types and target restoration species, as well as according to restoration approach. We tested the response of four native grass species (*Cenchrus ciliaris*, *Enteropogon macrostachyus*, *Eragrostis superba*, and *Chloris roxburgiana*) to four different restoration approaches (tilling, manure application + seeding, seeding, no treatment). We also tested the interaction between planted grass and other functional groups using ANOVA. In each of two soil types, we located three 50m x 20m treatment blocks. Within each block, were 16 treatment plots that were randomly assigned to one of 16 species-site preparation combinations (4 species * 4 site preparation treatments). We seeded in May 2017 and assessed species cover in July and August 2017. Preliminary results suggest total grass cover was higher in the seeded treatment than the seeding + manure treatment. Both tilling and no treatment did not result in any significant above ground biomass suggesting that lack of seeds rather than soil capping or water availability might be the key mechanism limiting grass growth. There were no statistically significant interactions between the effects of the treatments and the occurrence of other, non-planted, grass species on planted grass cover. In contrast, the Tukey's HSD post hoc paired tests showed significant differences among all treatments. Overall, planted grass species performed better in loam soils (median 45% cover) than in high clay (black cotton) soils (median =40% cover). Similarly planted grasses performed better than other grass species and forbs in both loam and black cotton soils. These experiments are aimed at informing landscape level grassland restoration for hirola, where tree encroachment has suppressed their recovery for nearly three decades.

LONG-TERM PLANT RESPONSES TO CLIMATE ARE MODERATED BY BIOPHYSICAL ATTRIBUTES ACROSS THE SOUTHWESTERN U.S. Seth M. Munson*¹, Robert H. Webb², Erin Bunting³; ¹U.S. Geological Survey, Flagstaff, AZ, ²University of Arizona, Tucson, AZ, ³Michigan State University, East Lansing, MI

ABSTRACT

Recent elevated temperatures and prolonged droughts in many rangelands throughout the world are likely to intensify according to future climate-model projections. This warming and drying can negatively affect the establishment and growth of perennial vegetation and lead to restoration failures. To better forecast these detrimental effects, we formulate a conceptual model of rangeland vulnerability to enhanced aridity that integrates hypotheses on plant species responses to reductions in water availability and how these responses are modified by biophysical attributes, including landscape, soil and plant properties. We test the model by integrating long-term monitoring results across the southwestern U.S. and employing a novel “climate pivot point” approach. Plant species, communities, and ecoregions ranged in their sensitivities to precipitation in different seasons, capacities to increase in abundance during wet conditions, and resistances to drought. Our model successfully explains how plant responses to climate are moderated by biophysical attributes. For example, deep-rooted plants were not as vulnerable to drought on soils that allowed for deep-water percolation, whereas shallow-rooted plants were better buffered from drought on soils that promoted water retention near the surface. Our results imply that multiple biophysical attributes of a site should collectively be considered in restoration planning because they mediate the performance of plant species through their influence on water availability and use.

UNDERSTANDING SPATIAL VARIABILITY IN PERENNIAL GRASS RESTORATION
FOLLOWING SHRUB REMOVAL IN THE CHIHUAHUAN DESERT: THE RESTORE NEW
MEXICO COLLABORATIVE MONITORING PROGRAM

. Brandon T. Bestelmeyer*¹, Laura M. Burkett¹, Leticia Lister²; ¹USDA-ARS Jornada
Experimental Range, Las Cruces, NM, ²Bureau of Land Management, Las Cruces, NM

ABSTRACT

Grassland to shrubland transitions are well documented throughout the desert grassland region of the Chihuahuan Desert. These transitions were triggered in the early 20th century by overgrazing of perennial grasses during drought periods, loss of fire regimes, and seed dispersal by livestock. Shrublands dominated by C3 species are highly resilient to natural disturbances, so herbicides specific to the C3 photosynthetic pathway are used to reduce the competitive preemption of soil water resources by shrubs and trigger the recovery of C4 perennial grasses. Anecdotally, there is evidence that shrub management treatments have been effective in some cases, but not in others, creating controversy about their value. As part of the Restore New Mexico partnership, we initiated a region-scale, long-term monitoring experiment embedded within shrub management treatments beginning in 2007. Within shrub management areas, we created treatment and control plots that were matched according to soils/ecological sites and initial state prior to treatments, such that control plots were excluded from treatment. Line-point intercept was used to measure cover prior to and after treatments. In addition, we sampled older treatments (2004 and earlier) using space-for-time substitution assumptions. Our records to date indicate that 1) treatments are generally effective in increasing perennial grass cover, 2) the composition of grasses that increase usually differs from that of putative reference states, creating “novel ecosystems” and 3) soil and climate properties are related to the magnitude of grass response to treatments; specifically, loamy soils and drier climates yield reduced grass response. Experimental monitoring data can be used to refine restoration approaches and resolve controversies about them.

MOISTURE, PLANT-PLANT INTERACTIONS AND HERBIVORY AS DRIVERS OF RANGELAND RESTORATION SUCCESS IN THE WESTERN US. Lauren Porensky*¹, Elizabeth A. Leger², Barry Perryman³, Jay Davison⁴, Matthew Williamson⁵, Matthew D. Madsen⁶; ¹USDA-ARS, Fort Collins, CO, ²University of Nevada, Reno, NV, ³University of Nevada Reno, Reno, NV, ⁴Univ. NV Cooperative Extension, Fallon, NV, ⁵UC Davis, Davis, CA, ⁶Brigham Young University, Provo, UT

ABSTRACT

Restoration efforts in the western US occur across a diverse array of plant communities and climatic conditions. Restoration is likely constrained by different factors in different locations, but few efforts have compared the outcomes of rangeland restoration experiments across broad spatial scales. We compared results from multiple studies to evaluate the roles of water availability, plant-plant interactions, and herbivory as drivers of restoration success across three dramatically different ecosystems: arid sagebrush steppe in north-central Nevada, slightly wetter sagebrush shrublands in northwestern Arizona, and a semi-arid shrubland-grassland ecotone in northeastern Wyoming. At the most arid sites, efforts to directly increase available moisture during plant establishment led to long-lasting restoration benefits. In an eroded old-field, irrigating for two growing seasons led to 6.7 times higher perennial grass cover and fewer large vegetation gaps, even three years after irrigation ceased. In another Nevada study, seed coatings designed to increase available moisture had mixed effects, but were generally beneficial when planted species were grazed during the second growing season. In Arizona, however, seed coatings had negative rather than positive effects. Across all sites, we found evidence that plant establishment was constrained by competition with other, already-established plants. In both the most arid and the most mesic locations, established perennial grasses inhibited shrub establishment. In Arizona, established perennial grasses reduced perennial grass seedling establishment. Plant-plant competition in semi-arid systems may reflect underlying competition for available soil moisture, but few studies have tested this mechanism in a restoration context. Overall, our results suggest that direct manipulations of moisture may be critical for restoration at the most arid sites, and a recognition of competition from established perennial plants is relevant across a wide range of arid and semi-arid systems.

ACTIVE OLD-FIELD RESTORATION IN THE MOST ARID LANDS OF THE GREAT BASIN

. Elizabeth A. Leger*¹, Jay Davison², Wally W. Miller¹, Benjamin Sullivan¹, Shauna Uselman¹, Lauren M. Porensky³, Owen Baughman¹; ¹University of Nevada, Reno, Reno, NV, ²Univ. NV Cooperative Extension, Fallon, NV, ³USDA-ARS, Fort Collins, CO

ABSTRACT

Restoration of former agricultural fields can be challenging, especially in arid systems, where factors such as wind erosion, water stress, soil alteration, and competition from weeds can strongly affect plant establishment and growth. Experiments were conducted in two former agricultural fields in Nevada's Mason Valley, testing the effects of irrigation timing, seed source, and seeding order on restoration outcomes. Multiple sources of grass and shrub seeds were drill seeded in four strategies: 1) simultaneously in year one, 2) shrubs only in year one, 3) grasses in year one followed by shrubs in year two, or 4) shrubs seeded alone in year two, after a year of weed control. Irrigation was applied to all treatments in either spring or fall + spring for two years, and we monitored emergence and survival for three years. All treatments affected performance, but results were highly context dependent. For example, in a higher fertility field, fall + spring irrigation increased shrub seedling emergence, while grasses had higher emergence in spring-only irrigation treatments. In contrast, in a lower-fertility field, there was no effect of irrigation timing on seedling densities of grasses or shrubs. In both fields, shrubs emerged best when seeded in year two, either alone or after grasses. In this treatment, shrubs from more local seed sources outperformed more distant collections while irrigation was ongoing, but, after dramatic declines in shrub densities after irrigation ceased, this effect did not persist. In contrast, commercially-available, non-local grasses initially outperformed more local grass sources under some scenarios, but after irrigation ceased, these advantages either disappeared or more local grasses outperformed commercial sources. Our trials indicate that supplemental irrigation and seed source can affect restoration outcomes in arid old fields, but results can vary greatly, even between fields in very close proximity. Because of these highly context-dependent results, a bet-hedging strategy that uses a variety of seed sources and irrigation treatments within an overall restoration plan may maximize the chances of restoration success.

INTRODUCTION. Lawrence D. Ford*¹, James W. Bartolome²; ¹University of California Santa Cruz, Felton, CA, ²University of California, Berkeley, CA

ABSTRACT

The introduction to this symposium will describe: why this is an important subject for study and applications to management; the plan for conducting the symposium; and the framework of talk topics and titles.

CALIFORNIA'S MEDITERRANEAN GRASSLANDS: BIODIVERSITY AND THREATS. Sasha Gennet*; The Nature Conservancy, San Francisco, CA

ABSTRACT

California's rangelands are a global biological diversity hotspot, and provide high forage production and other ecosystem service values. However, over 200,000 hectares of grasslands and oak woodlands have been converted since the 1980's due to heavy demand for irrigated agricultural crops, housing, and associated infrastructure to support the state's booming population. Land values continue to spike statewide, exacerbating the pressure on many landowners to sell or convert their lands, and stretching public and private conservation dollars ever thinner. Warmer temperatures and highly variable rainfall, a complex regulatory environment, aging ranch infrastructure, and invasive species are also amplifying the challenges ranchers and rangeland managers are facing. We will explore these threats in maps and stories, and propose a variety of solutions and strategies to conserve California's Mediterranean grasslands and oak woodlands.

MANAGING ANIMAL SELECTIVITY TO ENHANCE BIODIVERSITY IN CALIFORNIA'S MEDITERRANEAN GRASSLANDS

. Lynn Huntsinger*; University of California, Berkeley, Berkeley, CA

ABSTRACT

The selectivity of grazing animals distinguishes grazing as a vegetation management process from other tools such as prescribed burning and mowing. Selective grazing has been presented as a problem in rangeland science since its inception, however, managers have gradually begun turning to taking advantage of selectivity rather than using grazing systems and other methods to suppress it. In California's annual grasslands, it is achieving widespread use on annual grasslands for creating within-year changes in annual grassland structure and composition, as well as driving long term changes in the grassland and woody vegetation. Temporal and spatial scale of vegetation management goals are critical to managing animal selection. Within-year grazing generated changes in habitat have been quite successful, including managing for vernal pools, a variety of endangered and rare species, and pollinators. Carry-over effects are far less certain, including native grass restoration and persisting control of pest species. Discovering the links between highly heterogeneous abiotic factors and biotic factors like herbivory at appropriate scale is critical to these efforts. Researchers in other parts of the world report similar results, although the supplantation of California's native grasslands by non-native annuals also has an important role. Can the fundamental principles of managing selectivity be apply in other ecosystems? In Nevada, with the widespread invasion of cheatgrass (*Bromus tectorum*) managers have already begun using related techniques to manage the annual non-native grass.

DRIVERS OF CALIFORNIA'S MEDITERRANEAN GRASSLAND BIODIVERSITY

. James W. Bartolome*¹, Peter J. Hopkinson², Michael D. White¹; ¹University of California, Berkeley, Berkeley, CA, ²University of California Berkeley, Berkeley, CA

ABSTRACT

Mediterranean grassland dynamics can be usefully understood as more closely fitting assumptions of non-equilibrium than equilibrium models. This implies that factors external to the system like low and erratic rainfall predominate, and factors like competition and grazing play lesser roles in determining community structure and diversity. Threshold models that include alternative stable states and persistent equilibria may incorporate assumptions leading to greater emphasis on control by biotic processes. The utility of models for predicting the relationships among drivers and grassland biodiversity are proposed to be highly dependent on drivers like topography, parent material, soils, and rainfall on more arid grassland sites. This contrasts to locally and/or seasonally mesic sites where biotic drivers like herbivory, reproductive output, and competition play a greater role. The choice of spatial and temporal scales upon which descriptive and explanatory models are built play an important role in determining how biodiversity drivers are explained.

FRAGMENTATION AND OWNERSHIP OF CALIFORNIA'S MEDITERRANEAN GRASSLAND &MDASH; EFFECTS ON BIODIVERSITY AND STEWARDSHIP. Luke Macaulay*, Felix P. Ratcliff; University of California, Berkeley, Berkeley, CA

ABSTRACT

Land ownership is one of the primary determinants of how rangelands are used and property size has been shown to drive many land use decisions. As such, knowledge about land ownership characteristics is key to understanding rangeland production, land fragmentation, and biodiversity conservation. This information is also useful in targeting outreach materials to improve production and conservation practices. Using a parcel dataset containing all 58 California counties we describe the characteristics of Mediterranean rangeland ownership across California and discuss the implications for livestock production and biodiversity conservation.

DEVELOPING REGIONALLY SPECIFIC GRAZING PRACTICES TO PROMOTE PRODUCTION, PROFITABILITY, AND ENVIRONMENTAL QUALITY

. Sheri Spiegel*¹, Brandon T. Bestelmeyer², Joel R. Brown³; ¹USDA - ARS Jornada Experimental Range, Las Cruces, NM, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³USDA-NRCS, Las Cruces, NM

ABSTRACT

Rangelands are valued for their capacity to provide diverse suites of ecosystem services, from food production to carbon storage to biological diversity. Although rangelands worldwide share common characteristics, differences among biogeographic regions result in differences in the types of opportunities for ranchers and other rangeland managers to preserve and enhance multiple services. For instance, opportunities to use grazing to promote biodiversity while meeting growing global demand for beef vary among the rangelands of Mediterranean California, the Chihuahuan Desert, and the Great Plains, USA. The drivers of these regional differences are biophysical, social, and economic. Understanding the drivers and their interactions can improve planning for regionally specific grazing practices, land uses, funding programs, and scientific research that optimize the provision of multiple services from U.S. rangelands. We present a model identifying the drivers that differentiate regional opportunities, and use it to compare grazing management options in Mediterranean California with those in other rangeland regions across the United States.

EFFECTS OF CATTLE ON RIPARIAN VEGETATION IN THE SAN JOAQUIN VALLEY, CALIFORNIA. Felix P. Ratcliff*¹, James W. Bartolome¹, Luke Macaulay²; ¹University of California, Berkeley, Berkeley, CA, ²UC Berkeley, Berkeley, CA

ABSTRACT

In arid rangelands, riparian areas are important components of ranching operations that also provide critical ecosystem services, including: habitat for fish and wildlife, increased landscape biodiversity, and regulation of the fate and transport of nutrients and pathogens. Many of these ecosystem services are mediated by vegetation composition and structure. In Mediterranean California, rangeland riparian sites likely behave in a non-equilibrium manner, where external abiotic factors shape vegetation composition and structure at multiple scales. Despite this, livestock are often cited as a major cause of rangeland riparian degradation. We monitored vegetation change along 5 creeks at Tejon Ranch in southern California, and found that livestock impacted vegetation in unexpected ways. Over two years, moderate cattle activity decreased cover of upland plants, exotic plants, forbs and grasses. Cover of wetland and native plants were unaffected by cattle, however bare ground significantly increased when cattle were present. There was also a near-significant increase in woody plant seedling abundance on grazed plots. Notwithstanding these effects on plant functional groups, a classification-based analysis of vegetation showed that cattle grazing had little effect on plant community composition. The results suggest that understanding the effects of cattle on riparian vegetation depends not only on the spatial and temporal scales of the investigation, but also on the way the vegetation response is framed.

POLICIES GOVERNING GRAZING TO BENEFIT CALIFORNIA'S GRASSLAND BIODIVERSITY

. Sheila Barry*; UCCE, San Jose, CA

ABSTRACT

The primary driver of grazing policies to benefit California's grassland biodiversity is the Federal Endangered Species Act (ESA). California has 301 federally listed threatened or endangered species. Since seventy percent (70%) of these species (212) have some nexus with livestock grazing with many of them occurring on grassland, the ESA has widespread impact on the conservation and management of California's grassland. Required mitigation for loss of habitat and impacts to species as a result of development and public works projects is resulting in a growing number of conservation easements being placed on both private and public-owned grasslands. These easements include a conservation management plan, which typically permits and often requires livestock grazing to manage the grassland habitat for the species being conserved. On public lands, even without an easement, livestock grazing to achieve specific habitat conservation goals may be required depending on the interests and needs of the public agency. Although there is an increase in the amount of conservation planning and monitoring as a result of the ESA, there is often little science used to guide appropriate grazing management or effective monitoring; agencies do not require the involvement of a California licensed Certified Rangeland Manager, even though state law requires it. Other regulations and policies that influence grazing and its potential impacts to biodiversity on California's grasslands, especially on public lands include California Environmental Quality Act (CEQA), Nation Environmental Policy Act (NEPA), Natural Community Conservation Planning Act (NCCP), water quality regulations including Federal Clean Water Act, federal and state coastal zone regulations and California's Porter-Cologne Act, and public access and use requirements. These regulations can create both challenges and opportunities for implementing grazing management that could benefit biodiversity in California's grasslands.

GRAZING MANAGEMENT PLANNING FOR ADAPTIVE STEWARDSHIP. Lawrence D. Ford*¹, Peter J. Hopkinson²; ¹University of California Santa Cruz, Felton, CA, ²University of California Berkeley, Berkeley, CA

ABSTRACT

The need to conserve declining special-status species and natural communities is severe. Controversy over livestock grazing practices and lack of scientific research to guide grazing management in specific habitats hinders progress in effectively deploying this important landscape-level conservation tool. To improve conservation outcomes amidst controversy and scientific uncertainty, we propose land managers implement the Adaptive Stewardship grazing model. Essential elements of the Adaptive Stewardship grazing model include:

- development of a site-specific grazing management plan as the initial step in using grazing for conservation purposes
- planning focuses on key adjustments to grazing practices and landowner leasing and supervision practices that are most likely to make conventional ranching better at achieving conservation and sustainability objectives
- flexibility of grazing practices and focus on achieving performance standards (results over methods)
- development of special-status species and natural community habitat needs into grazing management targets at specified places and during specified seasons
- incentives for rancher stewardship
- monitoring design to generate quantitative and qualitative results on the highest priority variables to efficiently inform and guide grazing and related activities throughout the grazing season as well as annual adaptations of the grazing strategy or the overall grazing plan
- cost minimization through efficient use of rancher services, monitoring, supervision, and administration.

We describe some of the difficulties facing managers who wish to incorporate Adaptive Stewardship grazing into their conservation management and propose strategies to surmount these constraints.

ADAPTATIVE MANAGEMENT IN THE SOCIAL ECOSYSTEM OF PUBLIC GRAZING .
Tipton D. Hudson*; Washington State University, Ellensburg, WA

ABSTRACT

Grazing management is not rocket science -- it's much more complex than that. Numerous scholars and practitioners have quipped that rangeland management is both art and science, and strongly both. This is because there are hundreds of variables affecting plant communities and the domestic animals managed by humans, which exist separate from the (at least) dozens of sociological and psychological variables affecting the humans' decision-making processes and the humans' relative abilities to consider all of the interactions between the hundreds of natural variables, interactions which number in the many thousands. It is no wonder that ranchers feel strongly that, to some extent, they must manage "by feel", and that when permit administrators want to follow rigid guidelines it seems overly simplistic. Nevertheless, not everyone is a good artist, and good artists almost invariably become good by mimicking masters and following rules, which agencies are compelled to provide. In a best-case scenario, range/forest managers and livestock operators will work together to manage animals, people, plant communities, and the mix ecological goods & services under some kind of adaptive approach. Several kinds of adaptability are needed: flexibility in grazing on and off dates, flexibility in duration of grazing, flexibility in stock density to accomplish varying grazing intensities relative to the plant community and long-term landscape goals, and flexibility in the methods used to enforce the provisions of a permit, especially where older permits omit language about adaptive management.

ADAPTIVE MANAGEMENT: A FOREST SERVICE PERSPECTIVE. Chad Horman*; US Forest Service, Cedar City, UT

ABSTRACT

Adaptive management has been discussed and proposed in allotment management plans (AMPs) and in National Environmental Policy Act (NEPA) documents over the past 20 years. During this time there have been successes and failures in how it has been defined, analyzed and implemented. Topics that will be explored from a Forest Service perspective are: defining adaptability and adaptive management; the constraints and boundaries that define how adaptable the Forest Service can be; and examples of success and failures in applying adaptability and adaptive management.

FOREST SERVICE ADAPTIVE MANAGEMENT POLICIES AND IMPLEMENTATION
. Judith Dyess*; U.S. Forest Service, Albuquerque, NM

ABSTRACT

The USDA Forest Service recognizes the need for flexibility to adapt grazing management on rangelands due to weather, disturbance such as wildfire, ecological dynamics, response and variability. The Forest Service is required to conduct analysis per the National Environmental Policy Act (NEPA) for the authorization of grazing on National Forest System lands. Guidance for conducting this analysis is found in the Grazing Permit Administration Handbook (FSH2209.13_90). NEPA requires analyzing and disclosing environmental effects, and taking public comment. National direction incorporates integrating adaptive management into the proposed action. For adaptive management to be successfully analyzed a description of the likely adaptive management practices needs to be depicted. This provides the responsible official the ability to facilitate changes in management that are needed to meet resource management objectives and/or improve resource conditions. Adaptive management is a system of management practices based on clearly identified intended outcomes and monitoring to determine if management actions are meeting those outcomes; and, if not, to facilitate management changes that will best ensure that those outcomes are met or re-evaluated. Adaptive management stems from the recognition that knowledge about natural resource systems is sometimes uncertain. Management flexibility is required to respond to unpredictable ecosystem drivers and stressors, such as drought, flooding and fire events. Adaptations may also provide for minor modifications that are needed due to changed conditions or new information. Implementation and effectiveness monitoring are essential components to successful adaptive management. Monitoring and collaboration with stakeholders and permittees provides an ongoing feedback loop for the need to maintain or change management on the ground. The Southwestern Region of the Forest Service has supplemented national direction emphasizing collaborative development of proposed actions which articulate the associated adaptive management and monitoring necessary to manage authorized grazing towards the achievement of resource objectives and desired conditions.

THE ROLE OF PERMITTEE/AGENCY RELATIONSHIP IN ADAPTIVE MANAGEMENT
. Andrew S. Brischke*; UA Cooperative Extension, Kingman, AZ

ABSTRACT

Adaptive Management in Natural Resources is often messy, rarely preventative, contentious, and often we must act without scientific certainty. Much of the time permittees or managers are adapting to things we can't predict. Both the permittees and range specialists must make decisions on the fly that are not necessarily covered in a NEPA document or in an AOI. Positive relationships between the rancher and agency are critical. It is the responsibility of both the rancher and agency to foster these relationships. Collaborative monitoring has been a successful strategy to help improve permittee/agency relationships.

PROVIDING FLEXIBILITY FOR GRAZING MANAGEMENT IN OUTCOME BASED
GRAZING AUTHORIZATIONS. Richard Mayberry*; USDI Bureau of Land Management,
Gettysburg, PA

ABSTRACT

Explore how flexibility is defined and applied in Outcome Based Grazing, and discuss differences from flexibility provided in Allotment Management Plans. Providing a framework for exercising grazing management decisions is a key component of the Outcome Based Grazing Authorization. Developing the objectives, monitoring and evaluation plan and identifying potential management actions provide the framework for the Authorization.

CONSTRAINTS TO ADAPTABILITY IN ALLOTMENT MANAGEMENT. Les Owen*;
Colorado Department of Agriculture, Broomfield, CO

ABSTRACT

Natural resource managers need flexibility in implementation of management practices due to the unpredictable nature of the environment being managed. The ability to adapt management prescriptions for grazing allotments on federal land is complicated by many factors. Laws, regulations, policies, and their interpretation and implementation at various decision levels can confound efforts to apply adaptability in grazing management. Different barriers to the application of adaptability in managing federal grazing allotments are discussed to provide a basis for identifying potential solutions.

ADAPTIVE MANAGEMENT IN THE SOUTHWEST: LESSONS FROM THE CORONADO NATIONAL FOREST IN SE ARIZONA. James K. Heitholt*; US Forest Service, Tucson, AZ

ABSTRACT

Adaptive management strategies are essential to managing livestock on rangelands. In the semi-arid climate of SE Arizona it has become increasingly more important to be as flexible as possible in the management of livestock. Many factors can and do lead to the derailment of a plan for grazing allotments on the forest. Factors may include: drought, fire, invasive species, international border impacts, or a combination of factors. These factors that may change a plan require the agency to make changes to management, monitor the changes and their effects, and follow-up with documentation to support agency actions.

ADAPTIVE MANAGEMENT IS AN EXAMINATION FOR DISCOVERY

. Jim Sprinkle*; University of Idaho, Carmen, ID

ABSTRACT

To borrow from the legal profession, an “examination for discovery” is a process which is partially undertaken to discover relevant facts and areas of agreement prior to a civil trial. For natural resources, this can be viewed as a means to apply adaptive management on the ground. For some management actions, there may be a body of data collection which supports the pursuit of a specific treatment. However, some circumstances may necessitate using repeated observations as a starting point from which to launch a management practice. In either case, the proposed action should be validated by the scientific method: forming a hypothesis, formulating a sample design with sufficient replication to evaluate the hypothesis, collecting data, analyzing the data, and rejecting or accepting the hypothesis as effective for management purposes. With this feedback loop, the proposed action can be evaluated for efficacy to achieve desired goals and management can be adjusted accordingly. This entire process works best when done in a collaborative fashion with agency, permittee, and University involvement. Barriers to the adaptive process include land managers who are risk adverse, permittees who are entrenched in tradition or constrained by financial limitations, and researchers who lack personal adaptability in sample design and data collection. For all involved, flexibility is required. An example for this type of collaborative flexibility is provided from the Southwest where the goal was to transform a high elevation “biological desert” with a high occurrence of an invasive non-native grass species to a site with more native grasses.

FLEXIBILITY: INSIGHTS FROM SUCCESSFUL RANCHERS

. Hailey Wilmer*; USDA-Northern Plains Climate Hub, Fort Collins, CO

ABSTRACT

Successful ranching families maintain flexibility in their operations over decades to multi-generational time spans. Interviews and focus groups with ranchers in the Western Great Plains help rangeland scientists understand flexibility, and barriers to flexibility, from a “ranchers’ perspective”. I seek to describe the multiple scales at which flexibility is important to ranchers by analyzing qualitative interviews with 16 cow-calf and cow-calf plus yearling operations, as well as data from a focus group of yearling operators in eastern Colorado and eastern Wyoming. These case studies reveal specific ways that simultaneous climatic, socio-cultural, ecological and economic variability drive ranchers to emphasize flexible, adaptive management approaches, even as rangeland management trends toward intensification. I describe how this flexibility is maintained through social adaptations, ecological knowledge/learning and through technological innovation. Ranchers describe how they seek flexibility in their 1) cultural traditions and personal, ethical decision-making processes, 2) through their grazing management and drought planning and practices, and 3) through social networks/relationships. I critically examine these rancher-reported sources of flexibility in light of the heterogeneity and resilience approaches to rangeland/natural resource management presented in recent literature. These insights into flexibility from successful ranchers ground adaptive management in a real-world context that can inform efforts by rangeland scientists and public land management agencies to promote flexibility in public/private rangelands.

A FRAMEWORK FOR SCALING UP CONSERVATION OF WET HABITATS IN SAGEBRUSH COUNTRY. Jeremy Maestas*¹, Thad Heater², Dave Naugle³, Patrick Donnelly⁴, Brady Allred³, Nick Silverman³, Michael Brown⁵; ¹Natural Resources Conservation Service, Portland, OR, ²Natural Resources Conservation Service, Reno, NV, ³University of Montana, Missoula, MT, ⁴U.S. Fish and Wildlife Service, Missoula, MT, ⁵Pheasants Forever, Wenatchee, WA

ABSTRACT

In the semi-arid sagebrush ecosystems of the American West, seasonal periods of water scarcity limit primary productivity and the distribution of associated mesic resources important to wildlife and ranching. Riparian areas, wet meadows and other mesic sites—such as high elevation rangelands and irrigated fields—are among the last places to retain enough soil moisture to remain productive late in the growing season. As summer heat dries out upland soils, species like sage-grouse, along with livestock and many other wildlife species, follow the green line seeking out wetter, more productive areas. These wet “mesic habitats” serve as grocery stores providing nutritious forage, including the protein-rich forb and insect foods required by sage-grouse chicks. Yet, mesic habitats occupy only a tiny fraction of the sagebrush ecosystem and have varying degrees of drought resiliency. Recently, the NRCS-led Sage Grouse Initiative (SGI) launched a campaign across eleven western states to accelerate protection, restoration, and enhancement of these mesic habitats to benefit working lands and wildlife. While mesic habitat conservation can be beneficial wherever it occurs, limited resources and the desire to make measurable progress necessitate a strategic approach. We present SGI’s framework for scaling up implementation of targeted mesic habitat conservation practices designed to keep water on the land and boost resilience to drought. Combining mesic habitat conservation with ongoing efforts in sagebrush uplands creates a more holistic ecosystem approach for benefiting western rangelands from ridge tops to valley bottoms.

PATTERNING ECOLOGICAL MINIMUMS; SEASONAL DROUGHT AND SPATIOTEMPORAL DYNAMICS OF PRIMARY PRODUCTION IN THE SAGEBRUSH BIOME.

. Patrick Donnelly*¹, Brady Allred², Dave Naugle², Nick Silverman²; ¹U.S. Fish and Wildlife Service, Missoula, MT, ²University of Montana, Missoula, MT

ABSTRACT

In semi-arid ecosystems annual and intra-annual precipitation variance lead to frequent periods of water scarcity that act as ecological minimums to alter and constrict patterns of primary production. We use the North American semi-arid sagebrush (*Artemisia* spp.) biome as a model system to evaluate long-term soil water dynamics and their spatiotemporal influence on landscape productivity during seasonal drought. Remote sensing and normalized differenced vegetation index derived from 15,180 Landsat satellite images were used as a proxy to examine soil water availability through shifting vegetative productivity on 600,000 sites from 1984 to 2016. Evaluations were conducted within a spatial ecohydrologic framework that partitioned the broader biome into regions along gradients of soil water dynamics. Ecohydrologic sensitivity to annual precipitation variance and geophysical settings were measured within functional soil water pathways; 'groundwater', 'pulse-water', and 'irrigation-water' that explained heterogeneity in landscape response. Despite only a 12% difference in mean annual precipitation and similar evapotranspiration rates, productivity during drought differed by 97% across ecohydrologic regions. Model results identified divergent ecological trade-offs specific to regions that exploited characteristics of deep soil or pulse soil water dynamics to leverage landscape productivity during drought. Groundwater systems were least sensitive to precipitation variance and occurred at double the proportional rate (51%) in regions of higher deep soil water potential. High sensitivity to precipitation change in pulse dominated regions were tempered by rapid productivity response that increased the extent of these sites nine times greater than other regions. Pulse water sites in some regions offset drought sensitivity using altitudinal shifts and occurred on average 300-400 m above more resilient groundwater sites. Findings provide new insight to functional mechanisms of drought induced ecological minimums that contribute important context to accelerate adaptation of predicted long-term fluctuations in climatic patterns anticipated to alter water balance across mid-latitude semi-arid regions.

PRACTICAL GRAZING MANAGEMENT STRATEGIES TO MAINTAIN OR RESTORE RIPARIAN FUNCTIONS AND VALUES ON RANGELANDS. Sherman R. Swanson*¹, Sandra Wyman²; ¹University of Nevada, Reno, Reno, NV, ²Bureau of Land Management, Prineville, OR

ABSTRACT

New laws dramatically changed rangeland management in the 1970s and riparian areas became a public land focus. Big meadows and problem areas were protected with fences. Exlosures demonstrated the contrast between management that allowed concentrated and prolonged use that impaired riparian plants and stream functions versus total protection. A focus on stream classification provided a process to stratify and delineate based on hydrologic, vegetation, and geomorphic attributes, processes, and features. Increased emphasis on sage-grouse habitat requirements focused managers on mesic forbs and well-timed grazing. Streams with significant wildlife and other values occur in mixed ownership watersheds with private and public lands. Watershed scale issues require a water catchment scale management approach. Focusing communities of stakeholders on physical riparian functions continues to build support for riparian stewardship, for healthy water-loving plants slowing and storing floodwaters across and under broad floodplains. A search for riparian compatible grazing systems failed to provide the silver bullet, but provided an abundance of tools and strategies that work or don't work in different settings and for meeting different needs. We now know that riparian areas are resilient and recover with proper management and associated tools. Grazing to allow plant health with moderate use or short periods of use, adequate recovery periods, and altering grazing periods, provide the focus to improve or maintain watersheds. Emphasizing either planned disturbance with ample recovery periods or decreasing disturbance with limited levels of use provides managers with a fundamental choice. That choice drives management actions, criteria for success, and appropriate criteria for short- and long-term (implementation and effectiveness) monitoring. Adaptive management creates greater resilience and increases management options if it combines practices to maintain or restore riparian functions and values. Adapting management to changing conditions requires flexibility with responsibility, implementation monitoring of local strategies, and effectiveness monitoring of SMART objectives.

MANAGING LIVESTOCK GRAZING FOR RIPARIAN RECOVERY IN NORTHEASTERN NEVADA. Carol Evans*¹, Gregg E. Simonds², Eric D. Sant², Kurt Fesenmyer³; ¹Retired, Spring Creek, NV, ²Open Range Consulting, Park City, UT, ³Trout Unlimited, Boise, ID

ABSTRACT

How livestock grazing is managed can have profound effects on how streams function over time and how these systems both respond to and even change the environment around them. In the Maggie and Susie Creek basins in Northeastern Nevada, a combination of surface and sub-surface data, photo documentation and use of remote sensing techniques are used to tell a compelling story of how collaborative partnerships and riparian grazing management have caused these stream systems to become increasingly productive and resilient over time. In the Maggie and Susie Creek watersheds, partners shared a vision to restore native trout and implemented a variety of prescriptive livestock grazing practices on both public and private lands over a period of more than two decades. Although the grazing strategies differed widely, all included periods of time when riparian plants were either ungrazed or could regrow following grazing impacts. The ensuing growth and establishment of riparian plant communities set into motion a sequence of events which included colonization and stabilization of floodplains, establishment of beaver, re-hydration of mid-level terraces and development of functional systems which mediated and even benefited from severe droughts and floods in recent years. Especially in the Maggie Creek Basin, an elevated water table is creating mesic conditions on terraces that have been long disconnected from the stream. Beaver seem to be an especially important aspect of this story. Although recovery of these watersheds is still a story in progress, the events that have unfolded over the past 25 years illustrate the power and potential of collaborative watershed management and of managing livestock grazing for riparian recovery.

REHYDRATING NEVADA: A STORY ABOUT COWS, CREEKS AND
COLLABORATION. Jon Griggs*¹, Carol Evans²; ¹Maggie Creek Ranch, Elko, NV, ²Retired,
Spring Creek, NV

ABSTRACT

Producer perspective on benefits of riparian restoration to the ranch.

STICKS AND STONES: LOW-TECH RIPARIAN AND WET MEADOW RESTORATION IN THE GUNNISON BASIN.

. Nathan W. Seward*; Colorado Parks and Wildlife, Gunnison, CO

ABSTRACT

In 2017, the Gunnison Climate Working Group Project Team (GCWG), a diverse public-private partnership, completed its sixth year of riparian and wet meadow restoration in the Upper Gunnison River Basin. This effort helps the Federal Threatened Gunnison sage-grouse (*Centrocercus minimus*), other wildlife, and ranchers maintain their livelihoods in the face of a changing climate. Riparian areas and wet meadows comprise a small proportion of the sagebrush landscape, but provide important Gunnison sage-grouse brood-rearing and summer-fall habitats because of the diversity and abundance of food resources such as succulent forbs and insects. Most of these mesic communities have been adversely impacted by accelerated erosion and lowered-water tables, and are likely to be further degraded by increased drought and intense precipitation events caused by climate change. To address these impacts, the GCWG has built over 1,200 rock, earthen, and stick structures following the guidance of restoration expert, Bill Zeedyk, to improve and restore hydrological and ecological function. The project has gained wide spread support by state, federal, local, private, non-profit, and academic groups. To date, we've enhanced over 1,200 acres of Gunnison sage-grouse brood-rearing habitat along 24 stream miles and significantly restored and developed resiliency in 175 acres of wet meadow. This project serves as an important demonstration of how simple, yet effective tools can be implemented across large landscapes with multiple land owners/agency jurisdictions to better prepare nature and people for an uncertain future.

THE PLANTS DON'T LIE: VEGETATION MONITORING REVEALS SUCCESS OF RIPARIAN AND WET MEADOW RESTORATION.

. Renee J. Rondeau*¹, Gay Austin², Suzanne Parker³; ¹Colorado State University, Hesperus, CO, ²Bureau of Land Management, Gunnison, CO, ³USFS, Gunnison, CO

ABSTRACT

Over 1000 wetland restoration structures were built on 25 mesic meadow stream miles in eight watersheds, 2012-2017. These meadows were identified as important habitat for Gunnison Sage Grouse, yet had been altered by downcutting. Our primary management objective was to increase wetland acres and wetland species cover. We established 166 randomly chosen permanent vegetation transects, associated with structures, at 13 sites; each site had at least 3 control transects. Transect length was varied to account for variable bank-to-bank width. We used the line-point intercept method, collecting data every 0.5m. For each point we identified all the species that intercepted a pin flag; we counted ground cover only when there was no vegetation cover. We re-sampled the transects and repeated photos each year, usually within a few weeks of the original sample date. We calculated changes in overall wetland species cover (obligate and facultative) by year and across sites, in addition to assessing the overall species composition. Wetland species cover, four years post treatment, at four sites, increased an average of 160%, ranging 28-245%, compared to a 15% increase at untreated areas. Sites with the most increase were ephemeral streams with a high sediment load, good snowpack, and light grazing pressure. Grazing from livestock varied from none to somewhat heavy. The rate of response increased with lower grazing pressure, but we also observed an increase in wetland species cover under higher grazing pressure. We conclude that our efforts have increased the groundwater level, which had a direct impact on the wetland species. Overall productivity of the wetland increased, providing Gunnison Sage Grouse, wildlife, and livestock with more “groceries”. This simple and cost-effective restoration effort works well in the sagebrush landscape.

THE BRIDGE CREEK RESTORATION STORY: BEAVER, BDAS & GRAZING MANAGEMENT.

. Nick Weber*¹, Nick Bouwes², Chris Jordan³, Joe M. Wheaton⁴; ¹Anabran Solutions, LLC, Bend, OR, ²Eco Logical Research, Inc., Logan, UT, ³NOAA, Corvallis, OR, ⁴Utah State University, Logan, UT

ABSTRACT

Bridge Creek, a tributary to the Lower John Day River, flows through the high-desert of central Oregon and serves as an important spawning and rearing stream for Mid-Columbia Steelhead. Much of Bridge Creek suffers from channel incision and features an overall lack of habitat complexity, hydrologic disconnection from groundwater and its floodplain, and high stream temperatures thought to be detrimental to juvenile steelhead. However, BLM made dramatic changes to the grazing management in roughly twenty years ago, which facilitated modest recovery of riparian vegetation and supported some beaver activity. However, it was not enough to address the degraded habitat associated with channel incision. Bridge Creek became an Intensively Monitored Watershed in 2007 and restoration treatments were implemented in 2009. The restoration approach consists of constructing in-channel structures that mimic the form and function of beaver dams (beaver dam analogues - BDAs) in order to expedite the recovery of incised stream reaches while at the same time encouraging establishment of stable beaver complexes. Monitoring results from the Bridge Creek IMW demonstrate the ability of this restoration approach to produce many of the beneficial processes associated with beaver complexes, including increased habitat complexity, groundwater and floodplain connectivity, and moderation of high summer stream temperatures. In addition, the conditions created by the installation of artificial beaver dam structures increases the likelihood that beavers will establish persistent colonies within treated stream reaches, thereby perpetuating benefits to stream and riparian function and steelhead habitat quality. These instream and riparian improvements have important spill-over benefits to the adjacent upland ecosystems and communities that depend on them.

THE GRASS IS ALWAYS GREENER: QUANTIFYING OUTCOMES OF LOW-TECH RIPARIAN AND WET MEADOW RESTORATION USING REMOTE SENSING

. Nicholas L. Silverman*¹, Brady Allred¹, Dave Naugle¹, Patrick Donnelly², Jeremy Maestas³;
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ABSTRACT

Riparian and wet meadow landscapes make up a small percentage of the overall land area in the Western United States, yet their impacts on wildlife, vegetation, and water resources are profound. When healthy, these areas act as zones of soil water storage allowing for increased plant productivity, groundwater infiltration, and the slow, steady release of surface and sub-surface runoff. When these areas are functioning sub-optimally, the watershed as a whole suffers from increased drought and flood vulnerability, decreased plant productivity, and degraded fish and wildlife habitat. Over the last century unregulated livestock management, drought, non-native invasive weeds, and conifer encroachment have impacted the Intermountain West in ways that we are still recovering from today. Historically, much of the restoration that has taken place in the Intermountain West has largely focused on upland rangeland. It wasn't until the late 1990s that practitioners began to focus on riparian and wet meadow restoration. While many of these restoration activities have been different in design, the processes they are meant to restore are often the same. Common to all these processes is the dynamic interplay between the hydrology and ecology of the landscape.

In this study we use satellite remote sensing to explore changes in vegetation productivity (NDVI) of three distinct riparian/wet meadow restoration projects. The projects range widely in geographic location (Colorado, Oregon, and Nevada), restoration practice (Zeedyk structures, beaver dam analogs, and grazing management), and time since implementation, but are considered “low-cost” and “low-impact” solutions. We evaluate changes in plant productivity, in addition to changes in time above a riparian productivity threshold. We also explore changes in vegetation sensitivity to precipitation over time since restoration. Restoration practices resulted in increased vegetation productivity of up to 25% and increased persistence of productive vegetation—up to six months in some locations. Mesic restoration practices also led to increased resiliency, buffering vegetation productivity from climatic variability.

NEW TECHNOLOGY AND FRONTIERS: EFFICIENTLY MEASURING CONSERVATION OUTCOMES THROUGH TIME WITH GOOGLE EARTH ENGINE. Brady Allred*¹, Dave Naugle¹, Patrick Donnelly², Jeremy Maestas³, Matthew O. Jones¹, Nicholas L. Silverman¹;
¹University of Montana, Missoula, MT, ²U.S. Fish and Wildlife Service, Missoula, MT, ³Natural Resources Conservation Service, Portland, OR

ABSTRACT

Evaluation of conservation outcomes is hard; relevant field data may be lacking, analysis skills may be absent or outdated, or conservation projects may span a geographical gradient too big to handle. Due to these and many other reasons, conservation outcomes are often pushed aside, ignored, or just impractical to do. Earth observation data—particularly satellite remote sensing—provides a platform to assess broad scale conservation outcomes, but users of such data are often faced with the same challenges of data manipulation or analysis. Emerging cloud based geospatial technologies (e.g., Google Earth Engine), however, eliminate many of the barriers in working with and applying these data to conservation assessments. Furthermore, publicly available web application can be built upon these technologies, providing simple and immediate access to targeting and evaluation tools.

The USDA NRCS led Sage Grouse Initiative built an interactive web application to change the paradigm of conservation analysis and evaluation. This online tool allows users to quickly identify and compare areas of concern in order to evaluate potential restoration or threat-prevention opportunities. Built upon Google Earth Engine and the commonly used Google Maps interface, the interactive web application quickly and easily visualizes datasets online; distributes datasets through fast and accessible downloads; and performs on-the-fly custom analyses. The web application allows ranchers, conservationists, and other partners to currently interact with data on encroachment of conifers, resilience and resistance to invasive weeds, conversion risk of native rangeland to cropland, collision risk for sage grouse flying near fences, and changes in mesic habitat over time. Dynamic and interactive applications such as these effectively puts the appropriate data directly into the hands of the people working on the ground, allowing a flexible and landscape-level approach to habitat conservation on western rangelands.

PLANNING, DESIGNING & IMPLEMENTING EFFECTIVE BEAVER-ASSISTED RIPARIAN RESTORATION PROJECTS.

. Joe M. Wheaton*¹, Nick Bouwes², Chris Jordan³, Nick Weber⁴; ¹Utah State University, Logan, UT, ²Eco Logical Research, Inc., Logan, UT, ³NOAA, Corvallis, OR, ⁴Anabranch Solutions, LLC, Bend, OR

ABSTRACT

Partnering with and/or mimicking beaver dam building has been a conservation and restoration tool for over a century. However, the popularity of such approaches has surged in the past decade as a cheap and cheerful alternative to expensive restoration and conservation projects. Moreover, such projects can be highly effective and simultaneously meeting multiple instream, riparian, upland, wet meadow and working lands management objectives. However, when partnering with a rodent and relying on beaver dams that naturally come and go, expectation management is critical. Moreover, the management of the rangelands and these riparian areas is too often disconnected. Proactive and effective grazing management is often an essential tool in the effectiveness and feasibility of such approaches. A variety of planning tools (e.g. Beaver Restoration Assessment Tool, Riparian Condition Assessment Tool) will be highlighted to help build appropriate expectations for what is possible where and to what degree. Moreover, specific examples of how ranchers and beavers are partnering effectively will be highlighted to illustrate how to use this information to appropriately design and implement such projects.

BEAVER MIMICRY IN MONTANA: EXAMPLE TECHNIQUES, EARLY BENEFITS, AND LESSONS LEARNED. Amy Chadwick*; Great West Engineering, Malta, MT

ABSTRACT

Beaver mimicry, also called low-impact restoration, provides a means for range managers on public and private land to improve natural water storage and subirrigate floodplains for improved stream flows, habitat, and forage production. Beaver mimicry is gaining momentum as a cost-effective restoration approach in Montana and other western states. In this presentation, I provide examples of beaver mimicry techniques from multiple projects, discuss natural resource benefits that have been realized from recent projects, and review lessons learned about adapting techniques to site conditions, managing expectations, and potential regulatory speedbumps.

ECOSYSTEM PIONEERS: EXAMINING BEAVER DISPERSAL AND SETTLEMENT SITE SELECTION TO IMPROVE RIPARIAN RESTORATION EFFORTS.

. Torrey D. Ritter*, Lance B. McNew; Montana State University, Bozeman, MT

ABSTRACT

The activities of beavers (*Castor canadensis*) provide a variety of benefits to stream systems by capturing and storing water and sediment, expanding riparian habitats, and increasing habitat heterogeneity. Understandably, land and wildlife managers are increasingly interested in implementing beaver restoration projects with the goal of improving stream health and landscape water storage capacity. However, most research on habitat selection by beavers does not address factors affecting successful colony establishment in novel areas. We radio-marked juvenile beavers and conducted beaver activity surveys in streams in the upper Gallatin and Madison River drainages in southwest Montana to investigate dispersal, survival, and settlement site selection. Our goal is to improve the ability of managers to identify suitable sites for beaver restoration that have the highest probability of successful colony establishment and associated habitat improvements. We examined the influence of habitat variables related to hydrology, geomorphology, vegetation, and local beaver colony densities on the probability a stream segment would be settled by dispersing beavers. Additionally, we modeled the probability of survival and dispersal of radio-marked beavers as functions of body mass and sex, as well as natal colony size, habitat quality, and local colony densities to assess additional factors that may influence the ability of beavers to occupy new territories. Results of these modeling efforts will be presented and management recommendations will be provided as they relate to beaver reintroduction and restoration projects in the western United States.

BEAVER PONDS AS CRITICAL HABITAT FOR SENSITIVE GREAT BASIN WILDLIFE SPECIES. Kent McAdoo*; University of Nevada Cooperative Extension, Elko, NV

ABSTRACT

Based on the accounts of early fur trapper forays in the 1820s, beavers (*Castor canadensis*) were abundant along the Humboldt River at early Euro-American contact and an important resource for Great Basin Indian tribes, but by the late 19th century, they had been highly over-exploited. Excessive reduction of beaver from this region probably caused changes in stream channel morphology, reduced perennial wetlands, and altered riparian vegetation. However, as the result of hunting restrictions and re-introductions (1920s through 1950s), beaver populations have rebounded to inhabit much of their former range and possibly even areas where they did not occur before European contact. Over the last 20 years, beaver activity in northeastern Nevada has increased substantially as these animals respond to and contribute to the functionality of streams. Many wildlife species are favored by beaver-created habitat. The Columbia spotted frog (*Rana luteiventris*) and Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) are two sensitive species that are largely benefitted by beaver activity. Functioning as ecological engineers, beavers create pools of slow-moving water that serve as sites for frog reproduction and wet meadows for foraging habitat and protective cover. In northern Nevada, spotted frogs are closely associated with slow-moving or ponded surface waters that are clear and have little or no vegetation canopy cover. Habitat changes caused by beaver may increase the resilience of Great Basin spotted frog populations in the face of threats from drought, climate change, overgrazing by livestock, and predation. Beaver ponds also provide critical refuge for Lahontan cutthroat trout, allowing them to persist, especially overwinter, in many small headwater streams. Cutthroat survival may be higher in beaver ponds than free-flowing stream sections as temperatures approach lethal limits. Proper beaver management is essential for sustaining Columbia spotted frogs, Lahontan cutthroat trout, and a host of other wildlife species in the Great Basin.

MOVING FORWARD, WHY LIVESTOCK PRODUCERS SHOULD BE INTERESTED IN MORE RIPARIAN HABITAT. . Eric T. Thacker*; Utah State University, Logan, UT

ABSTRACT

Range managers have long recognized the importance of riparian areas. Early range management often referred to riparian areas or watering points as "sacrifice areas" due to the concentrated use by livestock. More recently rangeland managers have recognized the importance of riparian areas for the variety of ecosystem services such as wildlife habitat, water quality, and watershed health. However, these areas are still vital to livestock production because they provide high-quality forage late into the growing season. Sometimes riparian management means excluding cattle from riparian areas, which could have a negative impact on livestock production. While livestock exclusion may be an effective management strategy other alternatives lie in the expansion of or the restoration of riparian habitat. We will provide a Case study of how this is being attempted and what it may mean for livestock producers, wildlife, and water.

HYDROLOGIC AND BIOLOGICAL RESPONSE TO RESTORATION OF
ANTHROPOGENICALLY-ALTERED SPRINGS IN THE GREAT BASIN. Leah Knighton*,
Steven L. Petersen; Brigham Young University, Provo, UT

ABSTRACT

Since the arrival of European settlers, many Great Basin springs and seeps have been altered to provide water for livestock using a springbox structure. This has resulted in altered natural hydrologic processes that often fail to maintain spring function such as depleted surface water and lowered water tables levels, below that needed to sustain hydrophilic plant species. The purpose of this study is to characterize the impact of springboxes on ecohydrology and assess restoration potential by testing different spring reconstruction techniques. Twenty-four springbox sites were located within the Sheldon National Wildlife Refuge, located in northwestern Nevada. Sites were divided into four groups based on flow rates. Within each group, springboxes were randomly assigned to one of six treatments; 1) capped pipes within the springbox to prevent outflow, 2) removal of the springbox and filled with sand, 3) removal of the springbox and filled with gravel, 4) outer springbox shell remains and is filled with sand, 5) outer springbox shell remains and is filled with gravel, and 6) control. Hydrologic (flow rate, geochemistry, temperature), vegetation structure (composition, cover), and wildlife use data were collected during 2016 and 2017. Intact springboxes filled with sand was most successful in returning surface water flows (3 of 4 sites recovered). Sites with restored surface flows saw a shift in plant composition away from sagebrush to more riparian species and increased overall biomass in the first year after treatment. The results of this study can be used by managers to assess the potential impacts of future restoration efforts on impaired spring ecohydrology. Additionally, these data provide understanding of the response of sagebrush-steppe plant communities to reestablishment of natural hydrologic conditions, and may give insight into techniques that could be used to encourage positive recovery in similar ecosystems.

HISTORICAL PERSPECTIVE: LACK OF COMMUNICATION, PARTNERSHIPS, AND SCIENCE, AND HOW THINGS BEGAN TO CHANGE. Mike Pellant*; BLM (retired), Boise, ID

ABSTRACT

Research in the Great Basin was initiated at the beginning of the 19th century to address the degradation of millions of acres of range and forest lands caused by unrestricted livestock grazing. The goal of these early research and rehabilitation efforts was to reestablish desirable forage species to support the livestock industry and reduce soil erosion. Research was conducted primarily by scientists from federal agencies and universities with extension specialists as the primary means for science delivery. This model generally persisted until the 1970's when several environmental laws were passed that shifted management of public lands from a focus on commodity production to a broader resource values approach. Science to support management moved to a more interdisciplinary approach to address complex resource values at larger landscape scales. Around this same time, invasive plant species, (poster child is cheatgrass (*Bromus tectorum*)) and wildfires increased in extent and in impacts to human and natural resources. Collaboration between scientists and land managers was strengthened to better address the spatial scale of issues as well as these new threats to functional ecosystems and their inhabitants. Examples of collaborative partnerships linking science and management will be presented along with the associated positive outcomes. This collaborative approach to addressing landscape scale issues will greatly reduce the potential for a future "dust bowl" catastrophe in the Great Basin.

CONSERVING THE SAGEBRUSH BIOME: WORKING AT THE EDGE OF SCIENCE AND MANAGEMENT.

. Karen L. Prentice*; Bureau of Land Management, Washington, DC

ABSTRACT

Diverse people and communities care about the sagebrush biome. It is a part of our life and our being. To conserve it, we need to work together. To work together, we need some shared understanding of the condition of the sagebrush biome, threats to the biome, and opportunities to restore and conserve the biome. We need communication and listening. We need to take the time to ensure a shared understanding of words, concepts, problems, and concerns. We need science and high quality information that we collaboratively agree helps us. We need some ability to link biome-wide science and data to local science and data. We need data sharing catalogs and decision support tools to help us make sense of available science and data. We need to remember that science and information does not appear in a gift wrapped box-instead, people find, develop, organize, interpret, and use science through personal passions, organizational missions; and personal and organizational relationships. The social organization changes as the science, organization of science, and science delivery changes. The Integrated Rangeland Fire Management Strategy (IRFMS, May 2015) initiated efforts to meet these needs through development of the *Science Framework for Conservation and Restoration of the Sagebrush Biome*, the Geospatial Framework, and the *Actionable Science Plan*. Recently, Department of Interior Secretarial Order 3353, “Greater Sage-grouse Conservation and Cooperation with the Western States”, recommitted to IRFMS and recommended increased access to information and improved mechanisms for increased cooperation between federal, state, and local agencies, tribes, non-governmental organizations, and industry to accomplish conservation and restoration of the sagebrush ecosystem, while considering economic tradeoffs. This session will discuss the continuation of IRFMS related efforts as well as new, related efforts which will build on the IRFMS efforts and work towards implementation of the SO3353 recommendations.

ECOLOGICALLY-BASED INVASIVE PLANT MANAGEMENT.

. Roger L. Sheley*; ARS, Burns, OR

ABSTRACT

Successional management is an ecologically-based way of organizing known and hypothetical causes of succession. The successional management model proposes three general causes of succession—site availability, species availability, and species performance—ecological processes primarily responsible for controlling the general causes, and factors that modify those processes. Pickett et al. (1987) proposed the ecological bases for a theoretical framework. Sheley et al. (1996) reconstructed and proposed an improved model for invasive plant management that addresses the underlying cause of invasion. This hierarchical model includes the general causes of succession, controlling ecological processes and mechanism, and their modifying factors. This model has been fine-tuned and readily applies to cheatgrass/medusahead infested rangeland. Since then, Sheley et al. (2006) tested the model for its ability to enhance the success of invasive plant management and restoration in small plots. In 2 of 3 cases, using this framework dramatically improved the outcome of management. This mechanistic and process-based model was incorporated into the state and transition models to provide an ecologically based decision-making framework for rangeland management. The combination of the two models are being used to make decisions about site-specific management. In addition to testing site-specific management treatments, this model provides an ecological framework for large-scale planning and implementation.

USING WEATHER DATA IN LAND TREATMENT DECISIONS. Stuart P. Hardegree*¹, Alex R. Boehm¹, Corey A. Moffet², John T. Abatzoglou³, Roger L. Sheley⁴, Mark Brunson⁵; ¹USDA Agricultural Research Service, Boise, ID, ²USDA Agricultural Research Service, Woodward, OK, ³University of Idaho, Moscow, ID, ⁴ARS, Burns, OR, ⁵Utah State University, Logan, UT

ABSTRACT

Access and interpretation of weather data for natural resource applications is often problematic. Weather stations in the western US are relatively sparse, local weather conditions vary significantly as a function of topography and elevation, and temperature and water availability for plants is affected by both landscape placement and soil type. Western rangelands are also subject to high annual and seasonal variability in the pattern and magnitude of thermal and precipitation events relative to the life cycle requirements of both desirable perennial plants and annual weeds. We discuss the availability and interpretation of site-specific weather data in the western US, the quantitative relationship between localized site conditions and ecological resistance/resilience, and the implications of weather-centric planning to Ecologically-Based Invasive Plant Management.

MEDUSAHEAD CONTROL. Dustin Johnson*¹, Sergio Arispe²; ¹Oregon State University, Burns, OR, ²Oregon State University, Ontario, OR

ABSTRACT

Medusahead is an invasive annual grass that is having persistent and large-scale impacts on western rangelands. Continued invasion by this and other exotic annuals represents a complex resource management problem that sagebrush rangeland managers must be able to address in order to maintain ecosystem productivity and function. However, medusahead management plays out in a highly variable environment and tactics that are successful in a particular location or year may not yield similar results in a different time or place. Consequently, traditional shorter term approaches for addressing rangeland management problems do not commonly lend themselves well to solving persistent, complex threats such as medusahead invasion. Rather, addressing the medusahead problem requires longer-term commitment to an adaptive management process. The science on medusahead control and associated restoration has advanced markedly during recent decades; however, much of this research has been conducted under a limited range of temporal and spatial variability relative to that which rangeland managers encounter in areas being impacted by or at risk of medusahead invasion. Therefore, the key role of science is to help managers identify a logical starting point for an adaptive management process focused on limiting the risk and associated spread of medusahead and, typically, iterative attempts at restoring areas already invaded. Limited resources generally demand that planned actions be prioritized based on their projected impact, likelihood for success, and cost efficiency. Restoration of medusahead-invaded rangeland is resource intensive and carries a high risk of failure; therefore, long-term strategies that reduce the spread of medusahead and increase invasion resistance of intact plant communities should receive priority. Restoration of medusahead-invaded rangeland should be prioritized based on probability of success and value. Passive and opportunistic restoration strategies should be planned in less valuable areas with a lower probability of success.

NOXIOUS WEED CONTROL THROUGH HERBICIDE AND BIOCONTROL: THE IDAHO SAGE-GROUSE ACTIONS TEAM PROJECT.

. Ann Moser*¹, Matthew J. Germino²; ¹Idaho Department of Fish and Game, Boise, ID, ²US Geological Survey, Boise, ID

ABSTRACT

In 2015 the Idaho legislature first authorized annual appropriations for sage-grouse conservation efforts. In the spirit of “All Hands, All Lands”, the State agencies responsible for implementing the Governor’s Sage-grouse Plan formed the Idaho Sage-grouse Actions Team, a group of partners dedicated to assuring that the State’s funds go to conservation projects that best benefit sage-grouse habitat, as well as working to leverage these funds with federal or other dollars. The Actions Team includes representatives from Idaho Department of Fish and Game, Governor’s Office of Species Conservation, Idaho Department of Lands, Idaho Soil and Water Conservation Commission, Bureau of Land Management, U.S. Forest Service, Natural Resources Conservation Service, U.S. Fish and Wildlife Service, and The Nature Conservancy. The team’s four priorities are to fund projects that support 1) Rangeland Fire Protection Associations; 2) strategic fuel breaks; 3) restoration and stewardship; and 4) research and innovation. In 2016, the team helped facilitate planning/proposal writing and provided matching funds for a Conservation Innovation Grant to the Ada Soil and Water Conservation District, with U.S. Geological Survey (USGS) as a research partner. The purpose of this initial project was to conduct experiments investigating emerging tools, including weed suppressive bacteria and herbicides, for controlling invasive annual grasses. This project’s emphasis was later expanded to include wildfire restoration on two State Wildlife Management Areas that support critical mule deer and elk winter range. The larger project, led by USGS, includes multiple partners and land ownerships, with the goal of providing land managers with realistic and effective options for restoring resistant shrub-steppe landscapes and minimizing the impact and spread of invasive annual grasses after wildfire. This presentation will address Idaho’s cooperative process, along with details on the experimental work on herbicides and biocontrols.

DEMYSTIFYING BEAVER AND BEAVER-INSPIRED IN-STREAM STRUCTURES AS RESTORATION TOOLS IN WESTERN RANGELANDS.

. David S. Pilliod*; US Geological Survey, Boise, ID

ABSTRACT

The capacity of the North American beaver (*Castor canadensis*) to alter hydrological, geomorphological, and ecological aspects of the environment has garnered their reputation as ecosystem engineers. Some of these capabilities may be beneficial to humans, such as impounding surface water in arid lands. Rangeland resource managers have been enticed by beavers' ability to influence surface water and increasingly consider using beaver to build dams or construct artificial dam-like structures to reverse stream degradation and increase late-season flow. Some of these beaver-inspired efforts are implemented as stream restoration projects. Here, I present the range of these practices occurring in western rangelands and discuss what we know and what we presume in terms of hydrological, geomorphological, and ecological effects. Preliminary results suggest that a better scientific understanding of these effects should help inform decisions about the use of beaver and beaver-inspired structures as restoration tools in rangeland streams. However, a complete understanding will likely require further research and better use of monitoring and adaptive management approaches.

AN ECONOMIC PERSPECTIVE ON RESTORATION SEEDING. Michael H. Taylor*;
University of Nevada, Reno, Reno, NV

ABSTRACT

We discuss the challenges to ensuring the availability of genetically appropriate native seeds for wildland restoration in Nevada and throughout the intermountain west. We present a framework for identifying the characteristics of seed species that suggest that additional policy is required to ensure its stable supply to the market. Our approach distinguished between production and market risk. Production risk relates to variability in production yields; market risk relates to the year-to-year variability in the price.

INCREASING THE AVAILABILITY OF NATIVE PLANTS FOR RESTORING
RANGELANDS: SEEDS OF SUCCESS PARTNERSHIPS. Fred Edwards*; Bureau of Land
Management, Reno, NV

ABSTRACT

What happens to sites after weed management, targeted grazing, or wildfire? In a low resistance and resilience landscape, a native seeding treatment is probably going to be needed. Anyone who has ever done a native seeding project knows getting seed from a variety of species and in the quantity you need is a major source of frustration and potential delay. Compromises in which seed sources are used, can have unknown, but potentially serious consequences for project success. The Seeds of Success program and partnerships in the Great Basin are evolving to increase the availability of genetically appropriate native seed sources available on the commercial market for all federal and non-federal land managers. This talk provides an overview of the strategic partnerships, goals, and objectives of regional Seeds of Success and native plant materials development partnerships in the Great Basin.

LONG-TERM EFFECTS OF POST-FIRE SEED MIXES ON BEGETATION RECOVERY:
REVISITING A LARGE-SCALE SEEDING EXPERIMENT IN TINTIC VALLEY, UTAH.
Jeffrey Ott*¹, Francis F. Kilkenny¹, Danny Summers², Tyler Thompson³; ¹USDA Forest Service,
Boise, ID, ²Utah Division of Wildlife Resources, Ephraim, UT, ³Utah Department of Natural
Resources, Salt Lake City, UT

ABSTRACT

Vegetation recovery following wildfire in the Great Basin is often hampered by lack of fire-resilient perennials and the presence of invasive annuals such as cheatgrass. To protect soil resources and reduce weed invasion, burned areas are frequently seeded with native and/or non-native perennial plants. The question of which species to seed is relevant for both short-term rehabilitation objectives as well as long-term management objectives which may include wildlife habitat improvement and restoration of pre-fire vegetation. To better understand long-term effects of post-fire seeding on vegetation recovery and succession, we revisited study sites in Tintic Valley, Utah, where seeding experiments had been initiated following a 1999 wildfire. Four different seed mixes, including two comprised entirely of native species, had been applied using rangeland drills at a shrubland site and aerial seeding plus chaining at a woodland site. New vegetation data collected in 2015-2017 revealed changes relative to the early post-fire period (2000-2002). We found significant increases in overall cover of seeded species although the relative differences between treatments did not change. Some seeded species, particularly rhizomatous grasses, increased while others declined. Cheatgrass increased in some of the treatments, especially the unseeded control and to a lesser extent the treatments where only native species had been seeded. The non-native seeded species were more effective than native species at suppressing cheatgrass, but the non-natives also had the undesirable effect of inhibiting shrub establishment. Our results indicate that post-fire seeding has lasting effects on vegetation composition and structure, implying that seed mixes should be carefully formulated to promote long-term management objectives.

SODA FIRE RESTORATION: DIFFERNIG APPROACHES IN OREGON AND IDAHO.
Matthew J. Germino*; US Geological Survey, Boise, ID

ABSTRACT

Rangeland wildfire and the human response to them continue to be one of the most extensive and intensive efforts in sagebrush-steppe rangelands. There are substantial challenges and opportunities made during post-fire response that require an “all hands, all lands” approach. Emergency Stabilization and Rehabilitation (ESR) efforts that followed the 2015 Soda Wildfire represent an improved effort to understand, and restore resistance and resilience in sagebrush-steppe landscapes. The fire burned approximately 113,000 topographically varied hectares in the Owyhee Mountains. This included priority sage grouse habitat, portions of two states, and >100 grazing allotment/pasture. The fire followed Secretarial Order #3336 on Rangeland Fire Prevention and Restoration, and thus a larger investment into invasive plant control and post-fire treatments were made. Treatment objectives and grazing resumption objectives were developed by BLM with input from interagency partners with a focus on resistant and resilient landscapes. Monitoring results continue to be shared with an interagency partner’s group. Monitoring data are reported with a focus on 1) treatment/vegetation responses effectiveness 2) re-treatment needs or opportunities, and 3) grazing resumption determination. During periods of livestock rest vegetative data was collected by monitoring >2000 plots across the burn area. The partners have worked together to substantially advance organization and documentation of data and create unparalleled learning opportunities. The monitoring data combine with complementary research efforts on topics such as identifying thresholds and tipping points in resistance and resilience (changes in exotic-annual and perennial grass cover and roots), assessing bunchgrass readiness to withstand grazing resumption, identifying suitable sites for sagebrush recovery, benefits of multiple-layered treatments, and other aspects of ecosystem response. While information collected on the Soda Fire is most applicable to the Soda Fire itself, there are many gained insights that will be useful for developing post-fire responses to other large rangeland fires.

MAKING NEPA WORK FOR WORKING LANDS. Jamie S. McCormack*; Bureau of Land Management, Burns District, Hines, OR

ABSTRACT

Navigating the requirements of the National Environmental Policy Act (NEPA) while maintaining flexibility in livestock grazing management can be difficult. What flexibility looks like on the ground is often hard to describe in the text of a NEPA document. However, long term dedication to the planning process, patience, and a defined strategy to use livestock as a tool to improve resources can produce a flexible allotment management plan. This presentation will explore the story of the Upton Mountain Allotment where reoccurring wildfire, invasive annual grass, and a set grazing schedule created the need for flexibility in livestock grazing. The Upton Mountain Allotment is home to Greater sage-grouse, mule deer, and Malheur prince's plume that need to be managed with the threats to their habitats in mind. Flexibility in the number of livestock and time of use was identified as a main strategy in working towards management objectives for the allotment and surrounding area. This presentation will also speak to the group of people involved, the coordination and cooperation that occurred, and how those discussions helped progress the project.

RANGELAND FIRE PROTECTION ASSOCIATIONS IN OREGON AND IDAHO: IMPLICATIONS FOR FIRE ADAPTATION AND AGENCY-COMMUNITY RELATIONSHIPS.

. Emily-Jane Davis*¹, Jesse Abrams², Katherine Wollstein³; ¹Oregon State University, The Dalles, OR, ²University of Oregon, Eugene, OR, ³University of Idaho, Moscow, ID

ABSTRACT

Wildfires are growing in size, frequency, and severity across rangelands in the U.S. West. Numerous Rangeland Fire Protection Associations (RFPAs) have emerged for rancher participation in fire suppression alongside federal agency firefighters. There has been growing policy interest in the RFPA model because it can offer advantages such as quick response and local knowledge, but little research to date. Our study analyzed RFPA establishment, functioning, successes, and challenges through four case studies of individual RFPAs and their state programs in Oregon and Idaho during 2015-2016. We found that RFPA-BLM relationships were challenged by histories of conflict, differences between state and federal standards, cultural dissimilarity of ranching communities and formal firefighting institutions, and negative incidents. But relationships were improved by experience and time spent together on and off the fireline, which built common understandings and allowed for informal and interpersonal interactions. RFPA members increased their understanding of federal fire management decisions, and BLM personnel developed respect for RFPA members' local knowledge and skills. We also found that although the RFPA model has focused on suppression, many ranchers view fire management more holistically and potential may exist for RFPA engagement in a wider range of activities. The example of RFPAs suggests that other types of "working lands communities" could engage in fire preparation and response and become more "fire-adapted" if issues such as safety, liability, interfaces with agency and contractor fire personnel, and organizational structures for legal and operationally feasible participation are addressed. Learning and adaptation may also help ease tensions between volunteer and professional institutions, even if volunteer partners begin with relatively limited understandings of fire management. Experience, repeated interactions, and being given responsibility may help local participants gain broader understanding of professional firefighting techniques, and build professional comfort with and regard for local knowledge and values.

CHALLENGES OF CREATING WIN-WIN CONSERVATION FOR GREATER SAGE-GROUSE AND LANDOWNERS AT A LOCAL SCALE. Chad S. Boyd*¹, Angela Sitz², Dustin D. Johnson³; ¹USDA-ARS, Burns, OR, ²U.S. Fish and Wildlife Service, Bend, OR, ³Oregon State University, Burns, OR

ABSTRACT

Sagebrush steppe ecosystems of the western United States are facing a multitude of challenges including spread of exotic annual grasses, increasing presence of wildfire, and expanding native conifer populations. These issues are ecologically complex problems, the nature of which varies strongly in both space and time. Such issues are set within an increasingly complex social context defined by competing values and variable land ownership patterns. Nowhere is this complexity more evident than with efforts to manage and conserve habitat for the greater sage-grouse. This species ranges across 11 western states and its status relative to the Endangered Species Act will be reviewed in 2020. Several years ago we began working with a diverse mix of ranchers, Federal and State agencies, county government officials, NGOs, and scientists to assemble a Candidate Conservation Agreement with Assurances for greater sage-grouse habitat on private lands in Harney County, Oregon. Initially, there were differing opinions on the nature of the problems that needed to be addressed in the CCAA. To address these differing ideas, we guided the group through a process using best available science to construct simple state and transition models that detailed the ecological behind desired and undesired changes in plant communities, as well as ramifications of such changes to sage-grouse. We found these models could be used to come to a common, science-based understanding of the problem set. With a common understanding of the ecology underlying dominant threats, we were able to garner a sufficient capital of trust within the group to successfully navigate contentious issues such as grazing management. This CCAA has expanded and now covers all sage-grouse counties in Oregon; the CCAA STM models are the basis of the State's habitat mitigation program and federal agencies are using them to inform management on millions of rangeland acres in Oregon.

DEVELOPING QUALITY LIVESTOCK WATER FOR MIDWEST RANGES. Jeff L. Davidson*; Kansas State Univ., Eureka, KS

ABSTRACT

Developing quality livestock water throughout the ranges of the Midwest continues to be a challenge. Water development through the years has increased productivity through improved grazing distribution. Much of the water developed has employed the use of relatively small water impoundments or “farm ponds.” However, allowing cattle free access to ponds speeds the sedimentation of ponds, and the fouling of the water through defecation and urination provides nutrients which encourage the growth of the toxic blue green algae – a problem that is becoming rampant throughout the Midwest.

Limiting cattle access to ponds reduces sedimentation, extending the useful life of the pond, and protects water quality by greatly reducing the amount of phosphorus and nitrogen present in the water. These nutrients, principally phosphorus, aid the growth of toxic blue green algae.

Cattle access can be limited by the use of a watering tank or trough downslope of the pond dam, or by the use of an access lane with a hardened surface that allows cattle access to only a small portion of the pond.

Cattle prefer clean water and avoid steep, muddy approaches to water sources. Limiting cattle access to a pond by developing a fenced watering point with a hardened surface is cost effective, and solves the concerns associated with un-limited access. Similarly, a tank downslope of the pond dam and gravity fed is also very effective if the elevation difference is sufficient to allow adequate water flow.

CHANGE IN RESERVOIR STOCK WATER TDS CONCENTRATIONS FROM MAY TO SEPTEMBER IN EASTERN MONTANA

. Mark K. Petersen*, Jennifer Muscha; USDA-ARS Fort Keogh, Miles City, MT

ABSTRACT

Reservoirs are valuable as temporary or seasonal sources of stock water. They are dependent on surface runoff or seepage causing losses and/or reduction in quality water from spring to fall. Contact with mineral soil may add solutes to retained water while evaporation may act to concentrate solutes. Cattle moving and standing in retained water can cause suspension of organic and inorganic matter. The objective of this study was to determine if the concentration of total dissolved solids (TDS) in catchment water systems with simultaneous cattle use were influenced by frequency of precipitation events characterized by the months. To estimate spring/summer variation in water TDS concentrations, 2 livestock reservoirs (Upper Flood near the eastern boundary and North 4 adjacent to the southern property line) were fitted with Troll 9500™ continuous monitoring submerged TDS sensors in June through August 2016 and 2017 at the 22,257 ha USDA-ARS Fort Keogh Livestock and Range Research Laboratory near Miles City, MT. Two sensors recorded a reading hourly at a depth of 2 feet in each reservoir. Data were analyzed as a completely randomized design testing the effect of year, site, month, and their interactions on TDS concentration using Proc. Mixed (SAS 2014). There was a significant year*site*month interaction ($P < 0.01$). The concentration of TDS was highest in August in North 4 reservoir in both years (avg 1406 ± 5.5 ppm) and lowest in the Upper Flood reservoir in June in both years (avg 538 ± 5.5 ppm). Average concentrations of TDS increased 25% from June to July 16% from July to August and 63% from June to August. Water TDS content was different between the 2 reservoirs and increased during summer months. To avoid productivity declines these results suggest monitoring water quality maybe important across time and location.

DEVELOPMENT OF AN INDIVIDUAL FREE-CHOICE MINERAL SUPPLEMENTATION PROGRAM FOR IMPROVED GRAZING OF HAWAIIAN RANGELANDS

. Mark S. Thorne*¹, John P. Hewlett², Glen K. Fukumoto³, Melelani Oshiro⁴; ¹University of Hawaii - Manoa, Kamuela, HI, ²University of Wyoming, Laramie, WY, ³University of Hawaii at Manoa, Kailua-Kona, HI, ⁴University of Hawaii at Manoa, Kamuela, HI

ABSTRACT

Mineral supplementation is necessary to correct for deficiencies in forages consumed by livestock. Hawai'i producers have struggled with mineral issues that include imbalances between calcium, phosphorous, and magnesium, and copper, iron, molybdenum, and sulfur. Imbalances in minerals can be markedly different between islands, ranches, and even pastures due to Hawai'i's highly variable forage environments that can change across very short distances. These imbalances have led to industry-wide depressed calving percentage, increased incidence of disease and other health issues, and reduced animal longevity, although the specific level of disparity varies greatly across the State. Most ranches in Hawai'i use commercial pre-mixed mineral products. However, these are inadequate at meeting the highly variable need for appropriate supplementation. Individual free-choice mineral supplementation has been around since the 1950s, although it has not been widely adopted. Practitioners tout its benefits, including increased performance and lower costs. This project investigates the feasibility of individual free-choice mineral supplementation in Hawai'i through two separate, year-long trials testing palatability and herd performance. Collected data will be used to build a decision support tool that will assist with the construction of location-specific mineral recommendations. First-year trial results document the relative palatability between a commercial pre-mix mineral ration and individual mineral components (Copper sulfate, Magnesium Sulfate, Monosodium Phosphate, Fish bone meal, and Trace Mineral salt) offered cafeteria-style to range cattle and are reported here. The trial was conducted in cooperation with five ranches utilizing cow/calf herds grazing different rangeland ecosystems. The cattle on trial did express preferences for the individual mineral components, contrary to popular wisdom, though the commercial mix was readily available. Preferences for the individual components varied by ranch and season of year. The combined cost of the individual mineral components was \$18/cow/year cheaper than the commercial mix when fed at the recommended rate.

CONFINED CATTLE FEEDING TRIAL TO VALIDATE FECAL DNA METABARCODING TO INFORM RANGELAND FREE-ROAMING DIET APPLICATIONS

. John D. Scasta*¹, Tamarah R. Plechaty¹, Justin D. Derner², Scott Lake¹, David Augustine³, Jessica L. Windh¹, Travis Smith⁴; ¹University of Wyoming, Laramie, WY, ²USDA-ARS, Cheyenne, WY, ³USDA-ARS, Fort Collins, CO, ⁴Agriculture Experiment Station, Laramie, WY

ABSTRACT

Diet composition of free roaming livestock and wildlife in extensive rangelands are difficult to quantify. Recent technological advances now allow us to reconstruct plant species-specific dietary protein composition using fecal samples. However, it has been suggested that validation of the method is needed through the comparison of known fed diets to laboratory results. Using 5 heifers (2 years of age, non-gestating, non-lactating) in a 6-week feeding study (IACUC approved protocol # 20170208DS00258-01), we offered new diets weekly and collected fecal samples from each heifer after 7 days of intake. The six diets were: 1) C3 grass hay, 2) C4 grass hay, 3) C3 grass hay + C4 grass hay + alfalfa (equal proportions), 4) C3 grass hay + C4 grass hay + alfalfa (equal proportions) + minor component of sagebrush (*Artemisia tridentata*) leaves, 5) Alfalfa + minor components of crested wheatgrass (*Agropyron cristatum*), western wheatgrass (*Pascopyrum smithii*), and blue grama (*Bouteloua gracilis*), 6) alfalfa. Homogeneous diets were fed ad libitum but heterogeneous diets with multiple components were fed at metabolic weight based rations with minor diet components introduced five days prior to fecal collection. Constrained ordination suggests that fed diets and laboratory quantified diets using DNA metabarcoding analyses of fecal samples were dissimilar. Detection of minor components was variable. When pooled by functional groups (C3 grass, C4 grass, legume), fecal DNA metabarcoding suggested diets were comprised of 82 to 87% of expected components and did not always align with expected proportions. Laboratory measured protein contributions by major components was also variable when compared to expected protein contributions and at times exceeded or did not meet expectations. Factors confounding quantification of diet composition are attributed to mis-identification in the field and the laboratory, and high numbers of “rare” species in diets attributed to fed hay sources that were not homogeneous.

MOTHER-OFFSPRING INTERACTIONS IN RARAMURI CRIOLLO CATTLE ON NEW MEXICO AND CHIHUAHUA RANGELANDS . Shelemia Nyamuryekunge*¹, Andres F. Cibils², Rick E. Estell³, Alfredo Gonzalez³, Octavio R. Estrada⁴, Felipe A. Rodríguez Almeida⁴, Sheri Spiegel⁵; ¹Range Science PhD, Las Cruces, NM, ²New Mexico State University, Las Cruces, NM, ³USDA - Agricultural Research Service, Las Cruces, NM, ⁴Universidad Autonoma de Chihuahua, Rancho Teseachi, Chihuahua, Mexico, ⁵USDA - ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Rangeland beef cows spend approximately six months annually raising their calves. This endeavor is known to significantly alter a dam's grazing behavior and spatial distribution. The objective of this study was to characterize cow-calf interactions in two herds of Raramuri Criollo (RC) cattle that grazed rangeland pastures in southern New Mexico, USA (NM, 4355 ha) and west-central Chihuahua, Mexico (623 ha) during March and late-April respectively. At each site, five to nine randomly selected mature nursing cows were fitted with Lotek 3300LR GPS collars and Sirtrak proximity loggers. GPS collars recorded animal position at 5-min intervals, whereas proximity loggers were programmed to record mother-offspring contact events at <3m distance. All calves were <2 weeks old at the onset of the study. In 2015 and 2016, respectively, collared animals grazed with a herd of 30 and 35 cows at the NM site and with 68 and 87 cows at the Chihuahua site. We computed number of contact events and duration of each event for 24h time periods, and for daytime and nighttime hours for the first three-weeks. ANOVA was used to determine if contact events and duration of each event changed as a function of calf age or time of day (day vs. nighttime). We also determined whether daily area explored by a cow and its calf differed. Day vs. nighttime mother-offspring contact events and contact time were not different ($P \leq 0.05$). Dams explored larger areas of the pasture than did their calves on any given day (40.3 vs. 29.2 ha; $P = 0.03$). Cow-calf interactions tended to decrease and mother-offspring difference in daily area explored tended to increase as calves aged. Our results suggest that RC calves follow their dams during daily grazing bouts and are likely to constrain their dams' feeding site selection the most during the first weeks after calving.

RARAMURI CRIOLLO, A CATTLE BREED ADAPTED TO SEMI-ARID AND ARID RANGELANDS, WHICH PRODUCES HIGH QUALITY MEAT

. Flavie Audoin*¹; George B. Ruyle¹, Gary P Nabhan², and Samuel R. Garcia³. ¹University of Arizona, School of Natural Resources and the Environment, Tucson, AZ; ²College of Social and Behavioral Sciences, The Southwest Center, University of Arizona; ³Animal and Comparative Biomedical Sciences, Food Product and Safety Laboratory, University of Arizona.

ABSTRACT

For the past twenty years, drought has strongly affected the southwest United States and northwest Mexico. This cross border region can best be described as arid to semi-arid, with annual precipitation of less than 16 inches. Choosing cattle breeds, and genetically selecting for cattle which are adapted to this type of climate, and topography in order to maximize the feed resources without degrading them is an ongoing process 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. They also appear to utilize a larger percentage of the landscape by grazing on steep hill sites, and rocky terrain. In addition, they have been observed grazing a broader cross section of plant types including shrubs, trees, and cacti than northern European breeds. However, a common misconception is that meat from this breed is inferior to that of European breeds. This study compared the meat quality of 31 steers of purebred Criollo (10 Raramuri Criollo, 12 Mexican Criollo [Corrientes]), and crossbred Criollo (9 Waguli x Raramuri Criollo). The objective was to measure the differences between purebred, and crossbred animals as an indication of their potential for meat quality. The study showed that the main differences are between purebred, and crossbred animals. But overall, the meat of these cattle raised on rangelands with no grain feeding is well marbled, and lean. Moreover, the meat is exceptionally tender (average ranging between 4.4 and 4.8 pounds/cm²). Finally, the meat presents a high percentage of omega 9 (between 30.93 and 35.19 %), and a low ratio omega 6:3 (between 0.55 and 0.72), which means that the meat is very healthy.

ACTIVITY BUDGETS OF SMALL RUMINANTS DURING DAILY HERDING IN TWO MALIAN VILLAGES: A GPS ASSESSMENT. Matthew M. McIntosh*¹, Sounkalo Traore², Konimba Bengaly², Andres F. Cibils¹, Janet Ott¹, Judith Moses³; ¹New Mexico State University, Las Cruces, NM, ²University of Segou, Segou, Mali, ³Common Pastures Project, Downing, WI

ABSTRACT

Malian farmers often assume that their small ruminant herds meet most of their daily dry matter (DM) intake requirements while being herded in fields adjacent to the village. We used GPS collars to test this assumption by estimating daily activity patterns of small ruminant herds in two villages in Mali (Koutiala and Ouendebougou). In Koutiala we tracked two small ruminants that grazed with a herd of approximately 40 animals during a week in September 2015 (end of rainy season). In Ouendebougou, we tracked three small ruminants that grazed in a herd of approximately 60 animals during a week in June 2017 (end of dry season). GPS receivers logged locations at 1 min intervals. Total time of each daily herding itinerary (h) and distance traveled in a day (km) by each collared animal were calculated. Time spent resting, grazing, or traveling per day was calculated for each collared animal based on known movement velocities of common animal activities. A land cover map was developed for the area within a 3 km radius of the village of Ouendebougou to estimate time animals spent on rangeland vs. cropland. Small ruminants were herded during 8.8 ± 0.23 (Mean \pm SE) and 7.42 ± 0.22 h.day⁻¹ in Koutiala and Ouendebougou, respectively. Animals rarely traveled more than 3.5 km from the village at either site. In Koutiala, small ruminant herds traveled 7.9 ± 0.14 km.day⁻¹ and spent 1.4 ± 0.33 ; 2.75 ± 0.16 ; or 4.76 ± 0.25 h.day⁻¹ resting, grazing, or traveling, respectively. In Ouendebougou, small ruminants traveled 14.34 ± 0.51 km.day⁻¹ and spent 0.20 ± 0.16 ; 0.57 ± 0.10 ; or 6.65 ± 0.16 h.day⁻¹ resting, grazing, or traveling, respectively. Small ruminants in Ouendebougou spent close to two thirds of their time (5.16 ± 0.23 h.day⁻¹) on crop stubble. Based on our estimates, it appears that small ruminants only harvest a small fraction (10 to 25%) of their daily DM intake requirements while on their daily herding itineraries.

EMERGING THEMES IN LIVESTOCK-PREDATOR INTERACTIONS: A SOCIAL ANALYSIS OF PREDATORS IN WYOMING. Jessica L. Windh*¹, John D. Scasta¹, Barton Stam²; ¹University of Wyoming, Laramie, WY, ²University of Wyoming, Thermopolis, WY

ABSTRACT

Livestock- predator interactions in the state of Wyoming, USA play an important role in the perceptions of predators from a producer standpoint. 274 responses were collected from a survey administered to Wyoming livestock producers regarding effects of predators on their operations. Two open-answer questions were included in the survey and evaluated qualitatively to determine trends in producer thoughts and concerns across the state. The first question asked how designations affected management of livestock losses to predators, while the second was an opening to receive any other concerns producers had. Producers mostly agreed that “trophy” designation of a predator makes management more difficult, however they appreciated the ability to receive compensation for kills. There was consensus that “predator” designation increased flexibility of predator management on ranches with these species. The four themes that emerged when responses were analyzed: 1. Grizzly Bears and Grey Wolves; 2. Hawks, Eagles, Buzzards, and Ravens; 3. Funding; and 4. State Control. All themes have a common underlying thread of state control being preferred to federal control of predators within the state of Wyoming.

ENVIRONMENTAL VIABILITY OF INCREASED FIELD USE FREQUENCY FOR IN-FIELD WINTER FEEDING

. Darren R. Bruhjell*; Agriculture and Agri-Food Canada, Beaumont, AB

ABSTRACT

This project was initiated in the summer of 2015 to assess the viability of increased field use frequency for in-field winter feeding on two soil types.

The purpose of this project is to:

- Determine the effects of a two-in-three year bale grazing rotation and associated nutrient loading (including carbon capture) on soil, forage yield and forage quality of two Alberta pastures
- Determine the effects of a two-in-three year bale grazing rotation on nutrient migration into a local shallow groundwater system
- Monitor and compare soil moisture and temperature regimes of winter bale grazed sites and non-winter grazed sites
- Assess potential for optical sensors (drone and quad-mounted sensors) to estimate forage biomass and carbon capture

This project will help characterize the in-field components of the nutrient cycle and the hydrologic cycle and how they respond to increased nutrient and residue loading that exceeds AAFC and provincial recommendations. An increase in nutrients combined with the other benefits of in-field winter feeding will improve pasture health through increased nutrient cycling, soil building, soil moisture retention and lower soil temperatures. The latter two parameters combined with plant residue and surface microsite creation through pugging have direct positive impacts on the hydrologic cycle.

Deliverables for this project include:

- Recommendations on bale grazing return rates to revise the existing AARD publication “Wintering Site Assessment and Design Tool” (AARD 2013).
- Recommendations for incorporating a risk assessment on potential groundwater impacts from increased nutrient loading to update the same publication.
- An bale grazing calculator that incorporates the economic components of bale grazing with the information being developed in AAFC Lacombe for other in-field winter feeding practices (swath, corn and stockpile grazing).
- Factsheets and/or publications and field days that highlight the results of this project.
- Tools that allows optical sensor equipment (NDVI) to measure field biomass and carbon capture.

MANAGING COWHERD DYNAMICS IN COMMON-POOL FORAGE RESOURCE SYSTEMS CHARACTERIZED BY POOR FORAGE QUALITY AND PRODUCTIVITY.

Rhoda F. Aderinto*¹, Ty Tinsley¹, Rick Machen¹, Alfonso Ortega-Santos², Benjamin L. Turner¹;
¹Texas A&M University-Kingsville, Kingsville, TX, ²Caesar Kleberg Wildlife Research Institute, Kingsville, TX

ABSTRACT

This research project discusses and illustrates the dynamics of managing cowherds in common-pool forage resource systems characterized by poor forage quality and productivity. Common pool resource systems are defined as those systems where it is difficult or impossible from excluded potential beneficiaries from obtaining benefits from use or harvest of the common resource. Also referred to as common property systems, over-use and degradation of the resource is not uncommon (i.e., “tragedy of the commons”). In many common-pool resource systems, top-down policy changes are not effective remedies to curve overconsumption, and bottom-up policies often take too long, since users are incentivized to deplete the resource before changing behaviour. In this project, we develop a common-pool forage system model and apply it to small-holder herding in semi-arid Nigerian uplands. Semi-arid Nigerian uplands are faced with open-access grazing (i.e., limited property rights), which has led to overgrazing forage resources and degrading rangeland soil and water resources. The model illustrated how the activities of individual herdsmen runs contrary to the best interests of the society at large by depleting and degrading the available forage in the environment at a faster rate than it could naturally replenish. Furthermore, additional model applications suggest that understanding the relationship between the forage resource system and its interactions with Nigeria’s socio-economic components are needed. Following previous research, we propose that socio-psychological factors (e.g., cooperativeness) can explain the success of common-pool resource sustainability without top-level regulations. Additional testing of the model is facilitated with Nigerian data to evaluate the effectiveness of alternative herder (individual) and herding (collective) policies aimed at balancing resource sustainability with short-term economic needs.

MANAGING COWHERD DYNAMICS IN ENVIRONMENTS OF LIMITED FORAGE PRODUCTIVITY AND LIVESTOCK MARKETING CHANNELS. Ty Tinsley*, Rhoda F. Aderinto, Rick Machen, Steven Chumbley, Benjamin L. Turner; Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

Sustainable ranching operations have access to adequate forage reserves for grazing and means by which to market livestock profitably. These become even more relevant during times of inadequate rainfall, when marketing animals to balance forage supply and demand is required. Island beef production systems are challenged by climate (semi-arid leeward environments) and geographic location (limited market access). During times of drought and reduced forage (e.g., Hawaii 2015-2016), livestock marketing options become limited since herd liquidation creates a backlog for island slaughter facilities. Thus, producers either retain animals normally culled for longer periods (further stressing forage resources) or make shipments to the mainland which can be costly. To provide long-term management support to these systems, this project is employing a systems approach to address the following questions: 1) How does the lack of market cow liquidation potential reinforce ranch stress and forage resource flexibility? And 2) what adaptive management practices could improve ranch drought resilience (both forage recovery and NPV of herd marketing options)? Identifying profit leverage points and understanding their impact to the ranching operation as well as NI (Net Income) are secondary points of interest. To address these questions, a systems model encompassing forage and grazing ecology as well as economics was developed. The model is segmented into rangelands of very high productivity, high productivity, medium productivity and low productivity to better capture the islands forage supply. Island forage quality and density is driven by annual rainfall. In addition, areas of higher productivity experience a higher grazing frequency, which feeds back to affect future productivity. The model will test scenarios regarding onset and recovery from drought as well as management responses to drought (e.g., feed purchases, land expansion, off-island herd shipments, grazing changes, etc.), enhancing financial and management information needed for sustainable island beef production systems.

**HETEROGENEITY IN FORAGE QUALITY, QUANTITY, AND VEGETATION
STRUCTURE DETERMINES RANGELAND LIVESTOCK USE UNDER PATCH BURN-
GRAZING.** Jonathan W. Spiess*, Micayla R. Lakey, Devan A. McGranahan, Marisol T. Berti,
Torre J. Hovick, Ryan Limb, Kevin Sedivec; North Dakota State University, Fargo, ND

ABSTRACT

Heterogeneity has recently become a focus for land managers interested in optimizing grasslands for both livestock and wildlife. We sought to increase heterogeneity in northern mixed-grass rangelands by applying spatially-discrete patch burns, which create contrast in vegetation structure and forage quality among recently-burned and unburned areas. Low vegetation stature and high forage quality in recently-burned patches should attract grazing livestock and in turn maintain structural contrast and high forage quality throughout the season. We initiated patch burn-grazing by applying spatially-discrete prescribed fires to patches within larger grazed pastures at two experimental rangeland locations in North Dakota: 8 cattle pastures at the Central Grasslands Research Extension Center (Streeter, ND) and 3 cattle and 3 sheep pastures at the Hettinger Research Extension Center (Hettinger, ND). To determine forage quality and productivity, we clipped vegetation at sampling points once per month during the grazing period. For each pasture, we nested sampling points within ecological sites within patches to determine if our imposed heterogeneity overcame inherent landscape heterogeneity. We determined forage quality of samples using near-infrared spectroscopy. To determine spatial patterns of livestock utilization, we counted fecal pats in the vicinity of forage sampling points at time of clipping. We measured the vegetation structure along transects within each patch using the VOR method. Here we present the pattern of biomass production, livestock use, forage quality, and vegetation structure within and among recently-burned and unburned patches in the summer of 2017. While the benefits of spatial heterogeneity to rangeland biodiversity are well-established, biomass production, vegetation structure, and forage quality address the viability of patch burn-grazing as a livestock production system in northern grasslands.

VARIATION IN POLLINATOR RESOURCES ACROSS FORMER-CRP FIELDS MANGED WITH PATCH-BURN GRAZING USING CATTLE OR SHEEP. Jasmine A. Cutter*¹, Torre J. Hovick¹, Benjamin A. Geaumont², Devan A. McGranahan¹, Ryan Limb¹; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT

The interacting effects of fire and grazing influence structure, composition and functioning across grasslands globally. Management focused on restoring the interaction of fire and grazing through patch-burn grazing is well-studied throughout the central and southern plains of North America. However, few studies examine this management strategy in drier climates, like that of the northern Great Plains, and minimal research exists on how sheep interact with fire. Furthermore, the westward expansion of the Corn Belt has diminished the rangeland available for sheep and grassland-dependent wildlife, making the adoption of a management strategy that can maintain economic stability while promoting biodiversity especially important in this region. We examined how different domestic herbivores (moderately-stocked sheep or cattle) affect biodiversity by assessing butterflies and the floral resources they depend upon in a landscape managed with patch-burn grazing (3, 65-ha pastures per grazer). We sampled butterflies three times per season using line-transect distance sampling and counted all flowering stems within 1 m of transects. Our first field season was conducted during a severe drought (21 cm below average), and showed notable differences in available floral resources between pastures grazed by different herbivores. Within cattle pastures we observed 35 total forb species with an average of 1.45 flowering stems/m² (se = 0.17), while in sheep pastures we only observed 12 species of forbs with an average of 0.22 flowering stems/m² (se = 0.03). Butterfly species richness followed a similar trend with 17 species detected in cattle pastures and 14 observed in sheep pastures. Despite these contrasts, butterfly abundances were similar between grazing treatments. Continued monitoring of how different herbivores in a patch-burn grazing framework affect butterflies and floral resources will provide important insights into how range management can better support pollinators, especially in areas where sheep are the dominant livestock.

DEVELOPING THE NEXT RENEWABLE RESOURCES EXTENSION ACT STRATEGIC PLAN FOR 2018-2022. Amber Dalke*¹, Barbara Hutchinson¹, Sheila Merrigan¹, George Ruyle¹, John Tanaka², Mark Thorne³; ¹University of Arizona, Tucson, AZ, ²University of Wyoming, Laramie, WY, ³Univeristy of Hawaii, Kamuela, HI

ABSTRACT

USDA Renewable Resource Extension Act (RREA) appropriates approximately eight percent of the RREA budget to competitive National Focused Fund projects with the remainder being allocated to state Extension programs through a formula. These projects aim to expand the reach of forestry and rangeland Extension programs through better coordination and delivery, use of innovative technologies, and development of easily replicable program models. RREA uses a Strategic Plan to outline core values and includes descriptions of natural resource issues, measurements, and reporting targets. While the underlying premise of past plans remain relevant today, there are new understandings of persistent natural resource issues and increased attention on innovations in program delivery using methodologies and communication technologies that engage people more directly. Thus, it is timely to undergo a process for incorporating these new program delivery methods into the next RREA five-year strategic plan. To understand changing trends in Extension activities and priorities, a national survey was created and distributed to Extension professionals focusing on forestry and rangelands on private and public lands. Survey results from approximately 420 individuals determined the nine areas of interest in the new strategic plan including: landowner engagement, public awareness, intergenerational transfer, ecosystem services, invasive species, wildlife habitat and management, water and wetlands, wildfire, and rural economics. The survey also revealed information about current and future trends in program evaluation, technology used within programs, and teaching approaches and methods. These results will assist Extension professionals prioritize programs and raise awareness about innovation in technology, evaluation, and teaching approaches. The completed strategic plan will be available in digital and print format for ease of access.

NATIVE POLLINATORS: AN ANALYSIS OF GRAZING TREATMENT EFFECTS ON RANGE POLLINATORS WITHIN EASTERN MONTANA

. Gabrielle E. Blanchette*, Hayes B. Goosey; Montana State University, Bozeman, MT

ABSTRACT

The state of Montana has approximately 38 million hectares of land. 24 million hectares of which are utilized as farm and ranchlands and 65.8% is utilized for pasture and rangelands. Much of this habitat is classified as lowland grassland/prairies and sage brush steppe ecosystems which overlaps with valuable habitat for native pollinators. As such, with Montana housing potentially hundreds of Hymenopteran species and producing millions of dollars in livestock revenue annually, it is a critical study area for analyzing the effects of livestock grazing on pollinator communities across landscapes. In this study, we analyzed the diversity, abundance, and community structures of primary Hymenopteran pollinators within the 5 most common families of Montana within two study sites of Eastern Montana. With both sites being exposed to either rest rotation, or off easement grazing practices, colored pollinator pan traps, Daubenmire frame sampling, and sweep netting provided further insight into how grazing treatment affects pollinator and insect aggregate communities. We collected over 10,000 specimens from approximately 22 distinct genera and found that the sub-genera *Dialictus* is most common across our study sites followed by *Agapostemon* and *Halictus*, all within the *Halictidae* family. As data is currently being analyzed and one more field season yet to be conducted, these results are relevant to the understanding of bottom-up and cascade effects of grazing treatments across a landscape, that potentially serve to inform better management practices for the conservation of native pollinators.

BALE GRAZING AS A PASTURE REJUVENATION OPTION. Darren R. Bruhjell*;
Agriculture and Agri-Food Canada, Beaumont, AB

ABSTRACT

Bale grazing continues to be an important component of many extending grazing systems. Whether conducted along or within a system that includes stockpiled grazing, swath grazing, corn grazing etc., many producers use bale grazing as a method to lower their winter feeding costs. Other benefits of bale grazing include improved animal welfare, increased pasture production and a reduction in greenhouse gases. From 2011 to 2015, Agriculture and Agri-Food Canada conducted a study that focused on the impact that bale grazing has on soil and forage resources. This Poster will focus on forage resources.

With the exception of a site that was subjected to overgrazing in years three and four, forage productivity and quality increased on all sites where bale grazing occurred in all years. Forage production at the Vermilion site was more than two times greater on the areas directly influenced by the bales in the first two growing seasons following bale grazing when compared to areas between the bales. When excluded from grazing this trend continued in years two (2.13x) and three (1.82x). When heavily grazed however there was no discernible difference in years three (0.88x) and four (1.05x). The effect on forage production at the Caroline site although less pronounced was still 20 to 40 percent greater on bale affected areas during all years (1.4, 1.3, 1.4 and 1.2 times respectively). In Vermilion, Crude Protein (CP) levels were consistently higher (30 to 40 percent) in areas influenced by the bales when compared to areas between bales. The effect of the bales on CP at the Caroline sites was less significant than the Vermilion site in the second growing season being only 20 percent greater in years one and two following bale grazing and ten percent greater in years three and four.

ABSTRACT

A UAV is an Unmanned Aerial Vehicle, commonly known as a drone. It is also referred to as a remotely piloted aircraft (RPA) by the International Civil Aviation Organization (ICAO), an aircraft without a human pilot aboard.

UAVs are used in agriculture primarily for aerial photography. However, the type of payload (camera or sensor) can vary depending on the specific application. Sensor types include Visual, Multispectral, Thermal, Lidar, and Hyperspectral (see right for descriptions).

Sensor descriptions and typical agricultural applications include:

- Visual - High resolution camera: For aerial mapping and imaging
- Multispectral - Multiple spectral bands: e.g. Near Infrared (NIR) to capture Normalized Difference Vegetation Index (NDVI) for plant assessment
- Thermal - Thermal Infrared (TIR) Sensor: For heat signature detection (e.g. livestock)
- Lidar - Short range LASER rangefinder: For 3D digital surface modeling (topography)
- Hyperspectral - Full spectral sensing: For small UAV applications (NDVI, water quality assessment)

Potential Considerations include:

- Cost, although prices are constantly decreasing
- Government regulation compliance
- Operator training requirements
- Site limitations

IDENTIFYING AND CHARACTERIZING OF SALT-TOLERANT ALFALFA (*MEDICAGO SATIVA SUBSP. FALCATA*) GERMPLASM. Katelin Frerichs*, Lan Xu, Arvid Boe; South Dakota State University, Brookings, SD

ABSTRACT

Soil salinity limits plant growth and crop production. More than 20% of cultivated land worldwide is affected by salinity, particularly in arid/semiarid regions. The situation is becoming more severe due to shifts in precipitation and evaporation pattern and improper irrigation. There is an urgent need to develop salt-tolerance economically valuable plants to minimize the loss and sustain agriculture production. Alfalfa is one of the most extensively cultivated forage crops. Some yellow-flowered alfalfa (*Medicago sativa* subsp. *falcata*) have exhibited morphological and physiological drought tolerance. Since soil salinity associated with physiological drought, it is reasonable to expect these drought tolerant *falcata* populations could be used for selecting potential parent materials for breeding salt-tolerant cultivars. The objectives of this study are to identify potential parent materials from the USDA Plant Introduction (PI) Collection and naturalized populations for breeding salt-tolerant alfalfa cultivars by characterizing variations their germination rate, seedling survival, growth, and biomass. Uniform seeds from eleven alfalfa populations were selected, stratified, and inoculated with *rhizobium* before seeding in plastic trays (54-cm by 27-cm by 6-cm) filled with pre-mixed salt-affected soil. Populations were consisted of five of *falcata* PIs, four predominately *falcata* (three of them are experimental populations developed from SDSU one cultivar, and one from commercial), and one conventional-hay type (Persist II) as control. Trays were maintained in a greenhouse with $24\pm 3^{\circ}\text{C}$ and 16 hours light/8 hours dark photoperiod cycle. Soil was maintained at its field capacity through daily misting. Twenty-five seeds of each population were seeded in 5 row per tray with 6 trays (n=6 replications). Seedlings were thinned, maintaining ten seedlings per tray after germination. Germination rate, survival, biomass, and soil salinity were measured at the end of 8 weeks. Data were analyzed to evaluate salt-tolerance variations among germplasms. The results will provide useful information for reclamation of saline-soil.

ADDING AQUEOUS SUGAR SOLUTION TO TOPSOIL TO TEST FUNGICIDE SEED TREATMENTS AGAINST NATIVE PATHOGENS

. Benjamin Hoose*, William Richardson, Rhett M. Anderson, Bradley Geary, Matthew Madsen; Brigham Young University, Provo, UT

ABSTRACT

Reseeding to restore disturbed rangelands is rarely successful or cost effective, particularly within hotter, drier, lower elevation sites. Seedling mortality is highest during the critical transition between reliance on stored carbohydrates in the endosperm and self-sufficiency through photosynthesis. During this transitional period, seedlings are vulnerable to attack from pathogenic fungus. Seed treatments with fungicides may protect the plant from fungus attack and improve seedling survival and vigor. Screening fungicides for use in wildland systems can be challenging in the laboratory as there is an array of native pathogens in the soil that may impact seedlings. Additionally, during the screening, fungal pathogens must be active and present in the soil at concentrations high enough to produce a significant treatment effect. Most laboratory fungicide screenings are tested against specific pathogens that have been cultured. Testing fungicides against the actual populations of pathogens in the soil within a controlled setting could improve the validity of the results. We hypothesize that an aqueous sugar solution could be added to native soil to activate fungal pathogens and promote fungal growth. We expect that increased microbial activity will result in greater pathogen attack and a better treatment response when evaluating fungicide seed treatments. In addition to screening fungicides, this method could be used for a variety of applications that evaluate soil fungal pathogen impacts.

IMPACT OF YEAR, SEASON, ECOLOGICAL SITE AND DIFFERENT HERBIVORY LEVELS ON TILLER RECRUITMENT IN A MIXED GRASS PRAIRIE. John R. Hendrickson*¹, Patricia S. Johnson², Lan Xu³, Kevin Sedivec⁴, Mark A. Liebig¹, James Garrett⁵, Igathinathane Cannayen⁶, Gary Halvorson⁷; ¹USDA-ARS, Mandan, ND, ²South Dakota State University, Rapid City, SD, ³South Dakota State University, Brookings, SD, ⁴North Dakota State University, Fargo, ND, ⁵Sitting Bull College (Retired), Dupree, SD, ⁶North Dakota State University, Mandan, ND, ⁷Sitting Bull College, Fort Yates, ND

ABSTRACT

Understanding how different grazers, such as cattle and prairie dogs, impact tiller recruitment, can help develop state and transition models needed for ecological site descriptions. Study areas were selected on two different ecological sites, thin claypan and loamy, both with and without prairie dogs on a ranch near Mahto, SD. Livestock enclosures were fenced on each study area two years prior to the start of the study and paired with nearby non-excluded areas. Therefore, on each ecological site, the grazing treatments were 1) No cattle, no prairie dogs (NCND), 2) cattle, no prairie dogs (CND), 3) no cattle, prairie dogs (NCD) and 4) cattle, prairie dogs (CD). In spring 2014, all the western wheatgrass tillers [*Pascopyrum smithii* (Rydb.) Á. Löve] within 4 randomly located subplots (15 x 15 cm) in each main plot were counted and marked with a colored wire. The subplots were revisited in the fall of 2014 and the spring and fall of 2015 and 2016 to evaluate tiller mortality and recruitment. Tiller tiller-1 recruitment greater than 1 indicates a growing population. Years 2014 (1.02) and 2016 (0.85) had greater ($P=0.0005$) tiller tiller-1 recruitment than 2015 (0.41) and tiller recruitment was greater ($P=0.0073$) on the thin claypan (0.84) than the loamy site (0.68). However, in the Spring 2015, the loamy site (0.53) had greater recruitment than did the thin claypan site (0.31). Tiller recruitment was highly variable with CND and NCND having tiller tiller-1 recruitment greater than 1 in 2014 but CD and NCD having tiller tiller-1 recruitment close to 1 in 2016. Year rather than grazing intensity may drive tiller recruitment. Increased recruitment on the thin claypan site may be the result of longer prairie dog occupation on these sites. Analysis of survivorship data should provide a clearer picture of the tiller dynamics on these sites.

COVER CROPS FOR IMPROVING SOIL HEALTH AND FORAGE PRODUCTION ON THE KENAI PENINSULA. C. A. Matney*; University of Alaska Fairbanks, Fairbanks, AK

ABSTRACT

Recently cleared lands on the Kenai Peninsula are not typically ready for direct seeding of forage or other crops. Most agricultural sites on the Kenai Peninsula were previously dominated by white spruce and paper birch with soils consisting of ash influenced loess over sandy and gravelly drift. These soils are low in organic matter and fertility. Land managers are in need of methods for soil improvement. Beginning in 2016, a three-year trial was initiated on three cleared locations across the Kenai Peninsula, seeded with a four-species cover crop mix to evaluate the potential of using cool season cover crops to improve soil health and as a potential forage for livestock. The trial consisted of two fertilizer treatments to support cover crop establishment: conventional fertilizer and organic fertilizer (fish bone fertilizer). Each treatment was replicated four times at each location with an individual plot size of 2.4 x 4.6 m. Plots were seeded in early July each year, and the species included in the cover crop mix were buckwheat, field pea, tillage radish, and white oats. Pounds of forage production, penetrometer resistance, as well as pre-treatment and post-treatment soil tests for nutrients, organic matter, and Solvita soil health were determined. This poster will present the preliminary results from 2016 and 2017.

SOIL HEALTH EFFECTS OF SUPPLEMENTAL FEEDING ON WORKING RANGELANDS
IN THE GUNNISON VALLEY, CO US. Jake Courkamp*¹, Corrie Knapp¹, Bruce Allen²;
¹Western State Colorado University, Gunnison, CO, ²Allen Ranches, Gunnison, CO

ABSTRACT

Climate stressors, such as drought, can push rangelands towards critical thresholds that, if crossed, will lead to impaired productivity and ecosystem function. As such, innovative management will be necessary to safeguard the functionality of these ecosystems and reduce the likelihood of undesired transitions. Supplemental cattle feeding in shrub-dominated ecosystems applies organic matter and nutrients to rangeland soils in the form of manure and waste hay. Given sufficient time, adding these critical components to the soil surface may help to foster the development of healthy, functional soils on rangelands with marginal soil and vegetation quality. Further, this practice may accelerate terrestrial carbon sequestration by enhancing primary productivity. To investigate the effects of this practice, we examined soil organic matter, infiltration, CO₂ burst respiration, and vegetation cover on a landscape where this practice has been implemented each spring for more than a decade. Between 80 and 100 cow-calf pairs have been fed hay daily on this landscape for 10-16 days annually in May. By comparing vegetation and soil metrics on this landscape and a nearby control area exposed to grazing, but not supplemental feeding, the study will quantify the benefits of this practice and determine if it warrants expanded application. Final results are forthcoming, but practitioners indicate that the vegetation in this area has improved since the practice was implemented. The study will also establish a carbon monitoring protocol and baseline on a much larger landscape. This to facilitate future research concerning management decisions related to terrestrial carbon sequestration. In this way, the study can use a widely-applicable methodology to both address the chronic lack of baseline data that exists at the ranch level and examine a seemingly beneficial management practice with the potential for expanded application.

THE EFFECT OF POLYACRYLAMIDE RATE AND DEPTH ON SOIL WATER STORAGE AND SEEDLING ESTABLISHMENT. Shannon V. Nelson*, Maria C. Valencia, Holly Black, Wyatt Petersen, Jeffrey D. Svedin, Neil C. Hansen, Matthew D. Madsen, Val J. Anderson, Bryan G. Hopkins; Brigham Young University, Provo, UT

ABSTRACT

Post-disturbance rangeland revegetation is hindered in areas of low precipitation facing invasion by annual grasses. The invaders germinate earlier and deplete water resources available to native and introduced perennial species. The use of polyacrylamide (PAM), a super absorbent polymer, is a possible solution because of its ability to hold water in the soil creating a potentially wider establishment window. Previous glasshouse studies indicated that PAM in bands in the soil increased the longevity of associated seedlings in drought conditions. The current study determined the optimal depth of PAM placement for water storage and seedling growth. Bottlebrush squirreltail [*Elymus elymoides* (Raf.) Swezey] seed was planted in 10 cm x 10 cm x 24 cm pots containing PAM at rates of 0, 1500, and 3000 kg ha⁻¹ placed in a layer at 0, 2.5, 7.5, and 15 cm below the soil surface. Relative to the control, the 7.5 and 15 cm depth PAM treatments increased the time with elevated soil moisture by 17 and 7 days, respectively. At the high PAM rate applied at the 7.5 and 15 cm depths the seedling longevity increased by 15 and 11%, respectively. Seedling height was significantly affected by both PAM rate and depth, with a 7% increase at the 1500 kg ha⁻¹ rate at the 2.5 cm depth and a 15% increase at the 3000 kg ha⁻¹ rate at the 7.5 cm depth. The number of blades per seedling was significantly influenced by rate, but not depth, with an 18% increase in blade number at the high rate, but the low rate produced an 8% decrease on day 77 after saturation. These data suggest that PAM has potential to improve seedling establishment in revegetation activities.

BUILDING PASTORALISTS&RSQUO; RESILIENCE: STRENGTHENING PARTNERSHIPS AND LOCAL GOVERNANCE INSTITUTIONS IN TUNISIA. Mounir Louhaichi*¹, Jutta Werner², Slim Slim³, Slim Jarradi⁴; ¹International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan, ²International Center for Agricultural Research in the Dry Areas, Tunis, Tunisia, ³School of Higher Education in Agriculture of Mateur, University of Carthage, Mateur, Tunisia, ⁴Food and Agriculture Organization of the United Nations, Tunis, Tunisia

ABSTRACT

Rangeland resources are among the most important – and almost certainly the most neglected – agro ecosystem component in dry areas. They are the largest land-use category, home to the poorest segment of the population, and crucial for millions of small-scale livestock producers. For many decades, these pastoral areas have been continuously deteriorating, with reductions recorded from 6.1 million hectares in 2005 to 5.5 million hectares in 2012. Managing rangelands sustainably presents a complex challenge for communities that depend on rangelands for their livelihoods, and for local authorities and policymakers who regulate land use. The current civil legislation in Tunisia does not effectively support the needs of the common rangelands. In fact, most rangelands (67 %) are not covered by the current forestry code. In order to tackle the fragile and extremely complex processes of policy change related to common rangelands, a participatory approach involving all concerned stakeholders from pastoralists, local and government authorities to non-governmental organizations and marginal groups was employed to update the current forestry code in Tunisia. The objective is to come up with an updated forestry code that ensure that the management of rangelands through local communities is formalized, regulated and protected by law, and that the roles of all stakeholders are clarified. To meet this objective a series of local and national workshops have been organized where all concerned actors are actively involved. This process may take up to 2 years before a new legislation approved by the general assembly is in place. The new pastoral code will ensure that the entire Tunisian nation benefits by reducing the embedded costs caused by rangeland degradation and through an enhanced negotiation culture related to common natural resources.

ASSESSMENT OF FORAGE UTILIZATION IN JICARILLA APACHE RANGE LANDS
. Andrea Carrillo*¹, Bir Thapa¹, Lambert Chee¹, Edward Lucero²; ¹Natural Resources, Dulce, NM, ²Natural Resources, Albuquerque, NM

ABSTRACT

Monitoring of rangeland grazing is crucial for its conservation, sustainability and ecosystem functions. The Jicarilla Apache Nation in Northern New Mexico has 879,661 acres, primarily rangelands for cattle, sheep, horse and wild life grazing. The primary objective of this study is to assess and compare forage utilization data collected in 2010 and 2017. Moderate levels of grazing intensity are correlated with soil stability, forage production, wildlife habitat, and diversity of native plants. Heights of ungrazed and grazed range forage species were measured to determine average utilization percentage. Cages were established in each of the 120 range units to determine ungrazed height. Grazed forage height data, 20 replications spaced 10 meter apart, along a transect were converted to percent of weight utilized by means of Utilization Gauge, which was developed from height-weight relationship curves. Forage utilization percentage data for 120 range units, three range use types, and 10 forage species were analyzed using GLM procedure in SAS. Results indicated that average forage utilization percentage ranged from 9 to 64 on summer ranges, 7 to 48 on winter ranges and 4 to 62 on continuous (year round use) ranges. Range units with Crested Wheatgrass (*Agropyron cristatum*), Blue Grama (*Bouteloua gracilis*) and Western Wheatgrass (*Pascopyrum smithii*) were heavily utilized (> 50%) and have major soil erosion implications. Average utilization percentage ranged from 21 to 58 for crested wheatgrass, 9 to 63 for Blue Grama and 5 to 62 for Western Wheatgrass. Other grasses such as Squirrel tail (*Elymus elymoides*), Galleta (*Pleuraphis jamesii*), and Alkali Sacaton (*Sporobolus airoides*) were utilized only 11 to 28%. Regression models to calculate optimum animal unit months were developed.

ASSESSING THE EFFECTS OF TRADITIONAL HARVEST ON COMMON CAMAS POPULATIONS IN A SEASONALLY WET PRAIRIE. Devin Stucki*, Ron Reuter, Tom Rodhouse; Oregon State University, Bend, OR

ABSTRACT

Common camas (*Camassia quamash* [Pursh] Greene) has been a staple food source of many indigenous peoples of western North America for thousands of years. Camas is a facultative wetland species that is strongly associated with seasonally wet prairies and once widespread populations have declined mainly due to the conversion of wetlands for agriculture. Restoration of camas prairies is necessary to counter the loss of habitat. Traditional camas bulb digging and harvesting has been thought to stimulate growth and increase plant densities. This study will assess how digging and harvesting of camas bulbs, as well as burning, affect camas populations in Weippe Prairie, Idaho. A total of 50 permanent plots (1 m²) were established in Weippe Prairie, with each plot receiving one of four treatments: digging, digging and burning, burning, and control. The plots were observed for changes of trend in camas plant densities, camas flowering stem densities, seedling densities, and ground cover. Preliminary results show that digging and harvesting camas bulbs does cause an immediate reduction in flowering camas plants, but this reduction is disproportionately less than the number of bulbs removed. Further monitoring of these experimental plots will help to characterize the long-term effects of traditional camas harvest and the utility of harvest for restoration purposes.

YIELD AND NUTRITIVE QUALITY OF *HEDYSARUM CORONARIUM* ACROSS THREE DIFFERENT AGRO-CLIMATIC ZONES OF NORTHERN TUNISIA. Slim Slim¹, Lamia Harbeg¹, Sawsan Hassan², Hloniphani Peter Moyo², Serkan Ates³, Mounir Louhaichi*²; ¹School of Higher Education in Agriculture of Mateur, University of Carthage, Mateur, Tunisia, ²International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan, ³Oregon State University, Corvallis, OR

ABSTRACT

Sulla (*Hedysarum coronarium* L.) is commonly included in the cropping system as a short-rotation forage crop (one to three years) in northern Tunisia. Thus, this study compared DM production and nutritive value of sulla stands of different ages (one, two and three year-old stands) across three agro-climatic zones in northern Tunisia [North (>600 mm), NW (500 - 550 mm) and NE (<500 mm)] to identify the optimum rotation length from forage production and quality standpoints. Soil organic matter, mineral content and pH were similar across all three regions. The average of the DM yield is 6.10, 7.47 and 9.88 t DM/ha in NW, N and NE regions, respectively. Three-year old sulla stand had the greatest DM yield (14.53 t DM /ha) in the NE region, while the DM yield of three-year old stand in NW was the least (4.74 t DM/ha). The ADF and NDF concentrations for the three year-old stand in NE region had the highest value (32.3 % and 59.5 %, respectively). Three-year old sulla stand in the NW region had the lowest NDF concentration (40.7%) and the greatest CP content (17.6 % DM). The results revealed that sulla had the greatest DM yield in its third year, regardless of the region, indicating that the sulla phase of the rotation should be at least three years for optimum forage production. The NE region has a long-standing tradition of incorporating sulla in crop rotations, explaining the higher yields in that region, compared to other regions with higher rainfall. **Keywords:** Sulla; years of cultivation; qualitative analysis; soil analysis; rhizobium
Abbreviations: north (N), north west (NW), north east (NE), dry matter (DM), acid detergent fiber (ADF), neutral detergent fiber (NDF), crude protein (CP).

EFFECTS OF WATER AND NITROGEN ADDITION ON COMMUNITY PRODUCTIVITY IN DRY MIXED GRASS PRAIRIE . Ruiyang Zhang¹, Michael P. Schellenberg*²; ¹Inner Mongolia Agricultural University, Hohhot, Peoples Republic, ²Agriculture and Agri-Food Canada, Swift Current, SK

ABSTRACT

This work highlights the response of plant community to two important limited-resources: water and nitrogen (N) in Dry Mixed Grass Prairie Ecoregion. The field study with a randomized complete block design in Swift Current Research and Development Centre (SCRDC) of Agriculture and Agri-Food Canada (AAFC) examined the effects of water and N addition on the aboveground biomass for grass, non-grass plants and plant community. This poster reports the data collected in 2016 (May to October precipitation: 523.1mm). In this study, water treatments included one control (natural precipitation) and two water supplementation from May to August (supplying 15% and 30% of the monthly precipitation). The N addition treatment was supplied with 28.6g/m² NH₄NO₃ (10g/m² N) at the end of May. Aboveground biomass of grass increased 91.9% and aboveground biomass of plant community increased 88.9% with N addition. Under N addition treatment, aboveground biomass of grasses and plant community was improved 32.0% and 36.1% with supplying water (30% of the monthly precipitation), respectively. However, no significant differences were detected for aboveground biomass of non-grass plant among different water treatments and N addition treatment. Consequently, under the climate conditions with excess precipitation, the effect of water supplementation is weak on grasses and non-grass plants. In addition, the response of grasses to N addition was more sensitive than that of non-grass plants. The N addition with sufficient soil moisture can effectively improve the productivity of plant community in Dry Mixed Grass Prairie Ecoregion.

RANGELAND WATER FACILITIES AND IMPACTS ON SPECIES RICHNESS. Byron A. Munda*; Arizona State University, Phoenix, AZ

ABSTRACT

Do Rangeland water facilities such as earthen tanks affect vegetation species composition? The Deadman Mesa Allotment on the Tonto National Forest has been vacant and ungrazed for over 17 years. The purpose of my study is to measure the vegetation around earthen tanks and determine if these watering areas drive species composition and how far does the extent reach.

WATER QUALITY CONDITIONS ACROSS PUBLIC GRAZING LANDS ON THE SIERRA NATIONAL FOREST. Rebecca K. Ozeran*¹, Claire Neal², Kelsey DeRose³, Kenneth W. Tate³; ¹University of California Cooperative Extension, Fresno, CA, ²University of California, Berkeley, Berkeley, CA, ³University of California, Davis, Davis, CA

ABSTRACT

Livestock grazing is one potential contributor to non-point source contamination of water bodies, and is commonly assumed to reduce water quality. In some cases, cessation of grazing activities is proposed in areas with impaired water quality. However, recent research in California has shown that grazing can be a land use compatible with state and federal water quality requirements. *Escherichia coli* (*E. coli*), a common fecal bacterium, is used as an indicator of microbial water quality and risk to human health. We quantified *E. coli* concentrations throughout the Willow Creek watershed of the Sierra National Forest in Madera County, California, to characterize *E. coli* concentrations in the watershed and assess whether current land uses are compatible with state and federal water quality requirements. Twenty-one sampling locations were identified by their primary association to one of three primary land use activities in the watershed: public recreation areas, federal public grazing areas, and rural residential areas. Sampling was conducted during July and August, to capture peak human and livestock use of the watershed. Water samples were collected weekly from each of these sampling locations and *E. coli* concentration determinations were completed within 6 ± 1 hours of collection, following established protocols. Preliminary results indicate that these multiple land uses are compatible in the Sierra National Forest under current management protocols, as *E. coli* concentrations were below the EPA threshold for recreational water use in 97% of our samples.

PHYSIOLOGICAL RESPONSES TO SOIL WATER AVAILABILITY DIFFER BETWEEN PARTIALLY TOP-KILLED AND UNTREATED MESQUITES. Caitlyn E. Cooper*¹, Tian Zhang¹, Jim Ansley²; ¹Texas A&M AgriLife Research - Vernon, Vernon, TX, ²Oklahoma State University, Stillwater, OK

ABSTRACT

It is widely known that various brush treatments can trigger alterations in tree morphology. However, less is known about associated changes in physiology under these treatments and how that may affect how follow up treatments should be applied. Therefore, the objective of this study was to determine how leaf-level stress indicators [gas exchange (photosynthesis (A), transpiration (E) and stomatal conductance (g_s)) and pressure-volume parameters] in mesquite (*Prosopis glandulosa* Torr.) are affected by leaf area reductions caused by partial-top killing from aerial spraying with a mixture of clopyralid and triclopyr (10.7 oz + 8 oz ac⁻¹). Leaf-level responses were measured monthly in summer 2017 in untreated control trees and individuals treated in 2007 and 2014. Rainfall prevented August pressure-volume measurements. Gas exchange measurements were taken at 900, 1200, and 1500 hr. On average, treated individuals had 22, 21, and 27% greater A , E , and g_s , respectively, than untreated individuals. Gas exchange rates decreased from June to July and remained low in August. Daily average A decreased from 23.6 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ in June to 14.2 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ in August. From June to July, osmotic potential at full turgor (Π_{FT}), turgor loss point (Π_{TLP}), and leaf bulk modulus of elasticity (ϵ) decreased by 11, 14, and 17%, respectively. However, capacitance at full turgor (C_{FT}) and turgor loss point (C_{TLP}) were unchanged. Results suggest that treated trees have a greater capacity for gas exchange which may result from alterations to the leaf:root area ratio or leaf:sapwood area ratio, and subsequent changes to water availability. Leaf-level gas exchange and pressure-volume characteristics appear to be coordinated and results suggest that mesquite utilizes osmotic adjustment to maintain gas exchange during times of low soil moisture availability. These findings are fundamental to understanding mesquite success following partial top-kill and will help guide future treatments.

HUISACHE (*ACACIA FARNESIANA*) SEEDLING COTYLEDON HEIGHT AND RESPROUTING ABILITY

. Pablo Teveni*, Robert D. Cox, Ronald Sosebee; Texas Tech University, Lubbock, TX

ABSTRACT

Huisache (*Acacia farnesiana* [L.] Willd.), a pest tree species on rangelands throughout south Texas, resists control via herbicide, fire, or mechanical methods through vigorous resprouting and prolific seed production. Until now, however, it has been unknown when huisache seedlings develop the ability to resprout. We determined the age at which huisache seedlings' cotyledon latent meristems are buried below the soil surface and plants attain resprouting ability. First, we grew 120 seedlings in the glasshouse and examined 10 every other month for 24 months to measure height of cotyledon latent meristem above (or below) soil level. Second, we grew 240 seedlings in the glasshouse, and cut 10 every month at the soil surface to determine resprouting ability. Seedling resprouting began at 6 months and increased to over 50% at 20 months. Seedling cotyledon latent meristem height had a quadratic relationship with time, with average cotyledon latent meristem height at or below soil level at 22 months of age. Seedling cotyledon latent meristems began to become buried at 7 months, with over 50% becoming buried at 21 months of age. We suggest that attempts at controlling huisache through top-removal methods might result in over 50% of plants resprouting when as young as 20 months of age.

ESTIMATION OF AVAILABLE FORAGE IN ASHE JUNIPER.

. Douglas R. Tolleson*¹, Lonesome Malambo², Jay Angerer³, Edward Rhodes³, Nick Garza⁴, Emily Pecilunas⁴, Jesse Golpin³, Robert Moen⁴, Reid Redden⁵, Morgan Russell⁵; ¹Texas A&M University, Sonora, TX, ²Texas A&M University, College Station, TX, ³Texas A&M Agrilife Research, Temple, TX, ⁴Texas A&M Agrilife Research, Sonora, TX, ⁵Texas A&M Agrilife Extension, San Angelo, TX

ABSTRACT

Ashe juniper (*Juniperus ashei*) occupies approximately 8 million acres of Texas rangeland and is one of three native junipers in the state. Considered an invasive, countless resources have been expended in efforts to manage and control its expansion. One biological method available is goat browsing. There is a need to better quantify available forage in junipers in order to inform goat stocking rate decisions. Our objective was to compare two methods of determining forage content in Ashe juniper: 1) allometric measurements (height, width, basal diameter) and 2) terrestrial Light Detection and Ranging (LiDar) scans. Nine Ashe juniper trees were selected at the Texas A&M Sonora Research Station; three < 0.9 m (small), three 0.9 to 1.8 m (medium) and three > 1.8 m (large). LiDar point clouds were collected prior to harvesting. Trees were hand cut and sorted into standard timelag fuel categories. Available forage was considered to be plant material (needles and stems) within the 1-hour category and that were less than 1.8 m from ground level. All harvested plant material was dried to a constant weight at 60o C. Subsets of the 1-hour category material was separated by hand into needle (~70%) and stem (~30%). Relationships between allometric measurements and area, volume, or weight were determined by linear regression. Available dry matter forage was 0.27 ± 0.14 , 2.40 ± 1.17 , and 13.02 ± 3.36 kgs for the small, medium, and large trees respectively. Basal diameter was the most effective single predictor of available forage ($y = 0.8009x - 2.2757$; $R^2 = 0.99$; $SE = 0.76$; $P < 0.01$). LiDar prediction of available forage was also effective ($y = 0.0026x + 0.385$; $R^2 = 0.95$; $SE = 1.57$; $P < 0.01$). Data obtained by either method can be used to help inform stocking rate decisions for goats in pastures with Ashe juniper.

IMPROVING THE SEED GERMINATION OF LITTLE BLUESTEM WITH SELECTION
. Tim Springer*; USDA-ARS, Woodward, OK

ABSTRACT

Rapid seed germination is an important characteristic when it comes to plant stand establishment under variable environmental conditions. This research was designed to improve the seed germination of six experimental Syn-0 lines of little bluestem [*Schizachyrium scoparium* (Michx.) Nash]. Two cycle of recurrent selection were used to develop Syn-1 and Syn-2 lines from six experimental Syn-0 lines. Cycle 1 consisted of germinating 3,500 open-pollinated seeds of each Syn-0 line in water of -0.8 MPa potential for seven days. All seeds that germinated in seven days (approximately 250 for each of the six lines) were selected to create six Syn-1 lines. Cycle 2 selection was similar to Cycle 1, except that Syn-1 lines were used to create six Syn-2 lines. To test the effects of selection, four 50-sessile spikelet samples of the 18 lines were germinated in water of -0.8 MPa potential for seven days for seeds harvested in 2015 and 2016. Germination of Syn-1 seeds was 3.7% higher than Syn-0 seeds, and Syn-2 seeds were 16.2% higher than Syn-1 seeds. Selection for improved seed germination at a low water potential simultaneously increased the speed of seed germination as well as 50-sessile spikelet weight. Thus, it was possible to increase the seed germination of the six little bluestem lines at the water potential used with recurrent selection with the added benefits of increased speed of seed germination and increased 50-sessile spikelet weight.

YEAR-TO-YEAR VARIATION IN POPULATION DENSITY OF *DELPHINIUM ANDERSONII*

. Jim Pfister*¹, Daniel Cook²; ¹USDA-ARS, Logan, UT, ²USDA ARS Poisonous Plant Research Laboratory, Logan, UT

ABSTRACT

Delphinium andersonii (Anderson larkspur) is a perennial forb on semi-arid rangelands, and population density is related to cattle deaths. A multi-year study was initiated in 2011 to measure toxicity, plant density and life history of *D. andersonii* populations in southern Idaho. In 4 out of 7 years, essentially no plants emerged and flowered because of drought conditions. During the 3 years when some plants emerged and flowered, plant densities were 2, 7, and 10 plants/m². Previous research has shown that plant densities greater than 5 plants/m² pose a serious threat to grazing cattle. Approximately 8% of the marked plants remained dormant for 2-4 years, then emerged when precipitation was favorable. Late winter and early spring precipitation appear to drive *D. andersonii* populations. Persistent drought is fatal to some plants, but dormant plants may re-emerge when sufficient, timely rainfall occurs.

LITTLE LOVE FOR FRACKING AHEAD OF EXPLORATORY DRILLING IN SOUTH AFRICAN GRASSLANDS. Devan A. McGranahan*¹, Kevin P. Kirkman²; ¹North Dakota State University, Fargo, ND, ²University of KwaZulu-Natal, Pietermaritzburg, South Africa

ABSTRACT

Applications for exploratory shale gas development via hydraulic fracturing, or fracking, have raised concern about energy development impacts to South African rangeland. Initially, fracking interest was focused in the arid, open Karoo, but applications for exploration have recently been handled for the grasslands of KwaZulu-Natal, a populous, agricultural province with high cultural, ecological, and economic diversity. We conducted four focus groups and an online survey to determine how residents of South Africa's grassland districts perceived fracking. Focus group participants were unanimous in their opposition, primarily citing concerns over degraded water quality and rural way-of-life. Survey data collection is ongoing, but preliminary analysis indicates consistency with focus group responses. When asked which provinces might be directly affected by fracking, KwaZulu-Natal was ranked behind Northern Cape, Western Cape, and Eastern Cape, reflecting an awareness bias towards Karoo projects. The most frequently identified concerns regarding Agriculture and Natural Resources were Reduced quality of water, Negative impacts to ecosystems and natural biodiversity, Reduced quantity of water, and Pollution hazards. The most frequent concerns regarding Social, Cultural, and Local Community issues were Impacts to human health, Visual/aesthetic degradation of tourism areas, Degradation of local infrastructure, and Physical degradation of tourism sites. The majority of respondents were pessimistic about potential benefits of fracking to South Africa's domestic energy supply and electricity production. The majority of respondents did not agree fracking would reduce negative impacts of coal mining or create jobs. Survey respondents showed strong pessimism about government's preparedness for fracking and agreed fracking created opportunity for corruption. The majority of respondents agreed they would consider fracking when voting, and identified a need for more research on fracking in South Africa. Expressed research needs focused heavily on environmental impacts, especially water, in addition to the welfare of local citizens and their communities.

WILD PIG DAMAGE ASSESSMENT APP FOR APPLE AND ANDROID DEVICES. John M. Harper*¹, Roger Baldwin², Shane Feirer³, Elizabeth Hiroyasu⁴; ¹University of California, Ukiah, CA, ²University of California, Davis, CA, ³University of California, Hopland, CA, ⁴University of California, Santa Barbara, Santa Barbara, CA

ABSTRACT

The geographical extent of wild pig damage on rangeland in California and elsewhere is currently unknown, making it difficult to mitigate and manage losses, and estimate the economic impact on private landowners. Capturing the geographical extent of wild pig damage would allow land managers to more effectively mitigate wild pig damage by allowing identification of specific areas that are conducive to wild pigs.

Our team decided to take an innovative risk to capturing the data needed. We believed that through the development of a mobile app for use on Android and Apple devices (smartphones, tablets, etc.) that land managers could quickly assess the type, nature, and extent of wild pig damage occurring on their properties. The app allows the capacity to reach a variety of different types of land managers, including a diverse set of natural resource managers and agricultural producers who are affected by wild pig damage on their property. Results from this project could revolutionize wild pig management by allowing landowners to identify and target control efforts in habitats heavily used by pigs, or by allowing landowners to alter habitats to make them less suitable for this invasive species

Our team can use the data as a basis to estimate economic losses and impacts on natural resources on private or public property. The data is used to develop materials like newsletters, trade magazine articles, public brochures, presentation materials, and a website for land managers to learn more about impacts of wild pigs. Results create tools for managers to assess the relative costs and benefits of control actions for wild pig management.

The app was launched in September of 2016, based on a prior survey (See <http://ucanr.edu/survey/survey.cfm?surveynumber=16522>). It is available at the iTunes App Store and the Google Play site by searching for the term wild pig damage. It is free.

COMPARING THE EFFECTIVENESS OF OBJECT-BASED VERSUS SPECTRAL-BASED CLASSIFICATION IN DISTINGUISHING VEGETATION USING VERY HIGH-RESOLUTION IMAGERY ACQUIRED FROM SUAS (DRONES). . Steve Petersen, Teresa Gomez*, Ryan Jensen, Grayson Morgan; Brigham Young University, Provo, UT

ABSTRACT

Remote sensing has long been used to monitor vegetation health and to detect change in rangeland ecosystems. Recently, small unmanned aerial systems (sUAS) have provided a tremendous improvement in image resolution and the ability to discriminate surface characteristics. The purpose of this research is to compare the effectiveness of object-based versus spectral-based classification in distinguishing vegetation (species, total cover), percent bare ground, litter, and rock using very high resolution imagery acquired from sUAS (drones). Images were obtained from sagebrush and annual grasslands in central Nevada (west of Elko). Flight missions were flown 100ft above ground level using automated flight paths, and individual images were processed into orthomosaics using Pix4D software. Features were classified using either spectral (supervised, maximum likelihood) classification or with eCognition (object based classification). Ground-based measurements were collected in the field to compare rangeland structure with output from either classification technique. Results indicate that very high resolution imagery can be effectively used to assess rangeland ecosystems that can aid in rangeland assessment and monitoring.

SCIENCE WITH A SELFIE STICK: PLANT BIOMASS ESTIMATION USING SMARTPHONE BASED &LSQUO;STRUCTURE FROM MOTION&RSQUO; PHOTOGRAMMETRY. Jonathan J. Maynard*¹, Jason W. Karl²; ¹USDA-ARS, Las Cruces, NM, ²University of Idaho, Moscow, ID

ABSTRACT

Significant advancements in photogrammetric Structure-from-Motion (SfM) software, coupled with improvements in the quality and resolution of smartphone cameras, has made it possible to create ultra-fine resolution three-dimensional models of physical objects using an ordinary smartphone. Here we present an open-source modeling framework for creating three-dimensional models of vegetation structure using smartphone video of a user-defined sampling space (e.g., 1 m²). Our main objective was to evaluate the accuracy of our SfM sampling method in predicting above-ground biomass relative to traditional estimation techniques. A series of permanent 1-m² quadrat sampling sites at the Jornada Experimental Range in southern New Mexico were used to develop the SfM sampling method, with each quadrat differing in its proportions of shrub vs. herbaceous vegetation composition. A smartphone mounted on a selfie stick was used to capture video of each 1-m² quadrat by circumnavigating it while moving the smartphone up and down to capture a range of image angles. Images were extracted from video frames at sampling rate of 4 frames per second and used to create densely reconstructed point clouds using open-source SfM software. Point clouds were georeferenced using a set of 3 control points located on the ends of a 0.25-m³ PVC corner frame placed at each site prior to imaging. Canopy volume was calculated for each point cloud using a foliar canopy approach, and used to model above ground biomass using published linear regression models. These results were compared to traditional nondestructive biomass estimates that were calculated by measuring the dimensions (cover and height) of individual plants or plant parts within each quadrat and converted to aboveground biomass using allometric equations. Preliminary results show a strong correspondence between measured and SfM modeled biomass. Our presentation will describe the details of this method and discuss its potential utility in increasing the accuracy and repeatability of field-based biomass estimation.

THE LAND-POTENTIAL KNOWLEDGE SYSTEM (LANDPKS): MOBILE APPS FOR SOIL IDENTIFICATION AND RANGELAND INVENTORY AND MONITORING

. Jeffrey Herrick*¹, Brandon T. Bestelmeyer², Joel R. Brown³, Ericha Courtright², Amy C. Ganguli⁴, Caitlin Holmes⁴, Jason W. Karl⁵, Nika Lepak⁶, Sarah McCord², Rachel Murph⁷, Jason Neff⁸, Amy Quandt⁴, Shawn W. Salley⁹; ¹USDA ARS, Las Cruces, NM, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³USDA-NRCS, Las Cruces, NM, ⁴New Mexico State University, Las Cruces, NM, ⁵University of Idaho, Moscow, ID, ⁶BLM, Boise, ID, ⁷USDA-NRCS, Denver, CO, ⁸University of Colorado, Boulder, CO, ⁹USDA-ARS, Las Cruces, NM

ABSTRACT

UTILIZING REMOTE SENSING TO GENERATE DISTURBANCE RESPONSE GROUP EXTENT AND VEGETATIVE STATE MAPS IN MLRA 25

. Lucas A. Phipps*, Tamzen Stringham; University of Nevada Reno, Reno, NV

ABSTRACT

Restoration of disturbed landscapes involves many considerations, generally relating to utilizing tools appropriate to a given ecological site. Soil and plant community information was gathered from an area near Midas NV, where dominant ecological site and related soil differs from minor components in a binary fashion. Loamy and Claypan ecological sites respectively, vary along an elevation and precipitation gradient through 8"-10", 10"-12" and 12"-14" precipitation zones. Spatial statistics from areas identified during field surveys will be utilized to build physical parameters for soil component extent at the site to determine soil component type. This information combined with ecological site change along aspect and elevation changes could provide spatial mapping of six ecological sites at landscape scale.

Vegetation sampling methods will also be compared to provide a locally accurate relationship between line point intercept, continuous line intercept (for shrub species), Daubenmire and ground based vertical imagery (GBVI) as provided by Open Range Consulting. GBVI can be utilized as training datasets to create land cover maps at a landscape scale. If a relationship is established between traditional plot scale vegetation metrics and classified land cover map pixels, then existing plot scale vegetation quantification datasets could inform landscape scale cover maps. This combined with enhanced ecological site maps as described above could provide a powerful landscape scale inventory or monitoring tool. Preliminary data will be presented and methods outlined in greater detail.

DEVELOPING A GRAZING STUDY VEGETATION MAP WITH REMOTE SENSING IN THE NORTHERN GREAT PLAINS

. Fatima G. Continanza*¹, Jennifer Muscha², Caitriana M. Steele³, Mark K. Petersen², Andrew J. Roberts⁴, Andres F. Cibils¹; ¹New Mexico State University, Las Cruces, NM, ²USDA-ARS Fort Keogh, Miles City, MT, ³USDA-ARS Jornada Exp. Range, Las Cruces, NM, ⁴USDA-ARS Fort Keogh, Miles city, MT

ABSTRACT

Accurate mapping of rangeland vegetation is critical in studies of livestock spatial distribution. Our objective was to develop a detailed vegetation map to help model the drivers of beef heifer grazing behavior on Northern Great Plains rangeland at the USDA-ARS Fort Keogh LARRL, Miles City, MT. Remote sensing technologies for mapping vegetation are less time-intensive than traditional on-the-ground techniques and cover larger areas. However, map classes should correspond with vegetation classes of interest, and the accuracy of a final map product should be known. Unsupervised classification of National Agricultural Imagery Program (NAIP) imagery guided ground data collection for training / testing supervised classification. Two line point transects were read at 15 sites within each class to determine plant cover and species composition. A 2 m belt transect was read along each line point transect to determine shrubs density. We discriminated four classes. Class 1: Badlands - sparsely vegetated hills; 57.7 ± 3.8 % bare ground (BG) and 998.7 ± 151.4 shrubs/ha. Class 2: Mixed grass prairie, dominated by cool season grasses; 13.7 ± 2.5 % BG and 227.5 ± 65.1 shrubs/ha. Class 3: Shrublands with mixed grass prairie understory; 27.1 ± 3.3 % BG and 765.1 ± 124.8 shrubs/ha. Class 4: Cool season grasses/legumes and shrubs; 8.5 ± 3.1 % BG and 1098.6 ± 268.4 shrubs/ha. Training data class separability was evaluated using Jeffries-Matusita and transformed divergence methods (ENVI software). Values of 1.6 – 1.9 indicated that classes were sufficiently separable. We used ENVI's maximum likelihood algorithm to classify combined NAIP, Landsat 8 Operational Land Imager and digital elevation datasets (spatial resolution sampled to 15 m). Testing data were used to develop a confusion matrix and to calculate Kappa. Overall accuracy was 89.1 % with Kappa = 0.8. We conclude that these results are acceptable for the scope of our study.

ECOLOGICAL SITE GROUPS: DEVELOPMENT AND APPLICATION BY THE BLM MILES CITY FIELD OFFICE. Cynthia A. Tusler*¹, Joshua Buckmaster², Reyer J. Rens²; ¹USDI-BLM, Miles City, MT, Terry, MT, ²USDI-BLM, Miles City, MT, Miles City, MT

ABSTRACT

The Soils and Range disciplines of BLM's Miles City Field Office (MCFO) developed Ecological Site groups independently and almost simultaneously. Each identified the need for a landscape unit useful at the Field Office and project management levels in response to the 2015 MCFO's Approved Resource Management Plan (ARMP). The ARMP directed using the Assessment, Inventory and Monitoring (AIM) Strategy for Land Use Plan (LUP) effectiveness monitoring. In addition, the ARMP integrated using data collected under the AIM Strategy to inform the Habitat Assessment Framework (HAF) for greater sage grouse. To implement ARMP requirements, the MCFO needed to develop a LUP monitoring design based on meaningful sample strata that fit the AIM Strategy and integrated many years of legacy monitoring data, some of which has been regularly collected since the 1960's. Data collected would inform the HAF, land health assessments, and reclamation success of surface disturbing projects across the MCFO. Grouping Ecological Sites by common soil properties and plant species proved to be the most ecologically relevant strata useful at different management scales and needs. The cooperative result was six strata representing the soils and vegetation across the MCFO's 2.7 million acres.

ECOLOGICAL STATE MAPS FOR THE SANTA RITA EXPERIMENTAL RANGE AND WALNUT GULCH EXPERIMENTAL WATERSHED. Wilma Renken*¹, Dan Robinett²;
¹USDA-NRCS, Tucson, AZ, ²Robinett Rangeland Resources LLC, Elgin, AZ

ABSTRACT

NRCS and Robinett Rangeland Resources LLC used existing soil survey and published Ecological Site Descriptions to map ecological states on the University of Arizona Santa Rita Experimental Range (SRER, 5500 acres) and the USDA ARS Walnut Gulch Experimental Watershed (7000 acres) in 2016-17. We developed protocols *a priori* for validating ecological sites and states as a basis for developing maps. Classification criteria for shrubs and exotic grass species were derived from long-term vegetation monitoring on the SRER and expert judgement. Other indicators for classification criteria were developed in the field and documented. From these protocols, we produced high resolution maps, revised state-and-transition models (STMs) with field keys. In addition, we identified research questions and made recommendations for additional monitoring to help NRCS and other land management agencies refine and develop STMs. In this presentation, we will illustrate maps of ecological states on Limy Slopes 12-16 inch pz ecological site (with suggested revisions). We used the best available information from the published literature and expert consensus to define states, disturbance regimes, transitions and threshold values. Topographic and climatic gradients as well as a recent history of land treatments (brush management) and plant invasions (exotic grass species) on the Limy Slopes ES offer abundant research opportunities for students and researchers at UA and ARS.

USING ESRI'S ARCGIS ONLINE AND COLLECTOR APP FOR TEACHING STUDENTS FIELD DATA COLLECTION AND MANAGEMENT. Marc R. Horney*; California Polytechnic State University, San Luis Obispo, CA

ABSTRACT

A number of apps have been developed recently that facilitate developing and deploying highly customizable data collection tools for use on cellphones and tablet computers. When networked, they allow teams of people to simultaneously and independently collect field data, which then can be uploaded to a common GIS repository. When managed well, this can help speed the collection, processing, and analysis of field data. This poster presentation shows how the Collector app for ESRI's ArcGIS Online web-based GIS is being used in an introductory principles of range management course at the California Polytechnic State University at San Luis Obispo to teach methods of field data collection and principles for organizing and managing field work. In this course, Collector and ArcGIS Online have (1) replaced Garmin GPS receivers and paper datasheets with students' smartphones for field data collection exercises in lab activities, (2) reduced the time required for processing results, and (3) created opportunities for learning about the design and management of data collection processes.

USING REMOTE-SENSING CAMERAS (RSC) AND GEOGRAPHIC INFORMATION SYSTEMS (GIS) TO PREVENT LIVESTOCK-CARNIVORE CONFLICT. Korinna Domingo¹, Diana Lakeland², Denise M. Peterson*³, Veronica Yovovich⁴; ¹Humboldt State University, Arcata, CA, ²Mountain Lion Foundation, Sacramento, CA, ³Mountain Lion Foundation, Salt Lake City, UT, ⁴Mountain Lion Foundation, Berkeley, CA

ABSTRACT

Advances in technology have provided new research tools for monitoring wildlife, but there is often a lag between when these tools are used and when they are applied to wildlife management. Here, we borrow newly common tools from the research world and suggest how they could be applied towards livestock-carnivore conflict mitigation. Remote-sensing cameras (RSC) and Geographic Information Systems (GIS) have become powerful tools for monitoring wildlife habitat use, changes in land cover, and wildlife movements. As RSC have become less expensive and more widely available, and new open-source GIS software has become accessible, these two tools are now within reach of the general public. We suggest a new way to combine RSC and GIS to create a proactive method for livestock-carnivore conflict prevention. We have sample data from RSC deployed in the Verdugo Mountains of Southern California and the Cosumnes River Preserve in the Central Valley to demonstrate how these methods could be used to prevent livestock-carnivore interactions. By mapping site-specific carnivore habitat use, livestock operators can project relative risk on their own property. With this specially tailored tool, they can plan grazing activities to avoid high-activity, and therefore high-risk, areas within their own grazing allotments. These promising tools, applied in a new way, could help minimize conflict on rangelands, protecting livestock, human livelihoods, and carnivores alike.

USING LANDSAT (HARPER) PROCESS FOR HERBAGE ASSESSMENTS OF BLUNT-NOSED LEOPARD LIZARD (BNLL) HABITAT STATUS

. Karen Doran*¹, Keith S. Guenther², Royce Larsen³; ¹Bureau of Land Management, Paso Robles, CA, ²Wildland Solutions, Brewster, WA, ³University of California Cooperative Extension, Paso Robles, CA

ABSTRACT

The HARPER process utilizes LANDSAT 8 imagery to accurately identify and map areas of low herbage and areas of undesirably high herbage in designated Blunt-Nosed Leopard Lizard (BNLL) core areas within the BLM's Carrizo Plain National Monument. The use of satellite imagery greatly increased the rangeland managers ability to assess, quantify and map herbage levels for BNLP core areas within each pasture. The cost of implementing a monitoring program using the HARPER process on a long-term basis is likely to be about equal to the current process of clipping and weighing herbage multiple times at random key areas. The HARPER process however yields significantly more useful information for rangeland managers and provides the ability to obtain good monitoring information for large areas with difficult access.

MAPPING INVASIVE SPECIES FOR MANAGEMENT

. Eric D. Sant¹, Timothy M. Bateman*², Gregg E. Simonds³; ¹Open Range Consulting, Preston, ID, ²Open Range Consulting, Logan, UT, ³Open Range Consulting, Park City, UT

ABSTRACT

Weeds and invasive plants from conifer to cheatgrass to knapweed and many others are rapidly degrading rangelands. Knowing the location, extent and cover of these is instrumental in managing and controlling their spread. Monitoring the effects of treatments is also crucial in managing these species. ORC has developed several tools that provide managers with this information.

ESTABLISHING NATIVE PRAIRIES FOR THE CONSERVATION OF GAME BIRDS AND WILDLIFE SPECIES

. leo A. herzberger*; graduate student grassland researcher, stephenville, TX

ABSTRACT

Leo Herzberger and James P. Muir

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ABSTRACT

The conservation of game birds and other wildlife species in Texas depends on landowners, who manage the bulk of the important habitats. When habitat is improved for game birds, other species that have similar habitat requirements benefit the overall health and functionality of Texas ecosystems. Our goal is to compare insect diversity and abundance in plots with different grassland mixtures. The project goal is to identify methods that most efficiently replace bermudagrass monocultures with diverse, native forb and grass species. The diverse grasslands should be a more favorable environment for wildlife, specifically grassland and savannah song and game birds. Our hypothesis in this component of the study is that a diverse mixture of native forbs and bunchgrasses will contain greater insect diversity and biomass. If this proves correct, it will encourage landowners and TPWD to replace bermudagrass monocultures with diverse grassland.

COW-CALF ENTERPRISE BUDGETS' ROLE IN EVALUATING THE ECONOMIC IMPACT OF SAGE-GROUSE CONSERVATION ON RANCHING OPERATIONS. Holly Dyer*, Tom Hilken, Holly Kirkpatrick, Kendall Roberts; University of Wyoming, Laramie, WY

ABSTRACT

Through USDA-NRCS funded sage-grouse habitat improvement projects, more than 1,000 ranchers have restored or conserved approximately 4.5 million acres, with private land conservation expected to reach 8 million acres by 2018. These conservation efforts have resulted in both reduced threats to the greater sage-grouse in 90% of the species' breeding habitat and have also benefited ranching operations by improving grazing and livestock water supplies. Existing research focuses on ecological effects, but the economic impacts to ranchers implementing sage-grouse habitat conservation plans remain unknown. The enterprise budget data across Major Land Resource Areas (MLRAs) within the sage-grouse core habitat presented in this poster are a crucial first-step to evaluating ranch-level economic impacts from sage-grouse conservation practices.

Researchers at the University of Wyoming gathered the data and produced the enterprise budgets which comprise all resources necessary for ranching production along with the rates of use and costs. These enterprise budgets help producers benchmark their operation's production and economic performance and estimate business decision outcomes. While a useful tool for producers, enterprise budgets also provide insight to researchers about representative operations within a region. Many Land-Grant Institutions already use enterprise budgets; however, most cow-calf enterprise budgets are outdated or nonexistent within the Western United States.

The team of researchers conducted 36 focus groups with ranchers from nine MLRAs (across seven states) to discuss how typical cow-calf ranches operate. Each focus group consisted of 3-5 ranchers and discussed herd characteristics and management activities, feed requirements, land use, variable costs, and physical resources needed for a production cycle. The data gathered from each focus group was applied to develop current, updated budgets for the public and to provide the baseline models for an economic study evaluating ranch-level impacts of sage-grouse habitat conservation practices.

CHARACTERIZATION OF SAGE GROUSE HABITAT IN PRIORITY WATERSHEDS.
Concetta C. Brown*; BLM, Ely, NV

ABSTRACT

In the field, technicians systematically traversed nine priority watersheds on roads by vehicle, observing vegetation communities and intermittently collecting GPS points. At each GPS waypoint, technicians identified dominant plant species (usually dominant shrub), documented average shrub height within a range of <6", 6" to 12", 12" to 24", 24 to 36", or > 36" and took one site photograph. Technicians took additional notes and drew line boundaries on field maps where there was visible demarcation between vegetation communities. The project mapped sage grouse habitat, including important communities such as black sage and Wyoming big sage, as well as other vegetation types in the area. The project area totaled 3,152,143 acres.

RECOGNIZING SITES FOR EFFECTIVE MITIGATION IN SAGE-GROUSE HABITAT
&NDASH; QUALITY SAGEBRUSH HABITAT VS QUALITY SAGE-GROUSE
LANDSCAPE. Brad Schultz*; UNR, Winnemucca, NV

ABSTRACT

There has been a proliferation of research about the biology of sage-grouse, their interaction with predators, and habitat requirements. Despite repeated statements that sage-grouse are a landscape species, habitat work often remains focused on plant community composition and structure at or near (<15-30 m) the nest site. Very little work has integrated nest site attributes with landscape level variables and processes, at the scale of the population management unit, which often covers hundreds of thousands of acres. The Montana Mountains in north-central Nevada have the greatest sage-grouse density in Nevada. A unique topography and geomorphology creates a mosaic of low and tall sagebrush species, interwoven with a high density of meadows, which collectively facilitates access to abundant forbs across short distances, from nest creation through late brood rearing. A comparison of the Montana Mountains with other areas inhabited by sage-grouse provides insight for prioritizing sites for mitigation or treatments to enhance sage-grouse populations. More big sagebrush (*Artemisia tridentata* species) on the landscape may or may not confer additional benefit for sage-grouse, as big sagebrush is only one component of a quality sage-grouse landscape. Too often, management focuses on quality sagebrush habitat, instead of understanding what creates a quality sage-grouse landscape. A suite of important habitat elements (to be presented) in close proximity to one-another are needed to have a quality sage-grouse landscape. When habitat elements important for sage-grouse are few and cannot be created/restored, the landscape is inherently less favorable for sage-grouse, regardless of the spatial extent of sagebrush ecological sites. All population management units in Nevada have sub-areas that either have or potentially could have the critical habitat elements in close proximity to one-another. Understanding the mix of these habitat elements helps prioritize projects or other mitigation measures for sage-grouse.

INFLUENCE OF CONIFER ENCROACHMENT ON BODY CONDITION OF GREATER SAGE-GROUSE

. Jordan C. Rabon*, Tracey N. Johnson; University of Idaho, Moscow, ID

ABSTRACT

Recent studies of conifer encroachment into sagebrush steppe have documented negative impacts on demographic rates of greater sage-grouse (*Centrocercus urophasianus*), but few specific mechanisms have been tested. Conifer densities may be positively related to predation risk, potentially altering time spent feeding by grouse, and closed conifer canopies can reduce floral food resources for sage-grouse. Altered habitat characteristics resulting from conifer encroachment may influence body condition for grouse, which has implications for individual fitness. Therefore, we evaluated the relationship of conifer canopy cover and stem density on body condition of sage-grouse during spring and summer of 2017 in southwestern Idaho. Body condition was assessed using body mass and plasma protein levels, both of which are influenced by protein consumption. We established two study sites from which we captured grouse, one with high levels of conifer encroachment and one with low encroachment. We captured male and female grouse, fitted females with VHF radio-collars, and collected habitat data at known-use locations. We collected 22 blood samples ($n=12$ hens and 6 males in high-encroachment sites and $n=4$ hens in low-encroachment sites). High-encroachment use locations were characterized by average conifer stem densities of 2.08 stems (± 1.56 , $n = 24$) at the 10-m scale, and 15.09 stems (± 15.32 , $n = 44$) at the 100-m scale. Low-encroachment use locations had no conifers within 10 or 100 m. Average plasma protein for females and males at high-encroachment sites was 4.99 g/dl (± 1.73) and 4.63 g/dl (± 1.17), respectively, and was 5.41 g/dl (± 1.47) for females at low-encroachment sites. We will evaluate relationships of mass, accounting for body size, with conifer canopy cover and stem density at multiple spatial scales. Results from this work will help elucidate specific mechanisms responsible for observed demographic rates and inform management efforts aimed at juniper removal in support of greater sage-grouse.

IMPLICATIONS OF GRAZING UTILIZATION LEVELS ON GREATER SAGE-GROUSE HABITAT IN CENTRAL IDAHO MESIC MEADOWS

. Keri York¹, Melinda Ellison*², Tracey N. Johnson¹; ¹University of Idaho, Moscow, ID, ²University of Idaho, Carmen, ID

ABSTRACT

Livestock management in mesic meadow pastures is of interest to industry, range managers, and conservationists because of the need to understand how best to accommodate livestock and wildlife. Greater sage-grouse (*Centrocercus urophasianus*) often use meadow pastures as brood-rearing habitat because of the availability of dietary forbs and insects, which are critical for juvenile sage-grouse survival and population maintenance. Understanding how grazing affects forbs that are important to sage-grouse can help develop management regimes that are effective for both livestock forage production and sage-grouse habitat.

This research addresses whether and how varying rates of livestock grazing utilization influences habitat and resource availability in meadow pastures that are potential brood-rearing habitat for sage-grouse. Bred heifer cattle (n = 75) were stratified by body weight into six mesic meadow pastures (~ 5.5 ac; n = 25, 20, 15, 20, 5, or 0), where stocking rates created a gradient of grazing utilization levels, and grazed for 25 d in July 2017. Data were collected in each pasture < 3 wk pre-grazing, < 1 wk post-grazing, and after an 8 wk regrowth post-grazing period to investigate the effects on availability and condition of preferred forbs and habitat characteristics, including measures of vegetation composition and structure, biomass, and grazing utilization level. Individual cattle body weights were measured at the beginning and end of the grazing period to evaluate cattle performance. To identify sage-grouse use of the trial area, pellet counts were conducted in each pasture.

Preliminary data from the first year of a multi-year study include: 1) pre- and post-grazing cover and biomass of forbs preferred by sage-grouse, and regrowth rates of preferred forbs; 2) short-term changes in species composition of preferred forbs; 3) horizontal and vertical structure of vegetation and forb canopy cover; and 4) performance and growth of heifer cattle.

WILD HORSE AND CATTLE GRAZING INFLUENCE ON GREATER SAGE GROUSE LATE BROOD REARING HABITAT

. Sebastian A. Tsocanos*¹, Jacob M. Burdick², Sherman R. Swanson³; ¹University of Nevada Reno, Reno, NV, ²UNR, Reno, NV, ³University of Nevada, Reno, Reno, NV

ABSTRACT

There is widespread agreement that many lentic meadows throughout Nevada are functionally at risk, threatening the long-term stability and possibly the short-term quality of habitat critical for greater sage grouse (*Centrocercus urophasianus*). What puts these riparian areas at risk, however, is often debated where cattle (*Bos taurus*) and federally protected wild horses (*Equus ferus caballus*) are both present. Our study examines the condition of 12 randomly selected meadows across Nevada where both cattle and wild horses graze within designated core sage grouse habitat. Large grazing animals can strongly influence the vegetation of wet meadows, affecting the quantity and quality of sage grouse preferred forb species such as dandelion (*Taraxacum officinale*), clover (*Trifolium sp.*), and yarrow (*Achillea millefolium*), and the abundance and structure of stabilizer species such as Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*), that are important for the long-term stability of meadow morphology, hydrology, and vegetation. In 2016 and 2017 we used trail cameras set to 5 minute intervals from mid-May through mid-September and 30 minute intervals over the winter to establish the timing, duration and number of grazers using each meadow throughout the year. We measured forage quality for sage grouse chicks based on the abundance, phenology, and succulence of their preferred forb species throughout the meadow and adjacent upland transition zone. In addition, we measured the short-term effects of grazers on the stabilizing vegetation along the central flow path through the meadow, specifically stubble height, alterations and stabilizing species cover and composition. This research will help improve our understanding of how current wild horse and cattle grazing management is effecting the quality of sage grouse late brood rearing habitat and the functioning condition of lentic meadows in diverse locations across Nevada.

REPTILES IN SAGEBRUSH ECOSYSTEMS: IS THE GREATER SAGE-GROUSE AN UMBRELLA SPECIES FOR LIZARDS AND SNAKES?

. Michelle I. Jeffries*, Robert Arkle, Justin Welty, David Pilliod; Department of Interior, Boise, ID

ABSTRACT

The diversity of lizards and snakes (Order Squamata) is particularly high in the arid and semi-arid rangelands of western North America and yet we know little about how these vertebrates will respond to changes in habitat associated with climate, invasive species, fire, fuel breaks, and natural resource management. Preliminary results suggest there are over 60 species of squamates within the range of the Greater Sage-grouse (*Centrocercus urophasianus*). Here, we utilize over 40,000 squamate occurrence records to identify which of these species are likely to be affected by habitat management actions aimed at improving or restoring habitats for sage-grouse by modeling current climate suitability within sagebrush ecosystems. Data on habitat management actions were derived from the Department of the Interior Conservation Efforts Database and Land Treatment Digital Library.

MANIPULATION OF ELK BROWSING TO IMPROVE RANGELAND VEGETATION
. Justin R. Taylor*¹, Jeremy G. Butler²; ¹Utah State University, Richmond, UT, ²Utah State University, Logan, UT

ABSTRACT

Manipulation of Elk Browsing to Improve Rangeland Vegetation

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In the Intermountain West, elk (*Cervus elaphus*) often occur in high numbers and in some cases over-use the best quality rangeland, potentially threatening other wildlife species such as mule deer (*Odocoileus hemionus*) and sage-grouse (*Centrocercus urophasianus*). Many shrub-dominated communities are in late successional stages, dominated by mature even-aged shrubs with little recruitment of young plants. Elk supplementation is an attractive option for reducing competition and for rejuvenating sagebrush stands through browsing since specific nutrients allow ungulates to ingest a greater proportion of low-quality and secondary compound-containing woody species like sagebrush. We offered choices of high-energy (granular molasses) and high-protein (soybean meal) supplements presented in 3 feeders stationed at three sites (one feeder per site, each feeder divided to contain each supplement) to encourage elk to visit and forage unproductive sagebrush stands. Elk preferred (3:1) molasses to soybean meal and a scan sampling technique using trail cameras revealed elk consuming supplement and browsing sagebrush on 42 ± 8.5 % and 57 ± 4.8 % of the scans recorded (N=435), respectively. Sagebrush utilization was indicated by recording pre and post treatment measurements of shrub canopy cover, sagebrush density along a 1 m wide belt transect with a distance of 100 m from the feeders with three transects at each site. Drop point measurements were taken along each transect post treatment. Three control sites were selected prior and all mentioned measurements were taken post treatment. In conclusion, manipulating elk foraging behavior through supplementation is a promising strategy to rejuvenate sagebrush stands and to enhance ecosystem services in the intermountain west.

Keywords: competition, browsing, preference, supplementation, sagebrush, behavioral manipulation.

INFLUENCES OF CATTLE GRAZING ON HABITAT ASSOCIATIONS OF THE BELDING'S
GROUND SQUIRREL. Kendra R. Allgier*, Tracey N. Johnson; University of Idaho, Moscow,
ID

ABSTRACT

Livestock grazing is a predominant use of grasslands, and its effects on grassland-associated wildlife are still being investigated. Wildlife responses to grazing vary among species and a better understanding of these responses is needed to determine appropriate grazing management that accommodates wildlife habitat and the domestic livestock industry. Burrowing mammals, such as ground squirrels (Family: Sciuridae), provide numerous ecosystem services in grasslands. However, ground squirrels are often viewed as agricultural pests and a large amount of resources are devoted to managing them as such. To better understand the relationship between livestock grazing and ground squirrel populations, we describe the effect of livestock grazing on the Belding's ground squirrel (*Spermophilus beldingi*) habitat. We evaluated vegetation and soil attributes at colony (n = 9) and non-colony (n = 6) sites within grazed (n = 12) and ungrazed (n = 4) pastures. Soils at colony sites were deeper ($x = 63.6 \text{ cm} \pm 6.67$) than at non-colony sites ($x = 55.8 \text{ cm} \pm 15.36$). At colony sites, visual obstruction was $x = 0.80 \text{ dm} (\pm 1.2)$ and vegetation height was $x = 35.02 \text{ cm} (\pm 0.95)$. At non-colony sites, visual obstruction was $0.87 \text{ dm} (\pm 0.63)$ and vegetation height was $50.20 \text{ cm} (\pm 1.28)$. We also evaluate soil and vegetation attributes at grazed and ungrazed study plots. Our results will contribute to understanding this species' response to livestock grazing and will help inform sustainable grazing practices in a northwest bunchgrass prairie in Oregon.

MANAGING OAK WOODLANDS FOR WILDLIFE. Bonnie Eyestone*; Point Blue Conservation Science, Visalia, CA

ABSTRACT

Oak woodlands are perhaps the most important for wildlife biodiversity and conservation. More than 300 species of wildlife depend on oak woodlands at some stage in their life history, but oak woodlands face threat by urbanization and agricultural conversion. Today only two-thirds of California's original oaks woodlands remain. Point Blue Conservation Science has partnered with the USDA's Natural Resources Conservation Service (NRCS) to encourage and foster private land stewardship to improve the habitat quality of privately owned oak woodlands while maintaining the economic viability of these working lands

This unique partnership allows Point Blue biologists partner with NRCS conservationists and ranchers to evaluate wildlife resource concerns and guide management decisions to meet their objectives while maintaining or improving habitat for wildlife. For example, Point Blue Partner Biologists provide technical assistance on habitat needs for a wide range of taxa, from leaving a certain density and/or variety of trees and shrubs on the landscape, which trees to select for removal, what snags to maintain, and where to create brush piles. For example, Ash-throated Flycatchers and Oak Titmouse, among other bird species, prefer oak woodlands with higher canopy cover for nesting; bats use sloughing bark on dead and dying trees to roost; and man-made brush piles or jack-strawed small diameter living trees can provide immediate habitat for ground-nesting or understory nesting birds while providing the shrub layer time to re-establish. Additionally, water quality and riparian habitats can be improved through the creation of controlled-access riparian pastures and off-stream water systems for livestock.

There is an array of conservation practices that land managers can utilize to meet their objectives and provide multiple habitat elements for wildlife. Using the best available science to manage oak woodlands for wildlife will, in turn, provide a more productive landscape and a healthy, resilient ecosystem for the future.

DEVELOPING EASTERN AND RIO GRANDE WILD TURKEY HABITAT SUITABILITY MODELS FOR NORTHEAST TEXAS

. Darrion M. Crowley*¹, Humberto P. Baldivieso², William P. Kuvlesky Jr.³, Alfonso Ortega-Santos³, Leonard A. Brennan³, Nicholas R. Kolbe⁴; ¹Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ²Texas A&M University-Kingsville, Kingsville, TX, ³Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ⁴Texas Military Department, Austin, TX

ABSTRACT

Developing habitat suitability models can be useful to help in estimating population abundance of Rio Grande (*Meleagris gallopavo intermedia*) and Eastern (*Meleagris gallopavo silvestris*) wild turkeys as well as identifying habitat for their wintering sites. Our study sites are located on Fort Wolters (Mineral Wells, TX; Rio Grande wild turkeys) and Camp Maxey (Paris, TX; Eastern wild turkeys). We focused on three main factors develop these models: food, water, and cover. For the food factor, we identified areas with hard mast (e.g. acorns, nuts) during winter, available corn (wildlife feeders), and favorable seed types (grasses). For the water factor will identify water sources and created 800 m buffers around them. Finally, we quantified areas dominated by woody cover for predator avoidance and roosting habitat. Previous studies show wild turkeys use woody vegetation habitat during winter to escape predators as well as the possibly of inclement weather. With these three factors we will be able to develop models that can help us quantify the spatial distribution of habitat for wild turkeys. These models will also be useful to integrate with abundance data to optimize surveying methods for wild turkey abundance in these two study sites.

ASSESSING HABITAT QUALITY FOR FOUR GRASSLAND SONGBIRD SPECIES OF CONCERN IN NORTHERN MIXED-GRASS PRAIRIE. John Pulliam*¹, Lance B. McNew¹, Marisa Sather²; ¹Montana State University, Bozeman, MT, ²Partners for Fish and Wildlife, Glasgow, MT

ABSTRACT

Grassland bird populations have declined faster than any other avian guild in North America during the past 40 years. In northern Montana, four species are experiencing dramatic population declines, Baird's Sparrow (*Ammodramus bairdii*), Sprague's Pipit (*Anthus spragueii*), Chestnut-collared Longspur (*Calcarius ornatus*), and McCown's Longspur (*Rynchophanes mccownii*). All four of these birds are classified as species of concern in Montana. The primary threat to grassland birds is habitat degradation and fragmentation due to conversion of native prairie for farmland, energy development, and exurban development. Most of the remaining native prairie is maintained for cattle grazing, either on private ranches or on public land leased to private ranchers. Informed management of native prairie has the potential to maximize habitat value for vulnerable species. However, the necessary information needed to design effective management strategies are lacking. In 2017, we began a 2-year study to evaluate relationships between avian abundance, nest density, and nest survival at management focused spatial scales and their relationships to local and pasture-level vegetative conditions. We conducted 150 fixed-radius point-counts at 50 randomly-selected 9 ha plots (3 visits per site) with similar forage productivity during 21 – 26 May to estimate local abundance. We subsequently conducted 2–3 nest searches of each plot using standard rope-dragging techniques to estimate nest density. Discovered nests were monitored to estimate daily nest survival. We modeled these parameters as functions of multi-scale habitat conditions including visual obstruction, biomass, and percent cover and heights of different vegetative classes. We will present information from our first year of study evaluating: the effects of local and pasture-level vegetation conditions on nest survival for our focal species, the effects of vegetation composition and structure on bird abundance and nest density, and the functional relationships among abundance, nest density, and nest survival of sentinel grassland birds in northern mixed-grass prairie habitat.

MULTI-SEASON OCCUPANCY MODELING AND DEVELOPMENT OF LONG-TERM AVIAN MONITORING PROTOCOLS AT QUIVIRA NATIONAL WILDLIFE REFUGE.
Kyle W. Schumacher*, Liz E. Tanner, Mitchell J. Greer, William J. Stark; Fort Hays State University, Hays, KS

ABSTRACT

In 2014, Quivira National Wildlife refuge in central Kansas initiated a collaborative research project with Fort Hays State University to develop long-term monitoring protocols. As part of this monitoring effort breeding bird point-count surveys focused on grassland bird species were established. Survey transects contained 30 observation points arranged to investigate grassland bird community associations with habitat classifications as defined by the US Fish and Wildlife Service's National Vegetation Classification System (NVCS). Surveys yielded 14,061 observations of 48 species in 2016 and 16,304 observations of 57 species in 2017. Multi-season occupancy modeling and nonmetric multidimensional scaling were conducted to assess bird community relationships to vegetation characteristics at each observation point. As the project progresses, additional analysis of bird communities will be conducted using remote vegetation sensing and the addition of habitat management covariates.

LIVESTOCK AND WILD HORSE GRAZING IN GREATER SAGE-GROUSE LATE BROOD MEADOW HABITAT. Sabrina M. McCue*, Sara McBee, Sherman R. Swanson, Mariah Evans, Jim Sedinger; University of Nevada, Reno, Reno, NV

ABSTRACT

Nevada's meadows provide juvenile sage-grouse with protein-rich forbs, especially during low precipitation years. Livestock and wild horses favor meadows over uplands during hot summer months for water, forage, and thermoregulation. Proper functioning condition of meadows ensures ground water availability to forbs and erosion resistance/resilience under grazing and high flow events. Improper grazing often leads to decreased meadow functioning condition. Well managed grazing can improve habitat conditions for sage-grouse, promoting young nutrient-rich growth. Successful grazing management in riparian areas often applies tools that allow recovery after grazing. There are many tools in the livestock management toolbox. There are currently no effective tools for managing wild horses. This study examines effects of wild horse and livestock grazing on vegetation and hydrologic response variables with regard to prevailing guidelines for sage-grouse late-brood rearing habitat in meadows. The goal is to identify grazing patterns leading to resilient or degraded lentic riparian habitats. Draft Inventory and Monitoring in combination with Designated Monitoring Area Methods for Lentic Wetland Areas (Dickard et al.) were modified and applied. Sage-grouse habitat indicators were assessed using methods established in the Sage-grouse Habitat Assessment Framework (Stiver et al.2015). Wild horse and livestock grazing activity captured from March to November by automatic cameras documented actual use. Such data and analyses are offered to move the wild horse management conversation beyond its current impasse and develop management concepts for livestock and wild horse use leading to successful management of lentic riparian resource values and habitat conditions for sage-grouse. To date, no systematic study of this type or issue has occurred across Nevada's riparian meadows.

Keywords: Management tools, proper functioning condition, lentic methods, sage-grouse, late brood habitat

EFFECTS OF PREVIOUS MECHANICAL DISTURBANCE ON NATIVE PLANT AND SMALL MAMMAL COMMUNITIES IN THE SONORAN DESERT. Felix Ayala-A.*¹, Alejandro E. Castellanos-V.², Ana Bertha Martinez-D.¹, Reyna A. Castillo-G.²; ¹Universidad de Sonora, Santa Ana, Sonora, Mexico, ²Universidad de Sonora, Hermosillo, Sonora, Mexico

ABSTRACT

Brush management techniques are widely applied on rangelands for multiple objectives; two common objectives are to increase forage production for livestock and to maintain a healthy wildlife habitat. Our objectives were to determine the effects of previous disturbances and the establishment of exotic grasses on native herbaceous vegetation and small mammal abundance and species richness on a desert scrubland community. The study was conducted in the southern end of the Sonoran Desert in the state of Sonora, México. Three pairs of 2 ha sites were selected for sampling: in each pair of sites, one was previously cleared by mechanical means and seeded with buffelgrass 27 years before and the other did not have previous mechanical disturbance (control). For vegetation sampling, response variables included canopy cover of woody plants, canopy cover of herbaceous plants and species richness; for small mammals, Sherman traps were used to evaluate abundance and species richness. Total canopy cover of herbaceous plants, litter, and bare ground resulted similar between treatments. In terms of relative canopy cover of herbaceous vegetation, results show higher percentage of buffelgrass (80 ± 15) on previously disturbed and seeded sites in comparison to the undisturbed treatment (18 ± 15); on the other hand, higher percentage of native grasses on the undisturbed sites in comparison to the previously disturbed and seeded treatment with 77% and 18%, respectively. The most abundant specie of small mammals was the *Dipodomys merriami* for both treatments; five different species of small mammals were found on the previously disturbed and seeded treatment in comparison to four species on the undisturbed sites. The results of the previous mechanical and seeding management practices on the desert scrubland community reflect a dominance of buffelgrass, while in areas with no previous mechanical disturbance is still dominated by native species. There is concern that disturbances associated with mechanical practices could facilitate the invasion of exotic grasses.

DIFFERENCES IN SOIL AND VEGETATION CHARACTERISTICS ON PASTURE LANDS INVADED BY MESQUITE AND PRICKLY PEAR.

. Douglas R. Tolleson*¹, Robert Moen¹, Nick Garza¹, Barron Rector², Colton Belew¹; ¹Texas A&M Agrilife Research, Sonora, TX, ²Texas A&M Agrilife Extension, College Station, TX

ABSTRACT

As demographics of land ownership change, former agricultural lands often become pasture invaded by mesquite (*Prosopis glandulosa*) or prickly pear (*Opuntia spp.*). Whether managed for agricultural or conservation purposes, there is a need to better understand the ecology of these lands. Our objective was to describe soil and vegetation characteristics in a series of studies evaluating rangeland management practices in southwest Texas. At two locations, we collected soil organic carbon (OC), organic matter (OM), plant frequency, dry weight rank, and herbaceous above ground standing crop from six ~2 ha plots within older (basal diameter 28.1 ± 4.3 cm) or younger (basal diameter 12.3 ± 2.1 cm) mesquite sites. Differences in soil and vegetation were determined by analysis of variance. At location 1, dominant plant species were *P. glandulosa*, *Nassella leucotricha*, and *Opuntia spp.* in the older, and *N. leucotricha*, *Bothriochloa ischaemum*, and *Opuntia spp.* in the younger mesquite plots respectively. Dry matter standing crop was $1,600.0 \pm 176.9$ kgs/ha in the older, and $3,533.7 \pm 467.4$ kgs/ha in the younger mesquite sites ($P < 0.01$). Soil OC ($P = 0.06$) was $1.62 \pm 0.08\%$, and $1.42 \pm 0.07\%$ in the older versus younger mesquite sites respectively. Soil OM values ($P = 0.06$) were $2.79 \pm 0.15\%$ and $2.43 \pm 0.12\%$. At location 2, dominant plant species were *N. leucotricha*, *P. glandulosa*, and *Opuntia spp.* in both mesquite sites; dry matter standing crop ($P > 0.1$) was 1189.6 ± 119.8 kgs/ha (older) and 1067.1 ± 122.9 kgs/ha (younger). Soil OC ($P < 0.01$) was $4.49 \pm 0.29\%$ versus $2.34 \pm 0.05\%$ and soil OM ($P < 0.01$) was $7.74 \pm 0.49\%$ versus $4.04 \pm 0.09\%$ in older versus younger mesquite sites respectively. Range managers will need to consider site history, current characteristics, and objectives in management decisions on former agricultural lands.

DIFFERING VEGETATION RESPONSES ON MOIST FLOODPLAIN ECOLOGICAL SITES FOLLOWING THE RE-WATERING OF THE LOWER OWENS RIVER

. John U. Hays*; Los Angeles Department of Water and Power, Bishop, CA

ABSTRACT

The Lower Owens River was diverted into the Los Angeles Aqueduct in 1913 leaving the majority of the 62 mile river channel devoid of flowing surface water for 93 years. Since 2006, controlled flows have been released into the river channel as part of the Lower Owens River Project. Livestock utilization limits were also implemented along the riparian corridor beginning in 2006. Long term trend transects were established on the adjacent moist floodplain sampling plant frequency and shrub cover. The principle objectives for the trend monitoring program were to monitor vegetation community response with the return of flows and track long term livestock grazing impacts on these sites. The majority of transects had been consistently read for the past 14 years. Twelve of the 46 transects were situated in the former 'dry reach' of the river which lacked perennial surface flow for 93 years. The remaining 34 transects were located in river sections that had received a minimal, continual flow beginning in the 1980's or received water from spring flow. Long term monitoring results documented two distinct trajectories. Portions of the river which historically received some water developed into larger grass dominated meadows whereas the 'dry reach' portions developed communities populated by *Atriplex torreyi* and *Bassia hyssopifolia*. The absence of coincident meadow development was likely caused by dissimilar successional starting points between the two sites. In this case more time may be required for meadow development in the 'dry reach'. Other factors that may be driving trajectories of the two communities are channel development, depth to groundwater, historical and current disturbance regimes.

MULTIPLE SPECIES OF SEED-FEEDING CATERPILLARS ATTACKING JUNIPER BERRIES REVEALED BY DNA SEQUENCE DATA. Kirk C. Tonkel*¹, Lindsay A. Dimitri¹, Veronica S. Kirchoff², William S. Longland¹, Brian G. Rector¹; ¹USDA-ARS, Reno, NV, ²University of Nevada-Reno, Reno, NV

ABSTRACT

Expansion of native junipers is altering landscapes in the western U.S., prompting extensive management efforts to counter this spread and the negative effects on impacted ecosystems. Our studies investigating sources of seed mortality in both western (*Juniperus occidentalis*) and Utah juniper (*Juniperus osteosperma*) have revealed a number of seed-attacking arthropods capable of destroying a large percentage of the seed crop of an infested tree. One of the most commonly encountered insects at collection sites in northeastern California and northwestern Nevada are fruit-boring cosmet moths (Cosmopterigidae) in the genus *Periploca*. DNA analysis of insect adults and immatures both reared and dissected from juniper berries was carried out to definitively associate *Periploca* adults with their immature stages and screen for parasitoid DNA to reveal parasitoid-host relationships. Sequence data for *Periploca* adults and larvae has revealed the presence of four genetically distinct varieties of these moths attacking juniper berries. Three of these four varieties have been identified as *P. atrata*, commonly referred to as the juniper cone moth, *P. juniperi*, and *P. serrulata*. Many details regarding the habits of several of these species of *Periploca* encountered in western and Utah juniper were not known when these moths were initially described. Berry dissections, rearing efforts, and DNA sequence data have linked numerous parasitoids to juniper berry-infesting *Periploca*. These findings help to develop a more refined understanding of the arthropod community influencing juniper seed production, which can provide potentially valuable tools for the ongoing management of juniper expansion.

PLANT LITTER EFFECTS ON CHEATGRASS EMERGENCE AND GROWTH IN MOLLISOL AND ARIDISOL SOILS. Jacob Ellis*¹, Camie M. Dencker¹, Benjamin Sullivan¹, Beth A. Newingham²; ¹University of Nevada, Reno, Reno, NV, ²USDA-ARS, Reno, NV

ABSTRACT

Bromus tectorum is the most common invasive grass in the Great Basin and is a major contributor to the increasing frequency of rangeland fire in the region. Previous research has shown that plant litter can promote *B. tectorum*, presumably by creating favorable conditions for germination and growth. We examined how varying plant litter depths (0, 1, 3, 5, and 7 cm) affected emergence and growth of *B. tectorum* in Mollisol and Aridisol soils. We calculated emergence and survival rates and used plant height, number of leaves and biomass as metrics of plant growth. After twelve weeks of growth, we found that emergence, survivorship, plant height, and number of leaves was greatest in the Mollisol soil type and increased with litter depth within soil treatments. Plants grown in Aridisol showed a much stronger litter response, where germination, survivorship, plant height, and number of leaves were dramatically lower with no litter. Litter responses became more pronounced after we reduced plant watering during the second half of the experiment. These results support the hypothesis that litter has positive effects on *B. tectorum* establishment and growth and that these litter effects increase with litter depth, even when the litter is especially thick. Litter depth was more important to *B. tectorum* emergence and growth in a high clay soil (Aridisol) than a high organic matter soil (Mollisol). Our results suggest that litter is important for *B. tectorum* emergence and growth. However, these patterns may not be consistent across all landscapes due to different soil types. Considering litter may promote *B. tectorum*, managers should consider possible litter removal treatments in high priority areas and avoid treatments that may increase litter, such as cover crops.

PLANT-SOIL RELATIONSHIPS OF EUROPEAN AND NORTH AMERICAN
POPULATIONS OF MEDUSAHEAD: A RECIPROCAL TRANSPLANT STUDY

. Robert Blank*¹, Tye Morgan¹, Edith B. Allen²; ¹USDA-ARS, Reno, NV, ²Professor Emeritus,
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ABSTRACT

Reciprocal transplant protocols were utilized to decipher factors important in the invasion ecology of medusahead. Medusahead seeds from three European (native) sites (Turkey, Greece, and Bulgaria) and three North American (invasive) sites in northeastern, CA (Alturas, Bull Flat, and Little Valley) were sown in all six soils. Pre-plant invaded soils had significantly greater bicarbonate-extractable phosphorus, cation exchange capacity, extractable calcium and manganese availability than native soils. Following harvest, soils and plant tissues were analyzed for macro- and micro-nutrients. Plants grown from North American seed had significantly more above-ground biomass than native plants, but only when grown in North American soils. Plants grown from European seeds had significantly greater shoot/root mass ratios, tissue N, tissue P (only in North American soils), tissue K, and tissue Ca than plants grown from North American seeds. Plants grown from North American seeds had significantly greater tissue Mn than plants grown from European seeds. Our data suggest that greater fertility of North American soils is a factor in explaining its invasiveness. We hypothesize that differences in nutrient uptake between North American and European populations of medusahead are due to evolution driven by inherent differences in soil fertility.

RESEARCH IN PROGRESS: QUANTIFYING PLOT-LEVEL CANOPY INTERCEPTION OF RAINFALL BY MOUNTAIN BIG SAGEBRUSH . Devon K. Snyder*; University of Nevada Reno, Reno, NV

ABSTRACT

In conifer-encroached areas, one mechanism thought to contribute to the loss of understory species is the interception of precipitation by the increasing tree canopy. Effective precipitation may be reduced in rangelands encroached by western juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus monophylla*) since trees have a large, dense canopy that can capture precipitation and allow it to evaporate before it can reach the soil surface. Recent research has quantified rainfall and snow interception by pinyon and juniper species, but little research has been conducted on the other vegetation in these systems, including big sagebrush (*Artemisia tridentata*). Understanding interception loss from understory vegetation is necessary to determine if pinyon and juniper in fact influence effective precipitation. To measure rain interception of mountain big sagebrush in the field, we are simulating storms over five 1.5 by 3 meter plots located in the Desatoya Mountains in central Nevada. Plants in each plot will be manipulated to test known canopy cover levels of 50%, 35%, and 20%. Each cover level will receive a minimum of 4 different storm intensities. Preliminary data from 11 rain simulations indicate that stands of sagebrush with approximately 50% canopy cover intercepts between 9.0 and 39.4% of rain storms ranging from 1.6 mm to 17.1 mm intensities. For comparison, plot-level interception for pinyon and juniper with 38% canopy cover measured in the same canyon intercepted 29.2% and 30.8% for 5 mm and 20 mm storm intensities, respectively. Scaling interception loss to a landscape level will aid in understanding the effect of various land management practices on soil moisture, groundwater recharge, and surface water availability.

VEGETATION DYNAMICS AT A COLD DESERT SITE: 35,000 YEARS OF VEGETATION TRADEOFFS. Robin J. Tausch*¹, Robert S. Nowak², Cheryl L. Nowak²; ¹Rocky Mountain Research Station, Retired, Reno, NV, ²University of Nevada, Reno, RENO, NV

ABSTRACT

Abundance and composition for the plant functional groups of trees, shrubs, grasses, and forbs covering 154 plant taxa from 52 fossil woodrat midden strata and covering the last 35,000 years were used to study temporal changes in the vegetation - climate relationships on a western Great Basin study site. Middens were from 80 km² of mountainous terrain covering 800 m in elevation and a range of topographic conditions. Six time periods were identified, each with relatively stable taxa abundance, taxa composition, and climate conditions. There were rapid, significant changes in both vegetation and climate during the five transitions between the six time periods. The most important temporal changes in plant taxa composition that have occurred in response to these climate changes are significant functional trade-off relationships between declining forb and increasing shrub composition, particularly as global climate warmed over the last 15,000 years. These patterns represent long-term changes in climate and vegetation that have important implications for the Great Basin. When European settlers reached the Great Basin the native herbaceous species in its plant communities were already impacted by 15,000 years of increasing stress from the combination of climate change and increasing woody dominance. During the last century the functional trade-offs, and the associated increase in woody dominance, have facilitated the establishment and dominance of invasive species in Great Basin plant communities. The increase in global temperature, the land use and management practices, and the establishment of exotic plant species over the last century have added to the decline of native herbaceous species and permanently changed community dynamics. Great Basin plant communities will continue to experience an increasing rate of change in vegetation composition and dynamics, with increasing management challenges, as global temperatures increase through the rest of this century and beyond.

PURSUIT OF INTEGRATED LENTIC RIPARIAN MANAGEMENT FOR SAGE-GROUSE, LIVESTOCK, AND WILD HORSES

. Sherman R. Swanson*¹, Sabrina M. McCue¹, Sara McBee¹, Sebastian Tsocanos², Jacob M. Burdick², Charlene Duncan¹, Brad Schultz³, Kent J. McAdoo⁴; ¹University of Nevada, Reno, Reno, NV, ²UNR, Reno, NV, ³UNR, Winnemucca, NV, ⁴UNR, Elko, NV

ABSTRACT

We have learned to apply state and transition concepts to prioritize objectives for rangeland management. In riparian areas, integrated riparian management begins with riparian proper functioning condition assessment to locate functional at risk conditions. Important resource values such as sage-grouse late-brood-rearing habitat aid in prioritizing objectives. To apply management of mixed use by wild horses and permitted cattle, managers must work together to understand the questions: Are lentic riparian areas at risk of losing riparian functions needed to sustain forage for horses, cattle, and sage-grouse? If so, what is it about current conditions and management that puts specific areas and riparian functions at risk? Is managed grazing useful for stimulating optimum forb diversity, abundance, and phenology for sage-grouse chicks? Are grazing issues best understood through intensity, duration, or season of use? Are duration and season of recovery periods useful riparian management tools for wild and free-roaming horses? If we are to sustain lentic riparian areas for forage and habitat using adaptive management, how should they be efficiently monitored? To address these questions we assessed riparian functional conditions and adapted draft Bureau of Land Management lentic monitoring and Habitat Assessment Framework (HAF) methods to study lentic areas in priority sage-grouse habitat and herd management areas in many different allotments. Methods emphasized the greenline (thalweg) where water flow and erosion issues are most likely. We hypothesize that allotments and herd management areas where large animal use periods in lentic riparian areas are short and varied in season, or where the amount of riparian use is only moderate will have less risk and better sage-grouse habitat.

INITIAL INVESTIGATIONS INTO MOVEMENT PATTERNS AND RANGELAND IMPACTS OF WILD HORSES IN WYOMING'S RED DESERT. Jacob D. Hennig*, John D. Scasta, Jeffrey L. Beck; University of Wyoming, Laramie, WY

ABSTRACT

Information concerning the spatial ecology of free-roaming horses and burros in the United States is severely lacking. Better understanding movement patterns and resource selection of wild equids is critical for improving management of these controversial animals. To improve such knowledge, we initiated a GPS-tracking project on wild horses in the Red Desert of Wyoming. In 2017, we fit 30 adult mares with GPS collars in the Adobe Town Herd Management Area (HMA) of southcentral Wyoming. The Adobe Town HMA has an area of 1,295 m² (500 mi²) that contains large swaths of private land and crucial habitat for multiple wildlife species. This area is characterized as high-elevation desert, restricted by precipitation and includes sagebrush (*Artemisia* spp.) and saltbush (*Atriplex* spp.) communities, and juniper (*Juniperus* spp.) dominated ridges. Here we present preliminary data on daily movement rates, mean home ranges, and utilization distributions of wild horses in the Red Desert. We discuss how utilization distributions overlap with sociopolitical boundaries such as private land, neighboring HMAs, adjacent states, and important wildlife habitat. We present additional findings on how vegetation structure and composition changes along a gradient of horse utilization. We also discuss future directions of our project, which includes an examination of horse impacts on sympatric wildlife and livestock species and how horse home ranges and movement patterns may shift in response to removal gathers.

WILD HORSES, LIVESTOCK, AND WILDLIFE USE OF SPRINGS AND RIPARIAN AREAS ON THE DEVIL'S GARDEN. Laura K. Snell*¹, David Lile², Roger Baldwin³; ¹University of California, Alturas, CA, ²UCCE, Susanville, CA, ³University of California, Davis, CA

ABSTRACT

In Modoc County, located in northeastern California there is a unique rangeland area heavily populated by wild horses and managed primarily by US Forest Service known as the Devil's Garden. Wild Horses have significantly exceeded appropriate management levels in recent years and expanded their range outside of the herd management area and on to private and tribal lands. This increase has prompted concern about resource degradation particularly associated with spring areas. In otherwise arid sage steppe rangelands springs provide critical watering sources as well as wildlife habitat for sage grouse, deer, elk, pronghorn, and other wildlife. Our objective is to quantify the relative frequency, duration, and timing of use by horses, permitted livestock, and wildlife at spring locations. In turn, we assess to what extent there is competition between species for watering sites. We also correlate how varying levels of horse and/or livestock use affects spring site vegetation and riparian health standards. Ten representative study locations were selected on the Devil's Garden and motion sensitive cameras were deployed at each location for 14-day sampling periods during the spring, summer and fall of 2015-2017. All photos were visually assessed to record species present, number of each species, and the time, date, and location of the observation. We present preliminary occupancy data, as well as results of corresponding vegetative cover, plant community, and bank alteration sampling. Implications for management and on-going research are discussed.

DRIVERS OF VEGETATION CHANGE IN HORSE MANAGEMENT AREAS IN THE GREAT BASIN. Brittany S. Barker*¹, David S. Pilliod¹, Collin Homer²; ¹US Geological Survey, Boise, ID, ²USGS, Boise, ID

ABSTRACT

Sagebrush ecosystems in the Great Basin have experienced extensive degradation from exotic invasive plants, altered fire frequency, urban development, climate change, and grazing practices. Feral horses may also negatively influence these ecosystems, but their ecological impact has been investigated in only a handful of studies. We compared vegetation change through time inside and outside of horse management areas (HMAs) in the northwestern corner of the Great Basin by analyzing sagebrush vegetation and soil components derived from Landsat imagery (1985–2016) together with historic (1977–1982; Soil Vegetation Inventory Method) and recent (2011–2016; Assessment Inventory and Monitoring) field plot data collected by the Bureau of Land Management (BLM). Preliminary results suggest that BLM allotments inside of HMAs had a higher abundance of bare ground and a lower abundance of herbaceous and sagebrush cover compared to allotments outside of HMAs across all years. Decreases in bare ground in certain years were accompanied by corresponding increases in herbaceous cover across all allotments. We found significant decreases in the prevalence and proportion cover of native functional groups, and significant increases of exotic functional groups, both inside and outside of HMAs. However, increases of exotic functional groups were particularly large inside of HMAs. We identified the potential drivers (e.g., fires, climatic shifts, grazing, and feral horse and burro use) of observed vegetation changes with multivariate models. This research will provide insight into the causal factors of ecological change in the Great Basin and can inform decisions regarding management of HMAs.

THE RELATIONSHIP BETWEEN FREE-ROAMING HORSES AND PRONGHORN POPULATIONS IN RIPARIAN AREAS OF NORTHWESTERN NEVADA

. Steven L. Petersen*¹, Amy J. Gooch¹, Gail H. Collins²; ¹Brigham Young University, Provo, UT, ²US Fish and National Wildlife Service, Lakeview, OR

ABSTRACT

Free-roaming horses (*Equus ferus caballus*) require consistent surface water to sustain healthy herds throughout the arid and semi-arid regions of western North America. Understanding the influence of horses on riparian habitats and associated wildlife populations is critical for establishing appropriate horse and riparian habitat management strategies. The purpose of this study is to quantify the spatial distribution of free-roaming horses across a sagebrush ecosystem, and to characterize the interaction between horses and pronghorn (*Antilocapra americana*) within limited riparian areas. This study was conducted at the Sheldon National Wildlife Refuge, located in northwest Nevada. Twelve mares were collared representing 10 bands using Lotek 3300 GPS collars and tracked between 3-24 months. Coordinate data acquired from each collar was used to determine the amount of time horses spent at water sources in relation to time spent traveling within band home-ranges. The behavioral response of pronghorn when horses were present was compared to pronghorn behavior when horses were absent. A behavioral ethogram for pronghorn was created consisting of 166 observation sessions, 492 hours of observation, and 12,186 instances of pronghorn behavior. For every 1m increase in distance from horses, pronghorn foraging increased by 0.6%. Most (>70%) of horse-pronghorn interactions were negative. In areas with limited water availability, constructive horse management is critical for protecting riparian habitats and assessing potential pronghorn impacts.

EFFECTS OF FERAL HORSES ON SOILS AND VEGETATION IN SAGEBRUSH AND RIPARIAN COMMUNITIES. Chad S. Boyd*¹, Kirk W. Davies²; ¹USDA-ARS, Burns, OR, ²USDA - Agricultural Research Service, Burns, OR

ABSTRACT

Feral horses (*Equus caballus*) are a non-native grazer in North America, South America, and Australia that are relatively unmanaged. This has led to concern about their potential to damage natural resources. Information about their influence on vegetation and soil characteristics in semi-arid rangelands and riparian areas has been limited by confounding effects of grazing by livestock and a lack of empirical manipulative studies. We compared plant community and soil surface characteristics in feral horse grazed areas and ungrazed exclosures at five sagebrush (*Artemisia*) steppe and riparian communities in northern Nevada. In the sagebrush steppe, horse grazed areas had lower sagebrush density and plant diversity, greater soil surface compaction, and lower soil aggregate stability compared to ungrazed areas. In the riparian communities, feral horse grazed areas had 7-fold greater bare ground, reduced litter and visual obstruction, and increased rush density compared to ungrazed areas. The cumulative effect of feral horses on soil characteristics in uplands suggests that they may negatively affect ecological function by increasing the risk of soil erosion and potentially decreasing availability of water for plant growth. The two-fold increase in sagebrush density with horse exclusion suggests that feral horses may limit sagebrush recruitment and thereby negatively impact greater sage-grouse (*Centrocercus urophasianus*) and other sagebrush-associated wildlife. The greater bare ground in horse grazed riparian areas increases the risk of erosion, and subsequently stream channel incising, and susceptibility to exotic plant invasion. The effects of feral horses on native ecosystems should be considered when developing conservation plans for these ecosystems and associated wildlife.

RIPARIAN AND STREAM CHANNEL DYNAMICS: HORSES, COWS AND WILDFIRE IMPACTS. Tamzen K. Stringham*; Univ. Nevada Reno, Reno, NV

ABSTRACT

Wild horses and domesticated livestock can have direct and indirect effects on the structure and composition of riparian areas and the hydrologic function of the associated ecosystem. In arid regions, where water is limiting, riparian areas often become the focal point for land managers. Quantifying the direct impacts from the individual user groups of wild horses versus domesticated livestock within a co-mingled allotment is difficult and further complicated by the variability in annual weather and natural disasters. In 2011, we began a case study to determine the effect of an off-site water installation on livestock use of a nearby riparian area dominated by an ephemeral channel. Complicating the study design was the present of approximately 500 wild horses, 350 over the established allotment management level. Further, complications occurred in August 2012 when the upper watershed burned necessitating a change in livestock management for the next two years. Data will be presented documenting riparian vegetation and stream channel dynamics from 2009 through 2015 in the presence of livestock and wild horse grazing, livestock removal, wildfire and flash floods. The story is insightful and thought provoking.

UTILIZATION OF SPRINGS AND RIPARIAN AREAS BY WILD HORSES, LIVESTOCK, AND WILDLIFE ON THE TWIN PEAKS HERD MANAGEMENT AREA.

. David Lile*¹, Laura K. Snell², Roger Baldwin³; ¹UCCE, Susanville, CA, ²University of California, Alturas, CA, ³University of California, Davis, CA

ABSTRACT

The Twin Peaks Herd Management Area for wild horses and burros in northeastern California and northwestern Nevada has exceeded appropriate management levels in recent years. The steady rise in horse and burro population has prompted resource concerns relating to wildlife, range and riparian health standards, and high priority sage grouse habitat. Concentrated use of water and green forage around spring areas by horses, livestock, and native wildlife continues to be a controversial issue, and there have been relatively few examples successfully quantifying relative use by various grazers in the sage steppe ecosystem. The study objective is to quantify the relative frequency, duration, and timing of use by horses, permitted livestock, and wildlife at spring locations and associated use levels. Nine representative spring sites within the Twin Peaks HMA were established as study locations in the summer of 2015. Motion sensitive cameras were deployed at each location for 14-day sampling periods during the spring, summer and fall of 2015-2017. Vegetative use including stubble height and bank trampling was collected concurrently. Photos are visually assessed to record species present, number of each species, and the time, date, and location of the observation. Six of the nine spring areas include spring/riparian enclosure fencing adjacent to the study site allowing a comparison of grazed and ungrazed areas. Implications for management are discussed.

HISTORICAL SOUTHEASTERN RANGELANDS. Reed F. Noss*; Florida Institute for Conservation Science, Chuluota, FL

ABSTRACT

Native grasslands of various types were once abundant in the southeastern United States ("the South"), but have declined so much that even many ecologists have not recognized their existence. Only by understanding how these communities came into being, how they waxed and waned over time, and what factors maintained them, can we establish a scientifically sound basis for conserving and restoring these ecosystems today and into the future. As defined here, native grasslands of the South include treeless prairies, mountaintop balds, savannas and woodlands, barrens, glades, outcrops, and canebrakes. Longleaf pine savannas were matrix communities across most of the southeastern Coastal Plain, whereas most other grassland types occurred as patches of various sizes within a forest matrix. Paleoecological evidence shows existence of savannas similar to today's millions of years ago, in the Miocene or earlier. The high degree of species endemism in these grasslands, especially in the Coastal Plain and including many ancient taxa, provides further evidence of antiquity. The rate of endemism is high enough that the Coastal Plain is now recognized as a global biodiversity hotspot. Fire is a dominant ecological process in most southeastern grasslands, with this region having the highest lightning incidence in the United States. Many plant species, today and in the past, show fire-adaptive traits and depend on fire for their existence. Many other southeastern grasslands were edaphic, restricted to unusual substrates such as highly calcareous, saline, serpentine, shrink-swell, or shallow soils. Fire is rare in some of these communities. Large herbivores were probably very important in maintaining many southeastern grassland types in the past, with herbivores probably interacting with fire much like in the Great Plains. Conserving and restoring both natural and semi-natural grasslands, large and small, is a high priority in this region.

ABSTRACT

The greatest threat to eastern North American biodiversity is the loss of eastern grasslands, especially those found in the southern states. Prior to European settlement, grasslands (including savannas, prairies, barrens, glades, balds, meadows, and several types of open wetlands and riparian grasslands) and open grassy woodlands once rivaled forests in their coverage of the southeastern U.S. landscape. Conservatively, more than 100 million acres of these "naturally open" vegetation types once existed from Maryland and Missouri south to the Gulf of Mexico. Fire suppression, overgrazing, conversion to row-crop agriculture, hydrologic changes, and development, among other factors, has led to the loss of more than 90 percent of the South's historic grasslands. Similarly, many of the open woodlands, whose understories would have been grassy and provided forage for native herbivores as well as cattle and other livestock, have become dense due to many decades of fire suppression. Today, the South's grasslands exist in three states of conservation. First, a very small number of types associated with rocky or inaccessible sites (e.g. Appalachian Plateau riverscour barrens, Blue Ridge grass balds) are likely similar in their present composition and acreage to pre-settlement times with >75% of original acreage still intact. Second, are the formerly vast network of oak and pine savannas that have become closed woodland or forest. More than 90% of savannas have been lost but several success stories indicate these may be our most easily restorable grassland systems. Third, are the millions of acres of former open, nearly treeless prairies that now represent extinct ecosystems. These have experienced near total losses exceeding 99.99%. Each case will require different restoration and management strategies. A review of the major grassland systems of the Southeast is presented along with a discussion of their conservation needs both in the short-term and long-term.

VALUE OF SOUTHERN RANGELANDS FOR NORTHERN BOBWHITE AND OTHER GRASSLAND BIRDS. Jef Hodges*; National Bobwhite Conservation Initiative, Clinton, MO

ABSTRACT

The northern bobwhite is an iconic species of the southeastern United States. Southern rangelands are considered important for nearly one third of the range-wide population of northern bobwhites. Across southern rangelands bobwhites have experienced a long-term (since 1970) average decline of 92% with the current short-term (2004-2014) decline average of 6.3%. Loss of grasslands through conversion to non-native monotypic species and unmanaged savannas becoming closed canopy woodlands have contributed to the decline of northern bobwhites. Recent efforts which have established native grasses and forbs to large landscapes and thinning and burning of pine stands resulting in re-establishing herbaceous ground cover, have resulted in increased bobwhite populations along with a suite of other grassland and scrub birds. Efforts are underway in both grasslands and pine savannas to expand on current successes.

LESSONS FROM FLORIDA - IMPORTANCE OF RECOGNIZING RANGELANDS IN THE SOUTHEAST. Sid Brantly*¹, Charles Kneuper²; ¹Landowner, Sharpsburg, KY, ²USDA Natural Resources Conservation Service, Temple, TX

ABSTRACT

There is similarity among U. S. Department of Agriculture agencies with regard to the definition of rangeland in the United States. There are subtle differences, but none of those definitions expressly exclude the mesic or semi-tropical eastern portion of the country. The 2014 National Resources Inventory (NRI) Rangeland Resources Assessment (USDA Natural Resources Conservation Service) defines rangeland as a land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grasslike plants, forbs, or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands some deserts, and tundra are considered rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.

This definition is virtually unchanged in the NRI definitions back as far as 19987. The definitions by NIFA (National Institute for Food and Agriculture), ARS (Agriculture Research Service), and SRM are similar, with a number of alternative examples in the latter portion of the definition. None of the differences exclude eastern rangeland. A number of state and regional resource documents describe as much as seven to ten million acres across the Eastern United States as grasslands and in excess of one hundred million acres of historical savanna types that could potentially be restored to rangeland. This paper for symposium presentation examines some of the federal significance in terms of technical and financial assistance that might be made possible with administrative recognition of these rangeland acreages by NRCS.

OVERVIEW OF THE SOUTHEASTERN GRASSLANDS INITIATIVE AND A CALL FOR ACTION. Dwayne Estes*; Southeastern Grassland Initiative, Clarksville, TN

ABSTRACT

The southeastern U.S. is not known as a major grassland region. Its grasslands largely disappeared two centuries ago. Today's remnant savannas, prairies, glades, barrens, balds, and wet grasslands (bogs, fens, meadows, marshes) are vestiges of a bygone era. Many are threatened by fire suppression, habitat loss, invasive species, and climate change. In spite of occupying less than one percent of the land area, Southeastern grasslands harbor a disproportionate percentage of the nation's grassland biodiversity. As grasslands continue to fade, the effects of ecological collapse are becoming clear. Without a paradigm shift and intervention, hundreds of species face functional or complete extinction. A stark realization is setting in that past and current conservation efforts aren't enough to address the myriad threats facing Southern grasslands. A new visionary approach is needed to re-think conservation on a big-scale. The Southeastern Grasslands Initiative (SGI), based out of Austin Peay State University (Clarksville, Tennessee), aims to establish itself as a clearinghouse to focus priorities in on-the-ground conservation and research for grasslands across a 21-state region. The SGI will employ a multi-faceted approach that combines restoration, preservation, re-creation, research, rescue, seedbanking, education, and market-driven strategies. Re-classifying many Southeastern areas as rangeland would go a long way toward benefitting grassland conservation in the Southeast. The SGI's long-term goal is to become a granting organization whereby we offer grants related to the eight strategies above to facilitate conservation at a scale not presently possible. Such an ambitious endeavor requires major funding. We are currently working with and seeking support from private philanthropic foundations, corporations, non-profit conservation organizations, and government agencies. To learn more about SGI please check out www.segrasslands.org.

WEEDY NATIVE SPECIES AND THE CONTRADICTIONS SURROUNDING THEM.
Merilynn Schantz*; Red Rock Resources LLC, Miles City, MT

ABSTRACT

Native plant species are not generally known to be weeds. Many even question whether native species can be invasive in the full extent of the definition. However, there are many native species in rangeland ecosystems that decrease habitat availability and forage quality and increase wildfire intensity. Many of these native species are woody, secondary succession species. A primary reason for native species becoming weedy is because of effective fire suppression strategies following European settlement of the western U.S. Suppressing historical wildfires has many times led to native woody species dominance of mixed plant ecosystems. In many cases, sites invaded by native woody species cross a threshold to a woody plant dominated state that is irreversible without significant management inputs. Across the Great Plains, native weedy species have become dominant in areas where wildfire frequency has decreased and led many grasslands to now be dominated by woodlands. Alternatively, in Great Basin ecosystems, historical fire suppression has led to dense woodland forests with low forage availability at high elevations and a buildup of fine fuel at low elevations, which increases fire intensity and spread. High intensity wildfire is particularly devastating to low elevation bunchgrasses and shrub species that keep their growing points above ground. Adding fuel to these wildfires is the increased dominance and spread of invasive annual grasses that decrease forage quality and wildlife habitat and both increase wildfire frequency and are increased by wildfire occurrence. Restoring structure and function these ecosystems can take a considerable amount of money and management efforts, many times with low success rates. A greater understanding of these rangeland ecosystems currently invaded by native weedy species and those that have been devastated by historical mismanagement should lead to better management strategies for restoring ecological structure and function to these vulnerable rangelands.

20,000 YEARS OF PINYON AND JUNIPER WOODLAND HISTORY: CONCERNS FOR THE FUTURE. Rick Miller*; Oregon State University, Corvallis, OR

ABSTRACT

Semi-arid woodlands have expanded and contracted across the Great Basin and Colorado Plateau throughout the Pleistocene and Holocene. Large scale expansions typically occurred during mild-moist climate conditions and contractions during the transition from mild-moist to dry. There is strong evidence that both tree infill into existing stands and expansion were slowly increasing prior to Eurasian settlement. However, expansion and infill rapidly accelerated during settlement in the late 1800s, peaking in the early 1900s. Causes attributed to woodland expansion and infill since the late 1800s have been widely debated, and are most frequently attributed climate, livestock grazing, altered fire regimes, and/or changes in atmospheric CO₂. There is considerable evidence that climate has been a primary driver of woodland expansion, contraction, and infill over the past tens of thousands of years and was likely a major factor during the persistent wet period throughout the West in the early 1900s. However, the effects of climate on woodland dynamics since Eurasian settlement cannot be separated from anthropogenic factors such as altered fire regimes, grazing, and elevated CO₂ levels. There is also considerable debate as to the proportion of woodland expansion versus regeneration, and old-growth or persistent woodlands versus recently converted sagebrush-steppe and savannas. This in part can be attributed to regional differences in disturbance regimes and ecological site characteristics, which can lead to regional biases when interpreting woodland dynamics across the Great Basin and Colorado Plateau. Managing these woodlands takes careful consideration of the ecological site components, potential and current vegetation, and the resilience and resistance to invasive annuals for the site of interest. Introduced invasives are a considerable threat in replacing both recently encroached and persistent (old-growth) woodlands throughout the West and can be linked to warming climate, fire, and elevated CO₂.

HISTORY OF SAGEBRUSH MANAGEMENT: FROM WEED TO KEYSTONE SPECIES
. Kirk W. Davies*; USDA - Agricultural Research Service, Burns, OR

ABSTRACT

Shortly after the introduction of livestock into sagebrush rangelands, it was recognized that sagebrush competed with forage species. This led to many efforts to control this “weed” to increase herbaceous vegetation for livestock. Sagebrush was mechanically and chemically controlled as well as prescribed burned to reduce its abundance. Sagebrush control was often coupled with seeding non-native forage grasses. This led to millions of acres of sagebrush rangeland being converted to non-native grasslands. However, as management focus shifted from livestock production to ecosystem services and the value of wildlife became recognized, scientists and land managers started to recognize the importance of sagebrush. Efforts to reduce sagebrush became less common. Following conservation concerns for sagebrush obligate wildlife species, increases in exotic annual grass, and increases in large fires in sagebrush rangelands, sagebrush conservation became a high priority. This resulted in increased efforts to restore sagebrush after wildfires as well as increased pressure to protect sagebrush communities. This also included efforts to control pinyon-juniper encroachment of sagebrush rangelands. Many of these efforts to conserve and restore sagebrush rangelands have been quite valuable; however, they are limited in scale. This is a cautionary tale of what is now considered a weed may be a keystone species in the future.

NATIVE SHRUB CONTROL AND ESTABLISHMENT OF MIXED-SPECIES SEEDINGS ON EIGHT ECOLOGICAL SITES IN UTAH.

. Thomas A. Monaco*¹, Kari E. Veblen², Eric T. Thacker², Rebecca Mann³; ¹USDA, Agricultural Research Service, Logan, UT, ²Utah State University, Logan, UT, ³USGS, Moab, UT

ABSTRACT

Brush control is often necessary to reduce overabundant shrub species and enhance herbaceous understory conditions. However, simply removing shrubs rarely leads to long-term benefits, especially when understory conditions express low resilience. Results can also vary widely depending on target shrub species and site-specific conditions. To clarify this variability, we established large-scale (200-700 acre) studies and applied herbicide to reduce density of big sagebrush, rubber rabbitbrush, broom snakeweed, and black greasewood at different ecological sites in Utah. In addition, we established replicated small-plot studies to evaluate how various herbicide products impact shrub density and plant establishment of old and new herbaceous species varieties. After five years, sagebrush reduction was much higher (75%) and native herbaceous cover increased to a greater extent on shallow-soil sites compared to deep-soil sites. Over the same timeframe, black greasewood and rubber rabbitbrush rapidly re-sprouted, even though initial mortality was noted after treatment. Heavy livestock grazing greatly weakened understory perennial grasses at rabbitbrush sites, and likely enhanced rapid shrub recovery. In contrast, broom snakeweed was reduced by 25% relative to control areas, and understory vegetation responded through simultaneous reductions in redstem filaree and increases in downy brome relative to control areas. Plant establishment of seeded species did not vary between old and new varieties, but species showed large differences in establishment across sites. Our talk will explore both within-site and among-site variability in vegetation dynamics to reach an understanding of the interactive effects soil pre-treatment conditions, shrub reduction, and herbaceous response.

USING NATIVE WEEDS FOR RESTORATION: CAN NATIVE ANNUALS HELP, RATHER THAN HURT, RESTORATION EFFORTS?

. Elizabeth A. Leger*, Tara de Queiroz; University of Nevada, Reno, Reno, NV

ABSTRACT

In the Great Basin, native annual plants occupy a niche similar to the niche exploited by invasive annuals, increasing in abundance after soil disturbances and wildlife. In arid systems, some native annual species have been shown to compete effectively with weeds. Native annuals are also an important component of wildlife habitat, and provide resources for many species. Despite their ecological importance, native annuals have rarely been used in restoration and habitat improvement projects in the Great Basin, and their potential for propagation has not been investigated. Seed source development for restoration and wildlife habitat improvement has focused on native perennials, and great strides have been made for those species. Similar work has not been attempted for annual species, despite preliminary results that suggest that annual species can play important roles in occupying disturbed habitats and reducing the fecundity of annual weeds. Here, we present evidence from field and greenhouse trials indicating that native annuals can compete effectively with invasive annual plants, as well as results from seed increase trials of wild-collected populations. While native annuals are, by definition, short-lived additions to any restoration project, their ability to quickly increase from seed and persist in the seed bank during unfavorable periods makes them a unique contributor to current restoration mixes, which typically focus on perennial species that may be slow to reproduce and are vulnerable to drought or other disturbances. Incorporating native annuals into restoration projects may allow for increased restoration success, and developing effective methods for seed increase will allow the seeding of larger-scale trials in invaded and degraded habitats.

SOCIO-ECOLOGICAL TRANSFORMATION OF THE GREAT PLAINS THROUGH JUNIPERUS INVASION

. Samuel D. Fuhlendorf*¹, Brad Wilcox², Andrew Birt³, Steven A. Archer⁴, Mike Sorice⁵, Urs P. Kreuter³, Rheinhardt Scholtz¹; ¹Oklahoma State University, Stillwater, OK, ²Texas A&M University, college Station, TX, ³Texas A&M University, College Station, TX, ⁴The University of Arizona, Tucson, AZ, ⁵Virginia Tech, Blacksburg, VA

ABSTRACT

Many ecological studies and observations indicate that the increased dominance of woody plants on Great Plains grasslands is a major threat to agriculture and conservation of grassland ecosystems. It is generally agreed that the dominant driver of invasion is fire suppression and altered fire regimes, while restoration is often discussed in terms of thresholds. With *Juniperus* invasion in the Great Plains, models predict that conversion of grassland to woodland can happen as quickly as 25-45 years and have identified thresholds for associated tree size and herbaceous biomass (fine fuel) that are related to fire frequency, fire intensity and other fuel-load altering processes. Our ecological understanding of the conversion process has progressed over the past several decades because of sound ecological studies, but patterns predicted by models are often incomplete in the privately owned landscapes of the Southern Great Plains. Sociological drivers exist that explain these patterns and are influenced by many social entities that range in scale from the federal government to the individual land owner. The traditional network of government agencies, such as USDA-NRCS and University Cooperative Extension Services, combined with the development of land-owner cooperatives, user groups and the Great Plains Fire Science Exchange has limited the invasion of these fire-sensitive trees in many places. Socio-ecological relationships among government agencies, land-owners and these new emergent organizations have managed to develop approaches to overcome thresholds and barriers predicted by the ecological models.

FIRE AND BROWSING EFFECTS ON WOODY ENCROACHED GRASSLANDS.

. Rory C. OConnor*¹, Mira Ensley-Field², Jeff Taylor¹, Jesse Nippert¹; ¹Kansas State University, Manhattan, KS, ²Macalester College, St. Paul, MN

ABSTRACT

North American grasslands historically had a suite of large herbivores that not only grazed (i.e. bison) but also browsed (i.e. elk, pronghorn, deer). Elk in the tallgrass prairie were extirpated by the 1860's and at the same time homesteading increased which decreased fire frequencies. The loss of these two drivers (browsing and fire) has coincided with the conversion of grassland to shrubland/woodland over the last 150 years in the tallgrass prairie. Woody expansion can be categorized in to two groups: non-resprouting species that can be killed with fire and resprouting species that cannot be killed with fire. Resprouting species require additional active management strategies to remove them from encroached grasslands. In this study we investigate community, stem density and physiological effects of continuous simulated browsing and prescribed fire on *Cornus drummondii*, a resprouting native woody species, in hopes to understand how a reintroduction of the historical drivers can potentially reverse woody expansion.

After three years of continuous simulated browsing we found that browsing alone does not change rates photosynthesis but it does increase stomatal conductance and transpiration rates. But when browsing was coupled with a prescribed fire, photosynthetic rates decreased, stomatal conductance and transpiration rates did not differ among treatments. The physiological responses from multiple years of browsing and a prescribed fire show that the shrubs are trying to maintain carbon acquisition but are not. The combined browsing and fire effects are manifest in the shrubs through smaller leaf area, hedging and decreased stem densities that result in a decrease of shrub cover and an increase in herbaceous understory. The increase in herbaceous understory was mostly due to increases in the dominant warm season grasses. Browsing or fire alone is not enough to decrease woody encroachment but coupled together, in our results suggest an effective management strategy.

CAN WE SUSTAINABLY MANAGE MESQUITE, A FIRE-RESISTANT NATIVE
INVASIVE SHRUB? Jim Ansley*; Oklahoma State University, Stillwater, OK

ABSTRACT

Much of the Southern Great Plains (USA) grasslands have become dominated by native invasive woody plants such as honey mesquite (*Prosopis glandulosa*) and juniper (*Juniperus* spp.) in the last 100 years. Mesquite has increased due to enhanced seed distribution via livestock consumption and fecal deposition, reduced frequency and intensity of fire, and livestock overgrazing that has weakened grasses competing with emerging shrub seedlings. This vegetation shift has become so pervasive that it threatens grass-dependent livestock production and grassland-dependent plant and wildlife species. Concurrently, different wildlife species and different income sources such as recreational hunting for shrub-dependent wildlife have developed that further threaten the impetus for grassland restoration. This trajectory will continue without anthropogenic brush management intervention. Mesquite is difficult to control in part because it can resprout following treatments that only kill above ground tissue (i.e., top-kill), such as fire or mechanical shredding. Moreover, recent studies have shown that mesquite regrowth following top-kill is essentially independent of extreme drought. Application of chemical spray treatments via aircraft offer the best potential regarding precision of application and effect, but costs are high relative to potential grazing income generated from these lands. This paper will summarize these various concerns and point to possible management solutions that achieve agricultural production, recreation and ecological restoration goals.

A MULTI-SCALE RESILIENCE-BASED FRAMEWORK FOR RESTORING AND CONSERVING WET MEADOWS AND RIPARIAN ECOSYSTEMS

. Jeanne C. Chambers*¹, Jerry R. Miller², Peter J. Weisberg³, Mark Lord², Keirith A. Snyder⁴, Rosemary W. Carroll⁵, Erica Fleishman⁶, Jason B. Dunham⁷; ¹USDA Forest Service, Reno, NV, ²Western Carolina University, Cullowhee, NC, ³University of Nevada, Reno, Reno, NV, ⁴USDA Agricultural Research Service, Reno, NV, ⁵Desert Research Institute, Reno, NV, ⁶Colorado State University, Fort Collins, CO, ⁷U.S. Geological Survey, Corvallis, OR

ABSTRACT

Riparian and wet meadow ecosystems comprise small percentages of aridland landscapes, but provide critical resources for upland, riparian, and stream-dependent species and supply water to downstream users and communities. Many of these systems have been degraded by various anthropogenic activities and are further threatened by climate change. We are developing a strategic, multi-scale framework for assessing resource values and threats to riparian and meadow ecosystems using resilience science that is broadly applicable. The framework provides the capacity to (1) prioritize riparian ecosystems for management based on ecosystem characteristics and response to disturbance, and (2) determine effective management strategies based on ecosystem resilience and resource values. *We define resilience of wet meadow and riparian ecosystems as the capacity to regain fundamental structure, processes, and functioning when stressors and disturbances alter geomorphic and hydrologic regimes and vegetation communities.* The framework builds on our prior development of a hierarchical classification of watershed types and their relative resilience to disturbance and is based on watershed geology and hydrogeomorphic characteristics, riparian corridor and valley characteristics and valley segment and stream reach characteristics. Similarly, meadow types are classified based on watershed, valley segment, and reach-scale geomorphic and hydrologic characteristics, and relative resilience to disturbance. We are identifying focal species, including Lahontan cutthroat trout and Greater sage-grouse, and evaluating their associations with watersheds with different hydrogeomorphic relationships and relative resilience. We also are identifying the key threats within the watershed and determining how they vary across the region. Databases, field guides, and other tools are being developed in collaboration with regional managers. The framework enables managers to use the best science available to focus management actions in locations where they will have the greatest benefits for restoring and maintaining wet meadows and riparian ecosystems and conserving the many species that they support.

UNDERSTANDING AND ASSESSING WATERSHED RESILIENCE TO DISTURBANCE.
Jerry R. Miller*; Western Carolina University, Cullowhee, NC

ABSTRACT

Developing effective management strategies for wet meadow and riparian ecosystems begins with an understanding of watershed resilience to disturbance. Late Holocene geomorphic and stratigraphic data collected from upland watersheds in central Nevada reveal that natural and anthropogenic disturbances during the past several centuries have led to two primary types of geomorphic response: channel incision and channel avulsion. Both can have significant detrimental effects on wet meadow and riparian ecosystems by lowering groundwater levels and altering the distribution, composition, and diversity of the existing vegetation. Our earlier geomorphic and hydrologic investigations of more than 50 upland watersheds in the Great Basin demonstrated that these catchments respond differently to external perturbations, and are characterized by different degrees of resilience to these disturbances. The most sensitive (dynamic) systems are characterized by basin traits that (1) promote rapid, high magnitude flood flows, (2) generate relatively fine-grained channel bed material and (3) have large quantities of highly mobile sediment. A hierarchical analysis of these and other watershed traits allowed for the classification of the basins into four primary groups of basin sensitivity/resilience. Work conducted during the past year is expanding the initial classification developed for central Nevada and applying it to other areas of the Great Basin. Ultimately, the ability to identify a basin's sensitivity to disturbance provides land managers with a powerful tool for managing land use. Moreover, the classification scheme provides insights into the potential success of restoration programs for channels characterized by different types of geomorphic processes and response rates.

GEOMORPHIC AND HYDROLOGIC CONTROLS ON EXTENT AND COMPOSITION OF RIPARIAN VEGETATION. Peter J. Weisberg*¹, Jeanne C. Chambers², Blake Engelhardt³, Anna Knight¹; ¹University of Nevada, Reno, Reno, NV, ²USDA Forest Service, Reno, NV, ³United States Forest Service, Bishop, CA

ABSTRACT

Riparian vegetation is structured by hydrogeomorphic processes operating along a nested hierarchy of scales including the watershed, riparian corridor, and stream reach. Yet most studies have focused on reach-scale channel characteristics with limited consideration of either the watershed geomorphic characteristics or longitudinal position along the stream network. We quantified the influences of watershed and reach-scale characteristics in structuring riparian vegetation in small mountain watersheds within the Great Basin. At the watershed scale, bedrock lithology and basin morphometry combined to influence vegetation extent and composition. Riparian extent was positively related to intrusive bedrock and drainage density, and negatively related to percentage carbonate bedrock and relative stream power. Disturbance adapted riparian tree and shrub species were prevalent in small, rugged, and high-relief watersheds. In contrast, meadow vegetation was favored in large, low-gradient watersheds with alluvium, carbonate and metasedimentary rock types and large side-valley alluvial fans. Riparian vegetation was also strongly influenced by longitudinal position within the watershed. For example, riparian aspen forest was more prevalent in steep, high-elevation parts of the watershed with high stream gradients, riparian willow and shrub communities in middle elevations where valleys broaden, and river birch communities where canyons narrow and frequent flooding occurs. At the reach scale, vegetation structure was strongly related to channel and bank characteristics such as terrace height, particle size, stream slope and width/depth ratio. Results are generalized to develop process-based management guidelines specific to watersheds with different hydrologic and geomorphic characteristics and, thus, resilience to disturbance. By evaluating the plant community with respect to its geomorphic context, our work identifies riparian systems that have greatest susceptibility to ecological state transitions resulting from stream incision and decreases in water tables. Our restoration guidelines incorporate plant community indicators within the overall hydrogeomorphic context driving vegetation patterns and responses to disturbance.

GEOLOGIC AND GEOMORPHIC CONTROLS ON GROUNDWATER AND SURFACE WATER AT REACH TO WATERSHED SCALES

. Mark Lord*, Jerry R. Miller; Western Carolina University, Cullowhee, NC

ABSTRACT

Riparian and wet meadow ecosystems are a critical ecological and human resource throughout the Great Basin. Understanding the controls on surface and subsurface water is an essential component in evaluating the resilience of stream and groundwater dependent ecosystems and determining effective management strategies. Our prior research on 56 riparian wet meadows in central Nevada indicates that meadows occur in groundwater discharge zones with high groundwater tables. These types of areas occur where geologic conditions have created significant sediment deposits that include fine-grained materials, for example, areas upstream of side-valley alluvial fans. Wet meadows require high groundwater tables and can form independently of streams, but they are threatened by stream erosion. Stream incision lowers groundwater tables and new stream channels can cut through stratigraphic units essential to supporting high-water tables. The degree of loss of wet meadows due to incision is controlled by site characteristics such as the direction of groundwater flow, stratigraphic complexity, and the interaction of stream and groundwater. Because different types of wet meadow vegetation have different groundwater depth requirements, patterns of vegetation can be used effectively and efficiently to provide a preliminary assessment of the controls on meadow location and sensitivity to stream incision. At larger, watershed scale, similar variables can be used to understand the distribution and hydrologic function of riparian and meadow ecosystems. The presence of perennial streams and wide valleys with significant sediment accumulations generally correlate with basins with meadows and wide riparian zones. Alternatively, basins with low permeability bedrock and little sediment accumulation tend to lack meadows and have streams that can produce high-magnitude floods. The ability to characterize the hydrologic setting and controls on meadow ecosystems are fundamental to our ability to develop a framework to support effective watershed management.

PREDICTING STREAMFLOW SENSITIVITY TO CLIMATE IN A DATA-POOR REGION &NDASH; A NEW TOOL FOR WATER MANAGERS IN THE GREAT BASIN.

. Rosemary W. Carroll*¹, Keirith A. Snyder²; ¹Desert Research Institute, Reno, NV, ²USDA Agricultural Research Service, Reno, NV

ABSTRACT

Groundwater inputs to streams, or baseflow, can potentially modulate discharge response to climate extremes, thereby protecting ecosystem health and water supply to downstream users. Baseflow also serves as a metric of watershed support for groundwater dependent ecosystems; such as springs, mountain meadows and riparian zones, that sustain much of the ecologic biodiversity in the Great Basin. Large portions of the Great Basin lack a robust stream and meteorological station network making it difficult to assess how sensitive baseflow is to shifts in climate. To address data scarcity we applied a nested-multiple regression approach to nearly 1500 HUC12-sized, perennial watersheds across seven sub-regions in the Great Basin: Central, Eastern Humboldt, Lava Plains, Lahontan, South East Idaho and Utah. Baseflow was calculated using a low pass, automated filter to both active and inactive stream gauges that contained at least 10 years of daily discharge data and were coincident with selected watersheds (n = 34). Monthly historical climate for water years 1896 to 2015 was obtained from the Parameter-elevation Regression on Independent Slopes Model (PRISM), aggregated by water year and processed for watershed mean values based on total and seasonal precipitation and associated mean daily temperatures. Climate variables were regressed against baseflow over each observed streamflow period of record, and these climate coefficients were then modeled as functions of watershed characteristics defining shape, topography, stream-network configuration and geology. The subsequent approach allows baseflow to be calculated solely as a function of PRISM and watershed characteristics and is thereby transferable to ungauged basins. We review baseflow as a function of total annual flow over the historic record and present individual sub-regional models of the Great Basin that allow a comparison of physical attributes that promote baseflow resilience to changes in precipitation and temperature.

USING FIELD DATA AND HYDROLOGIC MODELS TO PREDICT WATER BUDGET PARTITIONING IN RESPONSE TO CLIMATE AND PINYON-JUNIPER REMOVAL - HOW WILL A GREAT BASIN MOUNTAIN MEADOW RESPOND?

. Keirith A. Snyder*¹, Rosemary Carroll², Tamzen K. Stringham³, Justin Huntington²; ¹USDA Agricultural Research Service, Reno, NV, ²Desert Research Institute, Reno, NV, ³Univ. Nevada Reno, Reno, NV

ABSTRACT

Keirith A. Snyder, ARS; Rosemary Carroll, DRI; Tamzen K. Stringham, UNR; and Justin Huntington, DRI

Sagebrush steppe and associated meadow systems are critical habitat in the Great Basin for wildlife and provide important ecosystem goods and services. Expansion of pinyon (*Pinus* spp.) and juniper (*Juniperus* spp.) in the Great Basin has reduced the extent of sagebrush steppe causing habitat, fire, and forage concerns. Additionally many meadow systems have been degraded due to a variety of factors such as grazing pressure by both cattle and wild horses, road capture, and potentially from climate change with the combination of stresses resulting in the expansion of these deeply-rooted evergreen trees. We focus on the Porter Canyon Experimental Watershed which was established to address the hydrologic and ecological effects resulting from changing climate or management option on the distribution of vegetation, ecosystem function and land cover. Ecosystem changes will influence temporal and spatial water budget partitioning of precipitation across the watershed with implications on hydrologic partitioning of soil moisture to evapotranspiration (ET), interflow and groundwater recharge. These changes will affect the resistance and resilience of downstream meadows. We used a combination of field measurements and an integrated groundwater and surface water flow model (GSFLOW) to understand flow within and between three regions: (1) plant canopy to the bottom of the soil zone, (2) surface water bodies and (3) the groundwater system below the soil zone. Model runs simulated tree removal and changes in climate. Field based measures were used to examine various components of the water-budget such as canopy interception, changes in soil moisture with treatment, and plant transpiration.

EFFECTS OF FIRE AND LIVESTOCK GRAZING ON RIPARIAN ECOSYSTEMS: INFLUENCE OF WATERSHED CHARACTERISTICS

. Camie M. Dencker*, Sherman R. Swanson; University of Nevada, Reno, Reno, NV

ABSTRACT

Following wildfire, the Bureau of Land Management customarily follows a 2-year deferral from grazing to allow short-term rehabilitation objectives to be met for burned area stabilization. However, lack of scientific evidence has many rangeland managers and permittees questioning its necessity. Riparian areas are particularly susceptible to concentrated livestock use during the hot season when uplands are senesced. This research sought to quantify riparian condition across channel and watershed attributes, fire severity, and pre- and post-fire grazing-use. We monitored 23-burned streams on public lands in Nevada, selecting reaches of greatest management concern across the watershed. To quantify stream recovery, we used Multiple Indicator Monitoring of Stream Channels and Streamside Vegetation and focused on indicators of riparian condition: greenline plant composition, woody species cover and height, and streambank stability and cover. We quantified watershed and stream channel characteristics in ArcGIS and measured stream gradient and substrate diameter at site. Riparian species composition and community structure were most related to watershed position. Bank stability, species richness, and woody species cover and height increased with duration of recovery periods and decreased with duration of continuous, hot season grazing-use prior to the fires. Bank cover increased with vegetation and streambank stability and moving up in watershed position. Banks were more stable with increased bank cover and decreased fine substrate, stream gradient, and post-fire grazing duration. Over the two-year study, bank stability decreased at sites with increasing fine substrate and grazing-use, which were more common lower in the watershed. Lower positioned sites were grazed the longest, have the lowest values for condition, and may be more susceptible to grazing pressure because of high proportion of fine substrate material. Grazing strategies that reduce the duration of hot season grazing promoted riparian vegetation recovery and bank stability following disturbance, which may help meet post-fire objectives more quickly.

EFFECTS OF DROUGHT AND WILDFIRE IN GREAT BASIN STREAMS: IMPLICATIONS FOR FISH AND WILDLIFE. Jason B. Dunham*; US Geological Survey, Corvallis, OR

ABSTRACT

Many species depend on water availability in low-order, headwater streams, which constitute the majority of streams in the Great Basin. Though these streams are important for a variety of reasons, we know very little about their current status (i.e., whether they are perennial or not) and potential responses to drought or other climate-related changes. To address these fundamental questions, we have deployed a series of instrument networks to track year-round patterns of temperature and flow permanence in focal watersheds in the northwest Great Basin, including southeast Oregon, northeast California, and northern Nevada. We have developed robust methods for determining both temperature and stream drying from instrumental records of temperature alone collected in stream channels. Results from an intensively monitored watershed in southeast Oregon revealed spatially and temporally variable responses to recent wildfire (2012) and drought (2015). Overall, the system exhibited a high degree of climate sensitivity, with implications for vulnerability of threatened Lahontan cutthroat trout. These findings have prompted a broader, collaborative effort to evaluate climate sensitivity of a much larger sample of streams managed for recovery of Lahontan cutthroat trout across the Great Basin. Though trout are the focal species, results of this work will have important implications for water-dependent wildlife, livestock grazing uses, and a variety of other values associated with water quality and availability in this arid landscape.

IMPORTANCE OF WET MEADOWS FOR GREATER SAGE-GROUSE IN THE GREAT BASIN

. Phillip A. Street*¹, Jim Sedinger²; ¹University of Nevada-Reno, Reno, NV, ²University of Nevada, Reno, Reno, NV

ABSTRACT

Identifying quality habitat is a critical step in the conservation and management of populations. Species often select habitat that maximizes their fitness in terms of reproduction and survival. For Greater Sage-grouse, the presence of protein rich forbs is required for chicks to persist and grow on the landscape. In the Great Basin, many of these forbs are abundant in spring, but die during dry summers, with the exception of forbs found in moisture-rich refuges. These refuges can be either in the form of wet meadows or at elevations that are high enough to receive more precipitation than the surrounding landscape. Using known locations of sage-grouse during July and August from 2013 to 2017, we built a year-specific resource selection model to identify these refuges as high quality late summer habitat. We assessed how the location of sage-grouse on the landscape relative to the predicted late summer habitat quality, affected survival of pre-fledged chicks and adults. We found that chicks in predicted lower quality habitat did not survive as well as chicks in higher quality habitat. Alternatively, adults that spent more time in the high quality habitat did not survive as well as adults that were located in habitat of lower quality. These results suggest that moisture rich refuges are essential for successful reproduction but attending these refuges likely comes at a cost in terms of adult survival. We hypothesize these cost are due to biotic processes such as density dependence and predation. We fit the habitat model to a validation dataset located 260 km from where the data used to train the model were collected, and found that the model accurately predicted where the birds were through both space and time. A predicted surface was created for the entire state of Nevada. Identifying these areas will help the managers balance grazing pressure, mining, and energy development in the Great Basin with the long term persistence of sage-grouse.

PRIORITIZING WATERSHEDS FOR MANAGEMENT AND DETERMINING EFFECTIVE STRATEGIES BASED ON AN UNDERSTANDING OF WATERSHED RESILIENCE TO DISTURBANCE.

. Jerry R. Miller*¹, Jeanne C. Chambers², Peter J. Weisberg³, Mark Lord¹, Keirith A. Snyder⁴, Rosemary Carroll⁵, Erica Fleishman⁶, Jason B. Dunham⁷; ¹Western Carolina University, Cullowhee, NC, ²USDA Forest Service, Reno, NV, ³University of Nevada, Reno, Reno, NV, ⁴USDA Agricultural Research Service, Reno, NV, ⁵Desert Research Institute, Reno, NV, ⁶Colorado State University, Fort Collins, CO, ⁷U.S. Geological Survey, Corvallis, OR

ABSTRACT

An understanding of the factors that determine watershed resilience to disturbance is a critical aspect of identifying those locations where conservation and restoration actions have the greatest potential for achieving the desired objectives and determining appropriate management strategies. We have developed a resilience-based framework for the Great Basin that is based on a hierarchical, multi-scale classification of watershed and riparian corridor resilience to disturbance. The framework provides information on the type, magnitude, and rates of ecosystem degradation and is based on the hydrologic, geomorphic, and biotic characteristics of the watersheds and their observed responses to disturbance. We have identified five distinct categories of watershed resilience to date, each of which exhibits different potentials for conservation and restoration management. These watershed categories include: (1) stream segments characterized by rapid and extensive incision that has significantly degraded riparian and wet meadow ecosystems. These watersheds exhibit little opportunity for effective restoration and, while often exhibiting currently stable conditions, are prone to renewed incision; (2) stream segments characterized by high magnitude floods and large amounts of highly mobile sediment that leads to frequent and extensive avulsion and widespread reworking of the valley floor. The dynamic nature of these systems inhibit long-term channel stability and the implementation of restoration projects; (3) watersheds and channel systems characterized by slow, but continuous channel incision and, in some cases, localized avulsion. These reaches exhibit the highest potential for restoration; (4) stream reaches characterized by large bed and bank materials that can only be entrained during high magnitude events. These relatively stable reaches are resistant to extensive geomorphic and biotic alterations due to anthropogenic disturbance; and, (5) stream segments that are semi-stable, but exhibit characteristics that make them highly sensitive to change, thereby requiring aggressive management strategies.

FORBS: THE FOUNDATION FOR HEALTHY POPULATIONS OF GREATER SAGE-GROUSE AND POLLINATORS

. Kasten Dumroese*¹, Jeremiah R. Pinto¹, Tara Luna², Francis F. Kilkenny³, Bryce A. Richardson⁴, Justin B. Runyon⁵, Deborah M. Finch⁶; ¹USDA Forest Service, Moscow, ID, ²Luna Consulting, East Glacier, MT, ³USDA Forest Service, Boise, ID, ⁴USDA Forest Service, Provo, UT, ⁵USDA Forest Service, Bozeman, MT, ⁶USDA Forest Service, Albuquerque, NM

ABSTRACT

Greater Sage-grouse and pollinators share dwindling sagebrush habitat in the western United States and thus are currently receiving intense attention from federal, state, tribal, and private land managers. Both rely on a robust availability of forbs; more than 5,000 native plant species grow within the bounds of the sagebrush ecosystem. For Greater Sage-grouse, the invertebrates associated with abundant forbs are a critical source of protein, especially for developing chicks. Given this knowledge, various sage-grouse assessment frameworks and pollinator plant lists encourage use of a broad suite of genetically appropriate native forbs in restoration activities. Despite this, typical seed mixtures specifically for restoration of habitat for Greater Sage-grouse often have very limited numbers of forb species, despite empirical evidence that the best habitat for Greater Sage-grouse may have 30 or more species (with multiple species within genera). Pollinators also require a broad suite of forbs to ensure pollen and nectar are available throughout the growing season. I looked at lists of species preferred and consumed by Greater Sage-grouse and species recommended for pollinating insects. Twelve genera are standouts: milkvetch (*Astragalus*), balsamroot (*Balsamorhiza*), mariposa lily (*Calochortus*), hawksbeard (*Crepis*), fleabane (*Erigeron*), buckwheat (*Eriogonum*), avens (*Geum*), desert parsley (*Lomatium*), bluebells (*Mertensia*), aster (*Symphyotrichum*), clover (*Trifolium*), and vetch (*Vicia*).

Given the current costs of direct seeding a robust suite of forbs, a management strategy might include direct sowing 6 to 10 “workhorse” species across the restoration area, and then outplanting seedlings of another 15 to 20 species in islands that serve as seed sources and nucleate the restoration area. Such islands might be used to foster connectivity between more pristine sagebrush habitat fragmented by degradation. This idea is not new, but the technique has yet to be thoroughly tested in sagebrush rangelands.

DIVERSITY IS MAGIC: NATIVE SEEDS LEAD TO RESTORATION SUCCESS. Thomas N. Kaye*; Institute for Applied Ecology, Corvallis, OR

ABSTRACT

Habitat loss is accelerating globally due to changes in land use, invasive species, and climate change. About 4% of Earth's flora is near threatened or already extinct according to the IUCN Red List, and in the United States, approximately 20% of all plant species are non-native. Habitat restoration with high plant diversity is crucial to restore species and ecosystem services. Plant diversity increases both community stability over time, and diversity of many other organisms below and above ground, including pollinators and others. In some cases, diversity of invasive species can be high and serve some functions of native species diversity, but invaders tend to homogenize plant communities across the landscape, with the same invaders present and abundant at many locations. Therefore, restoring with natives is key. Recent replicated and regional experiments in upland and wetland prairie habitat restoration in Oregon have shown that treatments such as fire can improve habitat quality, but they must be combined with seeding native species to increase diversity. In addition, even after the effects of grassland management treatments fade over time, diversity boosts from seeding tend to persist for at least five years. If novel plant communities must be restored in highly degraded landscapes, prioritizing native plants that remain in habitat fragments or invaded sites as community members (i.e., species with demonstrated resilience to climate change and invasion), even if they did not historically co-occur, may increase restoration success. Seeding with native species is necessary to increase diversity, restore habitats, and enhance ecosystem function.

HOW COMMON IS LOCAL ADAPTATION IN THE GREAT BASIN? . Elizabeth A. Leger*¹, Owen Baughman², Alison Agneray², Erin Espeland³, Rob Fiegner⁴, Matt Forister², Matt Horning⁵, RC Johnson⁶, Tom Kaye⁴, Francis F. Kilkenny⁷, Jeffrey Ott⁷, Bradley St. Clair⁸; ¹University of Nevada, Reno, NV, ²University of Nevada, Reno, NV, ³USDA Agricultural Research Service, Sidney, MT, ⁴Institute for Applied Ecology, Corvallis, OR, ⁵USDA Forest Service Pacific Northwest Research Station, Corvallis, OR, ⁶Washington State University, Pullman, OR, ⁷USDA Forest Service, Boise, ID, ⁸USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR

ABSTRACT

Plants experience variation in natural selection across their range due to differences in biotic and abiotic factors. When adaptive evolution occurs in response to local selective pressures, populations are considered to be locally adapted, and we would expect to observe: 1) differences among populations in phenotypic traits, 2) correlations between these trait values and environmental or other habitat-related variables, and, if reciprocal transplants experiments have been done, 3) higher fitness of local over nonlocal populations in the local's environment. Focusing on plants native to the Great Basin, we asked how frequently each of these three signatures have been observed in wild populations. We conducted a broad literature search to find published studies that compared phenotypic traits of multiple populations of native Great Basin species in one or more common environments. We located 216 experiments in 170 published studies involving a total of 3650 populations of 124 taxa of forbs, grasses, shrubs and deciduous trees, totaling 326 taxon-unique samples. For each sample, we documented whether each of the three signatures of local adaptation was present, and recorded which traits were involved. Additionally, using published data, we asked which phenotypic traits showed the strongest relationships with mean annual temperature and precipitation. Of the studies suitable for detecting each signature, we found that 95.4% reported population differentiation for at least one trait, 81.4% reported significant trait/environment relationships, and 70.4% reported greater performance of local populations in at least one garden for a fitness-related trait. Results indicate that the prevalence of local adaptation in the Great Basin is similar to results in other systems, with many phenotypic and phenotypic traits varying by environment. Our results indicate that considering local adaptation when selecting seed sources could improve restoration success in this large and increasingly imperiled region.

THE SCIENCE OF SEED MOVEMENT AND SEED TRANSFER DEVELOPMENT IN THE WESTERN UNITED STATES. Francis F. Kilkenny*; USDA Forest Service, Boise, ID

ABSTRACT

Seed transfer guidelines are tools that help ensure that seed used in reforestation and restoration is "genetically appropriate" – adapted to local environmental conditions and reproductively compatible with remnant local populations. These tools have been used to guide reforestation practice for nearly a century in forestry, and have recently been adopted for use in the restoration and conservation of non-forest ecosystems, particularly rangelands. In the last 15 years seed transfer guidelines have been constructed for a number of postfire restoration workhorse species in the Great Basin of the western United States. One of the primary goals of the Great Basin Native Plant Project, a partnership between United States Forest Service, Bureau of Land Management and over 25 other cooperating groups, is to continue producing seed transfer guidelines for Great Basin restoration species. This talk will give an overview of what we can learn from seed transfer development and use in the Great Basin, and present a vision for the future of seed transfer in a rapidly changing world.

GETTING THE RIGHT SEED: SEED COLLECTION COLLABORATION IN THE GREAT BASIN. Dirk Netz*¹, Fred Edwards², Sarah M. Kulpa³; ¹U.S. Forest Service, Sparks, NV, ²Bureau of Land Management, Reno, NV, ³U.S. Fish and Wildlife Service, Reno, NV

ABSTRACT

Implementing a strategic native seed collection process begins with coordinated efforts between Great Basin regions and states. In Nevada, Federal and State partners are targeting native grasses and forbs for seed collection by seed transfer guidelines. Target species are beneficial to Greater sage-grouse and pollinators, and have some cultivation research completed to show how they will perform in an agricultural setting. The objective is to obtain multiple collections of target species across key seed zones that can be increased through collaborations with the seed industry. Our ultimate goal is to increase the availability of genetically, appropriate native seed to improve the health, diversity, and success of restoration efforts and plant communities in the Great Basin. Here, we discuss the steps taken and lessons learned from our seed collection partnerships in Nevada.

USE OF SEED ENHANCEMENT TECHNOLOGIES FOR OVERCOMING ABIOTIC AND BIOTIC LIMITATIONS TO NATIVE PLANT ESTABLISHMENT/. Matthew D. Madsen*, William C. Richardson, Ryan Call, Benjamin Hoose, Rhett M. Anderson; Brigham Young University, Provo, UT

ABSTRACT

Rangeland degradation and desertification is a global problem, with many regions of the world experiencing declines in ecosystem goods and services and biodiversity. Often the only means of restoring these lands involves seeding with native species. The sagebrush steppe ecosystem of western North America is an example of a desert system that is undergoing rapid ecological change as wildfires and other disturbances remove native perennial plant communities and convert the system to an exotic annual grassland. Land practitioners currently do not possess the tools needed to consistently reestablish native plants into these degraded landscapes. In this presentation, we will examine limiting factors impairing seedling establishment and show how seed enhancement technologies have the potential to overcome these identified barriers to restoration success. We will specifically share how seed enhancement technologies have the potential to improve seed delivery, protect seeds from predation and pathogen attack, improve seed germination timing, minimize mortality from freezing soils, preserve seed energy levels, and enhance seedling vigor to promote survival under drought conditions. These seed enhancement strategies have the potential to dramatically improve the effectiveness of seeding treatments that are intended to protect or restore the diversity and productivity of arid land ecosystems.

A DEMAND-SIDE ANALYSIS OF THE NATIVE SEED INDUSTRY IN NEVADA. Michael H. Taylor*; University of Nevada, Reno, Reno, NV

ABSTRACT

Native plants and seeds are increasingly sought after by federal, state, and private land managers in Nevada and on rangelands throughout the intermountain west. Native plant materials are believed to increase the likelihood that restoration and post-fire rehabilitation projects will be successful at restoring desired ecological function. We will examine the demand for native plant materials in Nevada for the 10-year period 2005-2014 and identify challenges to the development of a robust native seed industry in Nevada related to the level and variability of demand.

NATIVE GRASS SPECIES AND SOURCE IDENTIFIED GENETICS. Matthew Benson*; BFI Native Seeds, Moses Lake, WA

ABSTRACT

“Better Seed Through Genetic Preservation,” has been the motto for our firm from the start. We have Shifted our focus from an agronomic paradigm to an ecological one which has created success on a scale in restoration projects never experienced. Grasping the difference in purpose and genetics between agronomic and ecological concepts is critical for the producer. End-users and producers should have a unified communication chain rather than a disintermediated commodity production process because separating production from the restoration project will not work. The final pieces of the complex puzzle of ecological restoration, now, must find market functions that can support the technical weight of an ecological system approach - not yield per acre, not largest restoration site size, but sustainable and robust plant communities into the future.

SUSTAINABLE LIVESTOCK GRAZING ON PUBLIC RANGELANDS &NDASH; WHY NOT? Kenneth W. Tate*¹, Kristin M. Oles², Dave A. Weixelman³, Leslie Roche⁴; ¹University of California, Davis, Davis, CA, ²University of California Davis, Davis, CA, ³US Forest Service, Nevada City, CA, ⁴University of California, Davis, CA

ABSTRACT

In the western U.S., millions of hectares of perennial grasslands, shrublands, and forestlands are held in the public domain and managed by state and federal agencies for multiple land uses, including livestock grazing. Society has strong contemporary expectations for stewardship of public rangelands to balance agricultural goals with social, cultural, and conservation goals in a changing environment. Since the mid-20th century, public grazing lands policy and management paradigms have moved to increasingly integrate agricultural and conservation goals. While there is clear evidence that livestock can be managed to conserve and enhance ecosystem services in grazed landscapes, there is also clear evidence that unmanaged, excessive grazing can degrade ecosystems and associated goods and services. Modern conservation management strategies (e.g., adoption of annual grazing standards or disturbance limits) have been implemented to better balance conservation and livestock production objectives. During the period 2000-2015, livestock animal unit months on federal lands has been reduced by 15% on average across the 11 western states, with extremes of 67% and 36% in Wyoming and California respectively. We propose that to achieve balance between agricultural and conservation goals, public lands grazing strategies must (1) establish and co-value measurable production and conservation objectives; (2) have real-time management action triggers to safeguard ecosystem services; and (3) be adaptive to accommodate spatially and temporally variable, site-specific conditions.

WHO'S RANCHING ON PUBLIC LANDS? THE SOCIAL AND ECONOMIC CHARACTERISTICS OF PUBLIC LAND RANCHERS . Bree N. Lind*¹, John Tanaka², Kristie Maczko²; ¹Y2 Consultants, Jackson, WY, ²University of Wyoming, Laramie, WY

ABSTRACT

Reliable information documenting characteristics of public land ranchers is needed to help land managers and policy makers understand ranchers' economic and social validity, the diversity of operations, and the contributions to local communities. A survey was administered to gather these data. Data were collected at both the national and Wyoming levels.

Cluster analysis was used to determine different rancher groups in both studies and the groups were then compared to one another. Rancher attributes gathered from survey responses were used as factors in determining the different cluster groups. These attributes included: values, debt-asset, ranch labor, ranch income, business organization, number of livestock, education, and community involvement. In the national study six distinct rancher groups were found. They included the small operation rancher, the sheep rancher, the family cattle rancher, the corporate rancher, the diversified agriculture rancher, and the cattle and sheep rancher. In the Wyoming study, four distinct rancher groups were found. These rancher groups were the small cow-calf rancher, the sheep rancher, the yearling rancher, and the large cow-calf rancher. It was found that ranchers are diverse and can be classified into different groups based on the information collected. Different groups respond differently to federal lands grazing policies. This information should be considered when making policy or land management changes.

RANCHER PERCEPTIONS OF ECOSYSTEM SERVICES FROM INTERMOUNTAIN WEST RANGELANDS

. Mark Brunson, Elisabeth York*; Utah State University, Logan, UT

ABSTRACT

Rangelands managed for livestock grazing are expected to provide additional ecosystem services to the public. Ranchers with public land permits are required to consider resources other than forage in their management; often they also do so on their own properties. We studied how ranchers perceive the ecosystem services on lands they manage. Semi-structured interviews conducted in the tri-state region of Idaho, Utah, and Wyoming yielded three principal motivations driving management choices: livestock production, heritage and legacy preservation, and control of one's own destiny. In addition a list of 19 ecosystem services was derived from discussions with interviewees. These themes and services were then used to guide development of a mail survey administered to a sample of 1,000 Bureau of Land Management permittees whose livestock graze on lands located across the Great Basin. Responses were obtained from 44% of ranchers receiving the survey. Results supported the importance of the three principal management motivations. Forage production, family legacy, and sustainable flows of clean water were the services rated most important. More than 90% of respondents also indicated that demonstrating good stewardship to the public or other ranchers was one of their management objectives. Contrary to previous studies, there was no clear preference for provisioning ecosystem services over other types (regulating, supporting, cultural). Ranchers tended to reporting managing for a larger suite of ecosystem services if they rely upon relatively large information networks for management information, depend upon their livestock operation for more than half of household income, and maintain a herd larger than 300 head. Overall, ranchers are aware of how their operations can affect or enhance ecosystem services, and will manage in ways that can support other services if forage production is not threatened. However, ability to manage for other services is constrained by factors inherent to the ranching operation.

LIVESTOCK GRAZING AND WATER QUALITY ON PUBLIC GRAZING LANDS - IMPLICATIONS FOR HUMAN AND ECOLOGICAL HEALTH.

. Kelsey DeRose¹, Rebecca K. Ozeran*², Claire Neal³, Leslie Roche⁴, David F. Lile⁵, Danny J. Eastburn⁶, Kenneth W. Tate¹; ¹University of California, Davis, Davis, CA, ²University of California Cooperative Extension, Fresno, CA, ³University of California, Berkeley, Berkeley, CA, ⁴University of California, Davis, CA, ⁵UC Cooperative Extension, Susanville, CA, ⁶University of California - Davis, Davis, CA

ABSTRACT

There continues to be great concern that microbial pollution by grazing livestock degrades water quality on multiple-use rangelands, threatening human and ecological health. Given the importance of clean water on these shared landscapes and the impending changes to federal and state recreational water quality standards, there has been growing stakeholder interest in research on relationships between microbial water quality and common resource use activities on public lands. Fecal indicator bacteria (FIB), such as *Escherichia coli* (*E. coli*) and fecal coliform, are commonly used as indicators of microbial water quality and risk to human health. We will discuss several recent studies that quantified FIB concentrations in watersheds containing U.S. Forest Service public lands grazing allotments throughout the Sierra Nevada and Cascade mountain ranges in California. Results of these studies were used to characterize FIB concentrations throughout multiple-use watersheds and to assess the compatibility of current land uses with state and federal water quality standards. Examined primary land uses included livestock grazing, recreation, and rural residential areas. Sampling took place during the summer grazing-recreation season to capture the peak period of human and livestock interaction. Samples from stream sites throughout each watershed were collected regularly over the sampling periods and were processed according to established protocols. Results from these studies indicate that well-managed livestock grazing, recreation, and clean water can be compatible goals on National Forest grazing allotments.

GRAZING FOR FUEL AND FIRE MANAGEMENT ON PUBLIC LANDS.

. Kirk W. Davies*; USDA - Agricultural Research Service, Burns, OR

ABSTRACT

Large, frequent wildfires are becoming more common in the Intermountain West. Exotic annual grass dominance is a serious threat across the sagebrush ecosystem, particularly in hotter and drier plant communities. Clearly, fuel management is needed, but sagebrush rangelands are expansive. Grazing by domestic livestock is likely the only treatment that can feasibly be applied across such large landscapes. Well-managed grazing reduces fine fuel loads and continuity, increases fuel moisture, and decreases fuel heights. Grazing alterations to fuel reduced the likelihood of initial ignition and fire spread. These changes to fuel characteristics also reduced fire behavior, temperature, and duration of elevated temperature. This resulted in reduced fire severity, in particular, less mortality of perennial vegetation. Subsequently, grazing decreased the risk of post-fire exotic annual grass dominance compared to ungrazed areas. These results demonstrate that grazing can be a valuable tool for fuel and fire management in rangelands.

LARGE UNGULATE HERBIVORY ON RANGELANDS OF THE INTERMOUNTAIN WEST

. Eric T. Thacker*, Kyle Nehring, Kari E. Veblen; Utah State University, Logan, UT

ABSTRACT

Large ungulate grazing is one of the most ubiquitous uses of rangelands in North America. Specifically, livestock grazing occurs across most public rangelands in the Western US. Federal rangeland managers are tasked with managing livestock grazing and balancing livestock and wildlife uses through proper grazing management. Quantifying and managing the impacts of ungulate herbivory on western landscapes can be a multi-faceted challenge. In the Western US unique challenges arise because wildlife are owned by states and habitats are largely managed by federal land management agencies. While federal land managers are not responsible directly for the wildlife they do have to manage for both wildlife habitats and livestock production. By analyzing data collected from a series of large livestock and wildlife exclosures we will outline individual and combined impacts of cattle and wild ungulate grazing on structure and composition of sagebrush dominated communities, including how soil properties moderate wild ungulate-driven changes to sagebrush stand structure. Our results will help managers untangle the complex ungulate foraging interactions.

CHALLENGES TOWARDS GOVERNANCE AND DECISION-MAKING PROCESSES IN EMPOWERING AND SECURING SUSTAINABLE USE OF RANGELAND RESOURCES AND MANAGEMENT IN CAMEROON

. Elhaj Jaji M. Gidado*¹, Stephen K. Ndzeidze², Richard A. Mbih³, Bongadzem C. Sushuu⁴, Harry M. Wirngo⁴; ¹Secretary General - MINEPIA - Cameroon, Yaounde, Cameroon, ²Oregon State University, Corvallis, OR, ³Assistant Professor, Corvallis, OR, ⁴University of Yaounde 1, Yaounde, Cameroon

ABSTRACT

In Cameroon, efforts towards governance and decision-making processes to ensure security of access to rangeland resources generally lack action to improve tenure, resource security and improvement of rangeland management. Rangelands occupy about 20 % of surface area in Cameroon; provide critical habitat to many animal and plant species; offer many vital goods and services to society and are home to pastoralists, agro-pastoralists, crop farmers, fishermen, and hunter-gatherers, who for centuries co-existed peacefully. Efforts to improve tenure and resource security, and rangeland management have involved and targeted different stakeholders and have employed different strategies to do so. In recent years this harmony is being threatened by changing land use patterns, poor land use planning and poor recognition of ownership rights. There have also been a number of valuable initiatives, processes, mechanisms and/or practices from which important lessons can be learnt to guide further developments. Despite efforts by state and non-state actors to improve pastoral tenure security little has been achieved because of poor coordination among actors and a complete absence of opportunities to document and or showcase these good initiatives. Generally, traditional pastoralist such as the Mbororo Fulani pastoralists are marginalized from development processes and most are uneducated having poor access to public services. However, cultural development associations have been working to improve the status and livelihoods of the natives. Capacity building of paralegals and community volunteers have been one of the cornerstones of these programs. Trainings have been supported in basic legal procedures, advocacy, and counselling, conflict resolution and human rights. This study, supported by the ILC Rangelands Initiative, sought to identify, review and analyze the different initiatives that are contributing/have contributed in making rangelands more secure.

CHALLENGES TOWARDS RESOLVING LAND USERS CONFLICT AMONG PASTORALISM AND INDIGENOUS PEOPLES' TENURE SYSTEMS IN RANGELAND. Bongadzem C. Sushuu*¹, Stephen K. Ndzeidze², Elhaj Jaji M. Gidado³, Richard A. Mbih⁴, Harry M. Wirngo¹; ¹University of Yaounde 1, Yaounde, Cameroon, ²Oregon State University, Corvallis, OR, ³Secretary General - Ministry of Livestock, Fisheries and Animal Industries, Yaounde, Cameroon, ⁴Assistant Professor, University Park, PA

ABSTRACT

In Cameroon rangelands are often characterized by a wide range of phenomena and activities that lead to conflicts and ecological change. Resolving land users conflict among pastoralism and indigenous peoples' tenure systems in rangeland have remain one of the major preoccupation of among farmers and grazier in Cameroon. Uncontrolled livestock movements are the major cause of overgrazing, declining ecosystem productivity, widespread and dangerous agro-pastoral conflicts. Pastoralists are capable managers of rangeland resources, because they understand the physical environment and challenges towards indigenous tenures systems, rights and access to communal pastureland. Increasing population densities compunds conflict between user groups of agro-pastoral landscape. Though today Farmer-grazier conflicts and pressure have increasingly been challenged by new conflicts such as increasing population and changing landuse patterns, pastoralist and indigenous people are still able to deal with these problems through the traditional authority. However, if given the right support and access to opportunities like dialogue platforms can improve conflict management among pastoralism and indigenous peoples' tenure systems in rangeland. These platforms show how local methods of conflict resolution can be built on to provide a greater opportunity for rangeland users to continue to contribute to even control, decision-making processes. In Cameroon, there exist functioning customary conflict resolution mechanisms, however, the state has developed its own mechanism for resolving conflicts that are less embeded in local institutions. Pastoralist-farmer alliances has been developed to facilitate resolution of land use and resulting conflicts with support from NGOs. Resolving conflicts also requires working at different levels, as part of a coordinated strategy of engagement. Some issues need to be resolved at local levels and others at national or even international levels. For example, resource and landuse conflicts at the local level in northern Cameroon are being aggravated influx of thousands of refugees from Central Africa Republic and Nigeria.

EMPOWERING AND SECURING PASTORALISM, LAND RIGHTS AND BUILDING PARTICIPATORY APPROACHES (CBMS) FOR SUSTAINABLE RANGELAND MANAGEMENT. Harry M. Wirngo*¹, Stephen K. Ndzeidze², Elhaj Jaji M. Gidado³, Richard A. Mbih⁴, Bongadzem C. Sushuu¹; ¹University of Yaounde 1, Yaounde, Cameroon, ²Oregon State University, Corvallis, OR, ³Secretary General - MINEPIA - Cameroon, Yaounde, Cameroon, ⁴Assistant Professor, University Park, PA

ABSTRACT

Rangelands remain one of the socio-economic and ecological backbone and major land use type of Cameroon. It sustains varied livestock on diverse ecosystems ranging from wet meadows, inland valleys to upland plateaus. Empowering and securing pastoralism, land rights and building participatory approaches for sustainable Rangeland management is very important for rangelands in Cameroon. Rangelands and good number agropastoral areas are considered as no man's land and classified as state lands that are formally recognized as communal lands meant for use by all and to which different individuals, groups or communities attribute variable more or less appreciative perceptions. Pastoralism is dominated by open free ranging with uncontrolled movement with degradation continuously being noticed. Undefined boundaries, unsecure pastoral tenure, land grabbing, trespassing, farmer-grazier conflicts, degradation, poor range products and more recently challenges of weed management, climate variability and range improvement are current management problems. The elaboration of a pastoral code due to the evidence based-advocacy in the local graziers in the area can be a way of transforming local actions to policy reforms. This can be a major step in ensuring pastoral tenure security. This base will enable communities to act. Rangeland management, land use planning, restoration of degraded lands, weed management or in summary local resource governance can therefore be pursued with a solid base. The existing social disposition in terms of institutions is the grouping of graziers in grazing zones called ardorates with the leader being the Ardo, a Fulani spiritual leader for they essentially dominate grazing in the area. It is this evidence based local communal organization that can reach out to resource users, coordinate behavior and negotiate change and improvement with development agencies. Community based management systems (CBMS) can be created on this existing base of institutional frameworks existing in the area with a delimitation of grazing zones.

EMPOWERING WOMEN AMONG THE FULANI PEOPLE THROUGH COMMUNITY BASED MANAGEMENT SYSTEMS OF MULTIPLE-USE OF RANGELAND RESOURCES . Richard A. Mbih*¹, Stephen K. Ndzeidze², Elhaj Jaji M. Gidado³, Bongadzem C. Sushuu⁴, Harry M. Wirngo⁴; ¹Assistant Professor, University Park, PA, ²Oregon State University, Corvallis, OR, ³Secretary General - MINEPIA - Cameroon, Yaounde, Cameroon, ⁴University of Yaounde 1, Yaounde, Cameroon

ABSTRACT

The empowering of women through development agencies and community based management systems (CBMS) for sustainable use of multiple rangeland resources among the Fulani people is increasingly becoming a focal point of women right in Cameroon. The Fulani pastoralists of the Western Highlands of Cameroon are a sub-group of the Fulbe, a wider pastoral group whose members are dispersed across Sub-Saharan Africa. They migrated and settled in the Western Highlands of Cameroon in the early periods of the 20th century at different times and migratory waves. Since their arrival in the region, they have experienced different stages of settlement transformation due to the changing socio-economic and ecological conditions influencing their nomadic lifestyle. In Fulani households, women were often relegated in most agro-pastoral task, and are only involved in the milking and selling of cow-milk alongside smaller livestock and animal products like chicken and eggs, while men are responsible for doing almost all the agro-pastoral jobs, sponsoring the cultivation of both tree, cash and food crops around their settlements. Recently, Fulani women's involvement in agricultural activities has increased as they farm and cultivate crops alongside their male counterparts at the same scale. Despite Fulani agro-pastoral interactions with their host farming and mainstream communities, their minority position in terms of population, and nomadic lifestyles has often contrasted with native cultures and state politics in the region who still perceived them as strangers. Their marginalization was the basis for the creation of Mbororo socio-cultural development association (MBOSCUDA) by Fulani youths, which encouraged the education of Fulani children and empowering women through capacity building, development agencies and CBMS for sustainable use and management of rangeland resources. Such CBMS approaches have facilitated cross-cultural integration and empowerment of Fulani women through complementarities and mutual co-existence over shared landuse resources, and promoting Fulani economic diversification in the region.

FORMULATING AND SECURING SUSTAINABLE RANGELAND/WATERSHED AGROFORESTRY THROUGH COMMUNITY BASED MANAGEMENT SYSTEMS (CBMS) STRATEGIES

. Stephen K. Ndzeidze*¹, Elhaj Jaji M. Gidado², Richard A. Mbih³, Harry M. Wirngo⁴, Bongadzem C. Sushuu⁴; ¹Oregon State University, Corvallis, OR, ²Secretary General - MINEPIA - Cameroon, Yaounde, Cameroon, ³Assistant Professor, University Park, PA, ⁴University of Yaounde 1, Yaounde, Cameroon

ABSTRACT

In the savanna grasslands of Cameroon, rangeland tree-based practices are new opportunities in market oriented sustainable resource management with enhanced land stewardship for improved integrated practices such as community based management systems (CBMS). Such prospects are only noticed where there is some institutional and organizational framework and strategies for grazing and livestock management. The common pool nature of rangelands in the Western Highlands watershed pushes most pastoralists to very unsustainable practices like excessive overgrazing with no plough back efforts to improve the range. Pastoralist are very independent with no checks and security of tenure, and compounded by open range grazing system on community land, we now have the growing problem of invasive weeds. Grazing activities are dominated by the Fulani Mbororo pastoralist who arrived the western highlands of Cameroon by 1916, but the indigenous people mostly involved in agricultural activities have increasingly engaged in grazing activities. Sylvopastoralism that combines tree/shrubs with forage (hay or pasture) in livestock production is fast emerging across several grazing zones as the most reliable integrating form of management to ameliorate the persistent degradation of the rangelands management. Though without existing institutions and structures to organize and coordinate the agroforestry activities for sustainable management, there is the need for formulating and securing sustainable tree/grass planting through CBMS strategies for integrating trees in grazing management. Agroforestry is a major challenge but is crucial for future rangeland improvements. To ensure the security of livestock production systems therefore, large-scale adoption and establishment of agroforestry with multi-purpose trees that are vital for watershed ecosystem management and protection is vital. Challenges to formulating and implementing agroforestry is partly because of lacked policies to ensure afforestation of watershed grazing land. Community grazier groups can be harness into small cooperatives within which different aspects about agroforestry management can be established

CHALLENGES TOWARDS GOVERNANCE AND DECISION-MAKING PROCESSES IN EMPOWERING AND SECURING SUSTAINABLE USE OF RANGELAND RESOURCES.

Stephen K. Ndzeidze*¹, Elhaj Jaji M. Gidado², Richard A. Mbih³, Bongadzem C. Sushuu⁴, Harry M. Wirngo⁴; ¹Oregon State University, Corvallis, OR, ²Secretary General - MINEPIA - Cameroon, Yaounde, Cameroon, ³The Pennsylvania State University, University Park, PA, ⁴University of Yaounde 1, Yaounde, Cameroon

ABSTRACT

The ecologically rich strategic location of savanna grasslands of Cameroon within Sub Saharan Africa, endows it with immense rangeland resources and fertile agropastoral landscape. Principally this study aims at portraying the ethnic diversity and related socioeconomic and cultural challenges towards securing sustainability and resilience in rangeland resource management among pastoralist and indigenous peoples tenure systems. Over time immemorial, rangelands and grazing activities such as transhumance have remained the major practice in the savanna grasslands of Cameroon as any part of in sub Saharan Africa. The evaluation of sociocultural, economic, environmental, and ecological challenges towards securing sustainability and resilience in rangeland resource management among pastoralist and indigenous peoples tenure systems are very significant on governance and decision-making processes. We also look at the implications of transhumance on wetlands ecosystem and habitat following intensive and unsustainable seasonal pastoralism in a mixed farming area. Culturally, the indigenes have learnt and are fully involved in cattle rearing which was formally a Fulani ethnic group practice. The latter became sedentary and have also learnt to devote themselves to agriculture. And so, we can go a long way to suggest that securing pastoralism, land rights and building participatory approaches such as Community based management systems (CBMS) for sustainable rangeland management can be the way forward. In Cameroon, rangelands are considered as no man's land and classified as state lands that are formally recognized as communal lands meant for all and to which different individuals, groups or communities attribute variable more or less appreciative perceptions. Pastoralism is dominated by open free ranging with uncontrolled movement with degradation continuously being noticed. Problems of tenure security and grazing rights are amongst the leading problems faced by pastoralists such as undefined boundaries, unsecure pastoral tenure, land grabbing, trespassing, land use conflicts (farmer-grazier conflicts), and recently challenges of weed management.

INTRO TO AIM: A CORE APPROACH TO MONITORING FOR MANY USES. Melissa D. Dickard, Emily Kachergis*; BLM, Denver, CO

ABSTRACT

The Bureau of Land Management's (BLM) Assessment, Inventory, and Monitoring (AIM) program was created to provide consistent, high quality information to support management and decision-making across the agency. Information empowers land managers to use public rangeland resources sustainably. Importantly, AIM data also facilitates working with stakeholders by establishing a common language for understanding resource condition. The AIM approach consists of five core principles informed by lessons learned from past monitoring efforts. These are: core indicators with standard data collection methods; electronic data capture and management; appropriate sample designs; structured implementation; and integration with remote sensing. The AIM principles provide a consistent framework and tools for field offices, state offices, and the Washington office to collect information to support decision-making.

INFORMING THE CONDITION OF BLM NATURAL RESOURCES: FROM PERMITTED USES TO NATIONAL LEVEL REPORTING

. Scott W. Miller*¹, Emily Kachergis²; ¹Bureau of Land Management/Utah State University, Logan, UT, ²BLM, Denver, CO

ABSTRACT

Under the Federal Land Policy Management Act, BLM is to manage the National System of Public Lands for multiple use and sustained yield. Sustained yield is to be assessed through periodic and systematic inventory of renewable resource condition and trend. The BLM's Assessment, Inventory, and Monitoring Strategy (AIM) is being implemented to provide the Bureau with high quality monitoring data to inform decisions from the scale of permitted uses, to resource management plan effectiveness, and on up to national scale reporting. In this talk, we will present how implementation of the AIM principles (e.g., use of consistent indicators, sampling methods and statistically appropriate sample designs) is allowing the BLM to meet its multi-scale data needs. Specifically, we will show case how individual field offices are using AIM monitoring to set potential natural conditions, from which restoration and reclamation effectiveness efforts are being assessed, and resource management plans are being modified or developed. The use of a single monitoring strategy to meet multiple information needs maximizes the return on monitoring investments through creating efficiencies in terms of training, data storage, and analytical resources.

DEFENSIBLE DATA: MAKING GRAZING MANAGEMENT DECISIONS IN THE 21ST CENTURY. Daniel Zvirzdin*; Bureau of Land Management, Elko, NV

ABSTRACT

Since in the late 20th century, the Bureau of Land Management (BLM) has struggled to make grazing management decisions in a timely manner. This has hampered the BLMs ability to fulfill its mission: to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. Although BLM regulations and federal laws and policies guiding grazing management have remained largely constant since the turn of the century, steady litigation has progressively slowed the grazing decision process. One liability common to many cases is the quality of BLM monitoring data. In an effort to improve data quality and make better informed decisions, the BLM adopted the Assessment, Inventory, and Monitoring (AIM) program. In the last five years, the AIM program has been a primary driver in improving the defensibility of the data the BLM collects. Perhaps as important as this direct effect, the fundamental changes AIM brought to the BLM monitoring program have given specialists within the BLM the perspective necessary to identify and address other weaknesses in the grazing decision process.

EVALUATING POST-FIRE RESTORATION TREATMENT EFFECTIVENESS WITH AIM.
Andrew C. Johnson*; Bureau of Land Management, Susanville, CA

ABSTRACT

As the size and severity of wildfires across the Western United States has increased, the cost and magnitude of post-fire restoration efforts has increased as well. The Department of the Interior (DOI) spends roughly 2% of its Wildland Fire Management budget on Burned Area Rehabilitation (BAR). Although implementation of post-fire restoration treatments is expensive and labor intensive, the tracking of post-fire restoration treatment effectiveness has been sparse and disjointed across the Bureau of Land Management (BLM). The BLM's Assessment, Inventory, and Monitoring (AIM) program offers a standardized framework to implement, monitor and track treatment effectiveness; inform adaptive management; and direct local management decisions. The BLM California's Eagle Lake Field Office used AIM to assess the success and failure of restoration treatments following the 2012 Rush Fire. The Rush Fire burned 315,557 acres, roughly one third of the public land managed by the Eagle Lake Field Office. In the winter of 2012, the Eagle Lake Field Office aerially seeded 24,000 acres by helicopter and drill seeded 3,000 acres with a rangeland-drill. In 2013, the Eagle Lake Field Office began monitoring the aerial broadcast and rangeland-drill seeding sites using AIM. In the Eagle Lake Field Office, AIM has provided a standardized framework to evaluate treatment effectiveness with quantitative benchmarks and in the context of broader landscape condition. By using realistic and applicable quantitative benchmarks, the Eagle Lake Field Office assessed the success of treatments and altered future management practices to incorporate lessons learned. This approach represents a framework for the structured and standardized implementation and evaluation of post-fire restoration treatments within the BLM.

USING MULTIPLE LINES OF EVIDENCE TO INFORM GRAZING MANAGEMENT

. Cassie Mellon*¹, Scott W. Miller², Justin Jimenez¹, Robin Jones³; ¹Bureau of Land Management, Salt Lake City, UT, ²Bureau of Land Management, Denver, CO, ³National Aquatic Monitoring Center, Logan, UT

ABSTRACT

The Salt Lake Field Office of the BLM is working to change grazing management on multiple allotments in Rich County, Utah. The area provides habitat for sensitive species including Bonneville cutthroat trout and greater sage-grouse. To conduct a Rangeland Health Assessment in support of a grazing use authorization, we gathered all available data. We included field data collected over a 7-year period at a mix of random and targeted locations on streams within the allotments. From these data, we derived several indicators of instream and riparian habitat condition. The resulting assessment was based on data from eight sites

An interdisciplinary team made the overall determination of aquatic conditions. We analyzed the data in relation to benchmarks established for the grazing permit, ecoregion, or to meet habitat needs for Bonneville cutthroat trout. This benchmark assessment was done for multiple indicators, focusing on those that were most likely to be influenced by livestock or important to sensitive species. For example, excess fine sediment within the stream channel is known to have a negative impact on Bonneville cutthroat trout populations. Thus, we included percent fine sediment as an indicator in this assessment. We determined that percent fine sediment levels less than 23% were considered to be in good condition, 23-37% in moderate, and greater than 37% was considered degraded. For this indicator, good conditions were only found within exclosures and a mix of moderate to poor conditions were observed outside exclosures. Overall site condition determinations were then extrapolated to all stream miles in the larger project area and the overall condition determinations were used to support the grazing use authorization. This is an example of how using quantitative data to make condition determinations will result in more defensible assessments, management decisions, and evaluations of aquatic ecosystem health.

A FRAMEWORK FOR NEPA ANALYSES USING AIM DATA. Joel Humphries*¹, Ben Billings², Zoe Davidson³; ¹BLM, Lakewood, CO, ²BLM, Monte Vista, CO, ³BLM, Sante Fe, NM

ABSTRACT

The Bureau of Land Management (BLM) Assessment, Inventory, and Monitoring (AIM) data provides new opportunities to augment information used in National Environmental Policy Act (NEPA) analyses to determine if land health standards are achieved to provide information for grazing permit renewals. We outline a framework of how to incorporate AIM data into NEPA Affected Environment and Impact Analysis sections using current AIM data analysis tools. First, we discuss how synopses of AIM data like Environmental Site Summaries or frequency distributions describe baseline conditions in the Affected Environment section of NEPA, with examples from the San Luis Valley Field Office in CO. Implementing the framework begins when an interdisciplinary team (IDT) establishes quantifiable benchmarks, ideally identified in current Resource Management Plan or Land Health Standards. Ecological site descriptions, policy, reference networks, and scientific literature can also inform benchmarks. AIM data within the analysis area are then evaluated against these benchmarks to determine if the monitoring and management objectives are met. In conjunction with AIM data analysis, the IDT determines additional lines of evidence as needed for the NEPA impact analyses. As appropriate, additional AIM data at random or targeted locations, use-based data, remote sensing data, and wildlife data are all considered in this multiple lines of evidence analysis to help in determining the land management decision. Second, we discuss how AIM data can be used in the Impact Analysis section to report on what resources are meeting, or not meeting land health standards or other appropriate quantifiable management objectives. By providing additional site and landscape scale information, AIM data can be used to improve NEPA analyses using quantitative data and provide better information to land managers.

APPLICATION OF ASSESSMENT, INVENTORY, AND MONITORING DATA TO A GREATER SAGE-GROUSE HABITAT ASSESSMENT IN OREGON. Molly Anthony*, Christopher Domschke, Glenn Frederick, Robert Pattison; Bureau of Land Management, Portland, OR

ABSTRACT

In 2015, the Bureau of Land Management (BLM) committed to conducting multi-scale habitat assessments for Greater Sage-Grouse (*Centrocercus urophasianus*) across BLM managed lands in the west. The first full implementation of this policy was conducted in 2017 by the Lakeview Field Office for the Beatys Butte area in south-central Oregon and north-central Nevada. This *Sage-Grouse Habitat Assessment Framework* (HAF), multi-scale summary report (mid-, fine-, and site-scale) informs the Rangeland Health Assessment associated with the livestock grazing permit renewal for allotments within the fine-scale area. The site-scale analysis evaluated sage-grouse seasonal habitat conditions using indicators derived from vegetation data collected in 2016 following Assessment, Inventory, and Monitoring (AIM) protocols. AIM points used in this analysis came from the Lakeview Field Office sample design with intensification in Sagebrush Focal Areas, and in the allotment where the permit renewal was occurring. The indicator values were used to determine site-scale suitability ratings for each plot. Core AIM indicators and supplementary indicators from the Oregon Greater Sage-Grouse Approved Resource Management Plan Amendment contributed to the suitability rating. The site-scale habitat suitability determinations were then used to estimate the proportion of suitable, marginal, and unsuitable area in sage-grouse seasonal use areas within the Oregon portion of the fine-scale boundary. Mid- and fine-scale analyses evaluated Greater sage-grouse habitat conditions at the regional and sub-regional scale. The estimated proportion of sage-grouse breeding, summer and winter habitat within the fine-scale analysis area that was suitable was 74.1%, 88.1%, and 93.9% respectively. The fine-scale area was determined to be suitable, because anthropogenic disturbance is low and availability of habitat does not limit dispersal potential between seasonal use areas. The mid-scale area was also determined to be suitable, primarily due to the composition of large occupied and contiguous patches of sagebrush, and sagebrush associated vegetation, land cover.

MULTI-SCALE WIND EROSION MONITORING AND ASSESSMENT FOR US RANGELANDS

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ABSTRACT

Wind erosion is a major resource concern for rangeland managers. Although wind erosion is a naturally occurring process in many drylands, land use activities, and land management in particular, can accelerate wind-driven soil loss – impacting ecosystem dynamics and agricultural production, air quality, human health, biogeochemical cycles, and climate. Wind erosion has large variability in space and time, and as a consequence is difficult to monitor effectively in ways that can support its management. Existing US air quality monitoring programs provide indicators of wind erosion intensity (e.g., particulate matter [PM] concentrations) and associated benchmarks (e.g., Clean Air Act) are regulated federally but provide no information about which landscapes are eroding, but how much, or when. Standardized rangeland monitoring programs like the BLM's Assessment, Inventory and Monitoring (AIM) Strategy and the NRCS's National Resources Inventory (NRI) collect information about soil properties (texture) and vegetation (foliar cover, canopy gap size, height) that, coupled with remote sensing products and numerical models, can be used to estimate wind erosion and dust emission rates across spatial scales to better inform management. Here I present an overview of the National Wind Erosion Research Network and ongoing efforts to develop decision-support tools that connect existing soil, vegetation and air quality monitoring programs to provide information to federal agencies and the public about wind erosion rates. I demonstrate how core indicators used in the AIM and NRI monitoring programs can be integrated to assess dust emission rates; enabling air quality, human health and ecosystem impacts of dust to be linked to changes in range condition and benchmarks for rangeland management. I then describe how AIM and NRI data can be used to interpret remote sensing-driven model estimates of wind erosion and understand interactions with land use and management activities across ecological sites.

PRIORITIZATION OF RESTORATION ACTIONS WITH MULTI-SCALE INFORMATION: AN ESCALANTE RIVER WATERSHED CASE STUDY

. Ken Bradshaw*¹, Scott W. Miller², Kevin H. Miller², Justin Jimenez³, Sandra Litschert², William W. Macfarlane⁴, Brian Laub⁴, Christian Perry⁴; ¹Bureau of Land Management, Kanab, UT, ²Bureau of Land Management, Denver, CO, ³Bureau of Land Management, Salt Lake City, UT, ⁴Utah State University, Logan, UT

ABSTRACT

Numerous datasets are available to public land management agencies for prioritizing aquatic restoration efforts, but their use has been limited by inadequate data access and/or a lack of guidance of how to integrate the data into a decision support framework. The objective of this work was to use the Escalante River Watershed (ERW) in the Grand Staircase-Escalante National Monument as a case study to show how public land managers can use multi-scaled information to prioritize restoration and conservation actions. The Colorado Plateau Rapid Ecoregional Assessment (REA) estimated ecosystem intactness at the subwatershed scale, as well as anthropogenic drivers for observed departures. Aquatic Assessment Inventory and Monitoring (AIM) was then used to characterize drivers of aquatic condition at specific locations within these subwatersheds. This case study provided insights about the limitations of the scale of data in land management assessments. The REA data can show drivers of aquatic intactness (e.g., hydrologic alteration and habitat quality) at the subwatershed level, but cannot be used to determine causes of departures from reference conditions at specific locations within a subwatershed and therefore aid in deciding what restoration actions are appropriate at the project scale. Aquatic AIM data can help to identify physical, biological, and chemical conditions at specific locations and provides some insight into the cause of departure from reference conditions so that land managers can prioritize restoration and conservation projects. Local knowledge from resource specialists and data gathered from watershed partner groups was also important for determining causes of departure. This study was an important first-step in developing guidance for assessing aquatic condition using multi-scaled data and for setting up a functional decision support framework that will aid public land managers in aquatic restoration project prioritization. Decision support tools will be developed that show how to incorporate these data into management decisions.

ASSESSING VEGETATION CHANGE THROUGH TIME: BRIDGING SVIM AND AIM THROUGH LANDSAT

. David S. Pilliod*¹, Brittany S. Barker², Collin Homer²; ¹US Geological Survey, Boise, ID, ²USGS, Boise, ID

ABSTRACT

Rangeland environments in the Great Basin are undergoing changes associated with invasive species, altered fire regimes, climate shifts and other disturbances. Some changes are expressed as state transitions in vegetation, whereas others are more subtle trends in cover. These changes have important ecological and economic implications and understanding the drivers of change has become an important area of research. We used thousands of historic (1977–1982; Soil Vegetation Inventory Method) and recent (2011–2016; Assessment Inventory and Monitoring) field plot data collected by the Bureau of Land Management to determine the amount of environmental change occurring on rangelands in the Great Basin and assess what factors are having the most influence on these trends. We combined discrete field sampling data with spatially-continuous annual data from Landsat satellite imagery (1984–2016) to map and quantify vegetation and exposed soil changes in grasslands and shrublands. Preliminary results suggest that some areas of the Great Basin are changing more than others and much of this change can be attributed to wildfire. Results also suggest that some areas have remained relatively stable through time. Areas of vegetation stability could be used as reference areas to better evaluate future changes in vegetation and soil.

APPLYING AIM TO ASSES RESOURCE MANAGEMENT PLAN EFFECTIVENESS IN
THE RAWLINS FIELD OFFICE. Brad Tribby*, Cheryl I. Newberry; BLM, Rawlins, WY

ABSTRACT

The Rawlins Field Office (RFO) is located in southcentral Wyoming and encompasses 3.5 million surface acres of BLM land often within a mixed landownership pattern. The RFO includes over 400 miles of perennial stream systems managed for multiple use. Predominant land uses in the area include energy development, cattle grazing and wildlife. The RFO Resource Management Plan (RMP) was signed in 2008, however no standardized monitoring programs existed for the field office. In 2016, the RFO determined that BLM's Assessment, Inventory and Monitoring (AIM) program would be a useful tool for RMP effectiveness evaluations. The AIM program was chosen because it provides a standardized process for BLM to collect quantitative information on the status, condition, trend, amount, location and spatial pattern of resources on the nation's public lands. In two years the RFO has sampled 172 upland sites and 84 riparian sites. Examples of Resource Management Plan effectiveness in the upland sites is grouping the sagebrush habitat plots into Special Focus Areas, Priority and General Habitat Management Areas for Greater Sage-Grouse and evaluating habitat quality. The aquatic sites are being grouped by stream type and being evaluated for overall habitat quality and land health standard attainment.

IDENTIFYING PRIORITY STRESSORS AND MAKING CAUSAL DETERMINATIONS: COLLABORATIVE MONITORING WITH AIM

. Jerrad Goodell*¹, Scott W. Miller², Justin Jimenez³, Robin Jones⁴; ¹Bureau of Land Management, Vernal, UT, ²Bureau of Land Management, Denver, CO, ³Bureau of Land Management, Salt Lake City, UT, ⁴National Aquatic Monitoring Center, Logan, UT

ABSTRACT

Aquatic Assessment, Inventory, and Monitoring (AIM) data collected by the Bureau of Land Management (BLM) suggested that perennial streams in Carbon and Emery counties of Utah exhibit increased nutrient loading and conductivity levels. Observed values exceeded state water quality standards and therefore did not meet BLM land health standards. However, water quality field data collection was limited to one-time grab samples collected in the summer during low flows, potentially leading to elevated concentrations. Based on aquatic AIM data, the BLM Green River District in 2017 coordinated with the Utah Division of Water Quality to collect monthly water samples within in Carbon and Emery counties to further address potential water quality exceedances following state guidelines. The goals of this monitoring were to determine 1) what is the spatial and temporal extent of water quality impairments, and 2) which land uses and ownership are most strongly associated with changes in water quality. The selection of sample locations was informed by Colorado Plateau Rapid Ecoregional Assessment modeling efforts that associated potential water quality exceedances with land uses such as agricultural activity, hydrologic alteration and oil and gas development. We will assess the attainment of state water quality standards using the temporally intensive sampling data and relate spatial patterns to both land use activities and ownership such as the percent agriculture cover, amount of irrigation return flows, density of oil and gas wells and urban area upstream of the sampling points.

SCIENCE BASED MANAGEMENT: USING THE BLM'S AIM STRATEGY TO MONITOR FUELS AND VEGETATION MANAGEMENT PROJECTS

. Casey P. Addy*; Bureau of Land Management, Salt Lake City, UT

ABSTRACT

As catastrophic wildfires continue to increase in size and frequency across the American West, fuels and vegetation management projects are quickly becoming first priority for BLM and other land management agencies. Science based monitoring of treatment effectiveness should be an intricate part of any fuels or vegetation management project. Currently, a general lack of consistency exists within the BLM for monitoring and reporting effectiveness of vegetation management projects (especially at the national level). Other variables such as standard processes for field site selection, methodologies for data collection, and interpretation and use of vegetation monitoring data varies drastically across BLM district and field offices. These inconsistencies create a large web of data that is inaccessible and unusable outside of the local field office. The BLM AIM Strategy solves many of these problems within the BLM by providing a standardized framework for sample design, monitoring, storage, and interpretation and reporting of monitoring data. The AIM Strategy has been successfully used on several pilot vegetation management projects in Utah. These projects can be used as case studies on how the AIM Strategy can be successfully used for monitoring effectiveness of fuels and vegetation management.

FORGING A STANDARD APPROACH TO LENTIC MONITORING AND ASSESSMENT APPLYING AIM PRINCIPLES

. Joanna Lemly¹, Melissa D. Dickard*²; ¹Colorado Natural Heritage Program, Fort Collins, CO,
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ABSTRACT

Monitoring lentic systems is imperative to the Bureau of Land Management (BLM) and US Forest Service's (USFS) multiple-use mandates directing management of watersheds for activities that potentially impact lentic resources, such as livestock grazing, timber harvesting, mining, energy development, and recreation. Consequently, knowing the condition and trend of lentic systems at both targeted sites and broader spatial scales is critical to achieving BLM's mission to "sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations." To more effectively evaluate resource condition across landscapes, and as a result of different management objectives that transcend traditional boundaries, the BLM decided to approach lentic monitoring under the broader Assessment, Inventory and Monitoring (AIM) strategy and the National Aquatic Monitoring Framework (NAMF) specifically. To address these needs, an interagency, interdisciplinary working group was formed to establish core indicators for lentic systems sampled under the AIM strategy. The selection of lentic indicators is following a process similar to that used to select and validate lotic core indicators under the NAMF, which included internal and external peer review. Lentic core indicators address vegetative cover and composition, plant height, woody species density and age class, and pedestaling. Supplemental indicators, which can be collected in addition to core indicators, include use-based measurements of stubble height and woody species use. This is unique because it is the first AIM protocol to include short-term and use-based indicators, which can tie condition to management. The draft protocol includes methods to evaluate condition and trends across various spatial scales, and multiple transect layouts to accommodate both systematic random sampling and targeted use-based monitoring. The protocol will be tested in the summer of 2018 for feasibility of field use, and research will be needed to validate sample sufficiency and ability to detect change.

HIGH QUALITY DATA: AN EVALUATION OF AIM DATA QUALITY AND DATA QUALITY PROCEDURES

. Sarah E. McCord*¹, Sarah Burnett², Nicole Cappuccio², Jennifer Courtwright³; ¹USDA-ARS, Las Cruces, NM, ²Bureau of Land Management, Denver, CO, ³Utah State University, Logan, UT

ABSTRACT

The goal of every monitoring program is to collect high-quality data which can then be used to provide information to decision makers. The Bureau of Land Management (BLM) Assessment, Inventory, and Monitoring (AIM) program is one such data set which provides rangeland status, condition, and trend information across BLM rangelands. These points represent aquatic and terrestrial resources across the western United States and Alaska. To date there are over 18,000 terrestrial points and 1400 aquatic points. While these data were collected for specific objectives, they are available for use by other BLM resource managers, other agencies and academic institutions to meet multiple resource questions and objectives. The broad utility of these data is due to the core methods and protocols employed during data collection as well as the quality assurance and quality control protocols employed by the AIM program. Here we evaluate the steps AIM takes to ensure quality, including project planning, core method implementation, observer training and calibration, electronic data capture, automated and manual data checks, and database structures. We describe the terrestrial database, TerrADat, and aquatic database, AquADat, and how these databases can be accessed by non-BLM users. Known quality procedures and evaluation measures improve the AIM data and can help users understand how and when the AIM data or data procedures may be useful to current and future applications.

CHALLENGES AND OPPORTUNITIES WITH STANDARDIZED MONITORING FOR MANAGEMENT DECISION-MAKING

. Jason W. Karl*¹, Sarah McCord², Scott W. Miller³; ¹University of Idaho, Moscow, ID, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³Bureau of Land Management, Denver, CO

ABSTRACT

The importance of monitoring for adaptive management of rangelands has been well established. However, the actual use of monitoring data in rangeland management decisions has been modest despite extensive efforts to develop and implement monitoring programs from local to national scales. More effective use of monitoring data is critical to inform adaptive management, to empirically justify management decisions, and to ensure a return on resources invested in monitoring programs like the Bureau of Land Management's (BLM) Assessment, Inventory, and Monitoring (AIM) program. Several challenges limit the use of monitoring data in management decision making. First, there is often a disconnect between aspects of monitoring (e.g., indicators, sample design, timing) and information needs of managers for making decisions. This can arise from a lack of specific monitoring objectives tied to management decisions or from monitoring indicators being analyzed and presented in forms that do not mesh with land management workflows. Second, in many cases little information exists on how to interpret monitoring results with respect to land potential (e.g., is the amount of bare ground more than what is expected for this type of rangeland?). Third, given limited resources, monitoring data often produce estimates with large confidence intervals, which causes challenges for interpreting whether a change has occurred or a land health standard has been met. Fourth, there is a tension between flexibility to design monitoring around management needs for specific, immediate objectives and maintaining standard monitoring approaches to build long-term datasets. This has the effect of reinforcing short-term monitoring at the expense of investing in standardized efforts that could address multiple objectives over the long term. We describe these challenges in the context of the BLM AIM projects discussed during the symposium. We explore potential opportunities for addressing these challenges and how the AIM program can be leveraged for success.

KEYS TO SUCCESS FOR DATA-DRIVEN DECISION MAKING: LESSONS FROM PARTICIPATORY MONITORING AND COLLABORATIVE ADAPTIVE MANAGEMENT . Maria Fernandez-Gimenez*¹, Hailey Wilmer², David Augustine³, Lauren Porensky³, Justin D. Derner⁴, David Briske⁵, Michelle Stewart¹; ¹Colorado State University, Fort Collins, CO, ²USDA-Northern Plains Climate Hub, Fort Collins, CO, ³USDA-ARS, Fort Collins, CO, ⁴USDA-ARS, Cheyenne, WY, ⁵Texas A&M University, College Station, TX

ABSTRACT

Recent years have witnessed a call for evidence-based decisions in conservation and natural resource management, including data-driven decision-making. Adaptive management (AM) is one prevalent model for integrating scientific data into decision-making, yet AM has faced numerous challenges and limitations. Collaborative adaptive management (CAM) seeks to overcome some of these limitations, especially “buy-in” by managers and other stakeholders. This presentation draws on the literature on participatory monitoring and a case study of collaborative adaptive rangeland management (CARM) to distill key lessons for data-driven decision making in rangeland management. Studies of participatory monitoring show that data are more likely to lead to management actions when resource users/managers are actively involved in the monitoring process. The CARM case study illustrates that even when resource users and managers are involved in identifying monitoring objectives and indicators, and interpreting data, it may take considerable time to develop 1) trust and mutual respect between those who collect and analyze data (often researchers), and those who use the data to make decisions (such as agency managers, ranchers, conservation organizations), and 2) a shared understanding of what the data mean. Further, it is important to recognize that all data (including scientific data and local knowledge) are interpreted in light of an individual’s existing knowledge and social context, which influence how a person makes sense of and applies the data. These challenges and successes within the CARM case study and broader experiences with participatory monitoring suggest key measures that researchers and managers can take to develop effective data-driven decision making programs for rangelands.

WOODY PLANT DYNAMICS IN FRAGMENTED LANDSCAPES OF THE GREAT PLAINS, USA. Rheinhardt Scholtz*¹, Samuel D. Fuhlendorf¹, Steven A. Archer², Robert Buitenwerf³, John Polo¹, Evan Tanner¹; ¹Oklahoma State University, Stillwater, OK, ²The University of Arizona, Tucson, AZ, ³Aarhus University, Aarhus, Denmark

ABSTRACT

Woody plant dynamics in fragmented landscapes of the Great Plains, USA

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Woodland expansion is a highly debated topic documented on numerous continents threatening grassland and savanna ecosystems. The Great Plains in USA contains several land cover types such as croplands, deciduous forests, shrublands and is expanding in energy development while the grasslands within the region are climatically suitable for woodland expansion. Processes such as fire can reduce woody cover and restrict woodland expansion. However, highly fragmented landscapes restrict natural processes such as fire. We sought to better understand woody plant dynamics within the fragmented grasslands of the Great Plains, USA to improve the global understanding of woodland expansion. This talk synthesizes the culmination of several studies highlighting how % woody cover potential is driven by climate but can be restricted by fire activity, which in turn is affected by landscape fragmentation. To this end, we present a novel approach to predict woody cover at landscape levels, which can be used as an early detection system for future woodland expansion.

USING HERBICIDES AND SEEDING TO RESTORE SAGEBRUSH TO BROME-INVADDED LANDSCAPES OF THE NORTHERN GREAT PLAINS. . Emily P. Metier*¹, Matthew J. Rinella², Lisa J. Rew¹; ¹Montana State University, Bozeman, MT, ²USDA-ARS, Miles City, MT

ABSTRACT

Using seeding to restore degraded rangelands of the northern Great Plains is a major challenge. Often, seeded species fail to establish and areas remain/become dominated by annual bromes and other unwanted plants. In this study, we used herbicides and reseeding to address fields at two coal mines that had become dominated by annual bromes after initial seeding efforts failed. Of particular interest was big sagebrush, among the species most difficult to restore to our mixed grass prairie study system. To avoid herbicide damage to big sagebrush and other seeded species, we applied a nonselective herbicide (glyphosate) prior to seeding or an herbicide that exclusively controls grasses (quizalofop) after seeding. We also combined the two herbicides to determine if both together outperformed either alone. Consistently across four experiments (2 seeding years × 2 mines), annual brome cover was 22% (13%, 36%) in the control, compared to 11% (5%, 25%) and 16% (7%, 35%) in glyphosate and quizalofop plots, respectively. Combining herbicides did not decrease annual brome cover below glyphosate alone. The second summer after seeding, seeding without herbicides increased big sagebrush densities from 0.15(0.03, 0.60) to 0.76(0.27, 2.11) plants m⁻² at Decker and from 0.02(0.004, 0.11) to 0.11(0.03, 0.43) plants m⁻² at Spring Creek [mean(95% CI)]. Combining glyphosate with seeding increased big sagebrush densities to 3.05(1.42, 6.56) plants m⁻² at Decker and to 0.43(0.13, 1.40) plants m⁻² at Spring Creek. Quizalofop did not have lasting positive effects on big sagebrush densities. In addition to big sagebrush, seeding increased other seeded species, but herbicide effects on these species were inconsistent. Herbicides can provide a window of opportunity for establishing big sagebrush.

HERDER'S INDICATORS PREDICT ECOLOGICAL CONDITIONS ALONG LIVESTOCK USE GRADIENTS IN THREE MONGOLIAN ECOLOGICAL ZONES. Chantsallkham Jamsranjav*¹, Maria Fernandez-Gimenez², Robin Reid², Byambatseren Adiya³; ¹Nutag Action Research, NGO, Ulaanbaatar, Mongolia, ²Colorado State University, Fort Collins, CO, ³Nutag Action Research Institute, Ulaanbaatar, Mongolia

ABSTRACT

Given the growing research on traditional ecological knowledge and its use in resource management, there is a need to understand the relationship between indicators used by researchers and those used by local people. Here we develop consolidated indicators that both local people and researchers can use. To better understand indicators used by pastoralists, we conducted in-depth field interviews with 26 herders in three ecological zones of Mongolia. We asked each herder to assess the condition of three different sites located along a livestock use gradient from their winter camp, and to describe the indicators they used in their assessment. We collected plant foliar cover, species richness, and soil surface characteristics, and compared these scientific measures of condition with the ratings and indicators used by herders. Across all ecological zones, herders used similar indicators to assess condition, including plant height, vegetation density, plant types, and the extent of bare ground. Herders described heavily used pastures as less densely vegetated (*siireg*). Statistical correlation between herder ratings and total foliar cover were positive and significant in all zones. Herders in the desert steppe indicated heavily used pastures have few plant types compared to lightly used pastures, whereas herders in the mountain and forest steppe indicated heavily used pastures have more bare ground and less litter compared to lightly used pastures. Correspondingly, we found that desert steppe herders' ratings were significantly correlated with field measurements of species richness, and mountain and forest steppe herders' ratings were significantly negatively correlated with bare ground and positively correlated with litter cover. Overall, our study shows a strong and positive relationship between the herders' ratings of rangeland conditions and the measured ecological variables. These results show promise for developing integrated indicators and monitoring protocols that are meaningful, credible and useful to herders, managers and scientists.

LITTER COMPOSITION SIGNIFICANTLY ALTERS THE PLANT COMMUNITY IN ALPINE MEADOWS OF QINGHAI-TIBETAN PLATEAU, CHINA

. Zhouwen Ma¹, Zhaofeng Wang*², Shenghua Chang³, Saman Bowatte², Fujiang Hou⁴; ¹State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China, Lanzhou, Peoples Republic, ²State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China., Lanzhou, Peoples Republic, ³State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China., Lanzhou, Gansu, Peoples Republic, ⁴Lanzhou University, Lanzhou, Peoples Republic

ABSTRACT

Abstract:

The alpine meadow grasslands of Qinghai-Tibetan Plateau (QTP), of China are currently undergoing numerous changes, especially as a result of climate change and intensified livestock farming. The shift in botanical composition is a significant change that can result many ecological consequences such as litter composition and dynamics. In this study we investigated the effect of litter of three dominant grassland species in QTP on the plant community characteristics.

The experiment was conducted at the QTP Research Base of Southwest Minzu University, Hongyuan, on the northeastern boundary of the QTP. We tested litter of *Kobresia setchwanensis* (Ks), *Elymus nutans* (En) and *Ligularia virgaurea* (Lv) with four different quantities for each type (0, 100, 200, 400 and 600g/m²). The litter was added in early May and the plant community characteristics were measured during the peak growing season in August.

We found addition of litter significantly affected the plant species richness, above-ground biomass, plant community coverage and the composition of plant functional groups. These responses were different depending on the litter type and the quantity. The above ground biomass and plant community coverage was significantly lower at the plots received higher rates of litter (400 and 600 g/m²) compared to the control. The plant species richness decreased with increasing rates of Lv litter added. The addition of Ks litter significantly reduced the Gramineae composition while significantly increased the Forbs composition. The litter addition had little effect on legumes. The Sedge composition was significantly higher at the plots received higher rates of litter.

Our results indicate that litter is an important control of plant functional groups and thereby impacting forage quality and quantity for grazing animals in alpine meadow grasslands.

Key words: Grasslands, Plant litter, Community structure, Species diversity, Alpine meadow

FREE-RANGING CATTLE FORAGING AT DIFFERENT SCALES: COWS CHOOSE THE FOREST, NOT THE TREES. Carlos A. de la Rosa*; UCLA, Los Angeles, CA

ABSTRACT

On the western slope of the Sierra Madre Occidental of southeastern Sonora, Mexico, a 928 square kilometer conservation easement protects large stands of primary and secondary tropical deciduous forest (TDF). Within this area, people sustain themselves through subsistence farming and low-density cattle ranching. Though cattle may negatively impact tree diversity in areas where they roam, few researchers have quantified cattle foraging preferences for woody plant species, or tested hypotheses explaining potential impacts. I investigated cattle foraging and ranging behavior in order to address the following questions: (1) are cows selecting (or avoiding) particular species of woody plant in the TDF? And, (2) is woody plant diversity in their preferred foraging habitat different from woody plant diversity across all forested areas accessible to cows? To quantify the woody plant component of cow diets, I designed and deployed animal-mounted time-lapse video and data logging equipment to record cow feeding and movement. Using GPS data on cow foraging paths, I returned to documented feeding points and censused woody plants within a 5m by 5m area surrounding the eaten plant. I also collected plant census data at 100m intervals across all habitat. I then compared diversity in cow diet, preferred foraging areas, and all available habitat. My results suggest that cows are not picky eaters—in terms of available species, they generally eat what is abundant, given the immediate choices in front of them. Selective behavior, however, is more apparent at the habitat level, cows preferring to forage in areas that are more diverse compared to diversity across all available habitat. A better understanding of cattle foraging and ranging behavior can help inform sustainable economic development practices and conservation, in Mexican TDF and in other multiple use forests.

NUTRIENT COMPOSITION AND DIGESTIBILITY OF CALIFORNIA PERENNIAL AND ANNUAL GRASSES AT FOUR STAGES OF GROWTH. Elaina D. Cromer*¹, Keela M. Trennepohl², Marc Horney¹; ¹Cal Poly State University, San Luis Obispo, CA, ²Western Illinois University, Macomb, IL

ABSTRACT

Beef products represent the fourth largest agricultural commodity in the state of California, valuing more than \$3 billion from 2013 to 2015 (USDA, 2016) and procure 90% of the income for the range livestock industry (FRAP, 2003). Forages found on California's coastal, desert, foothill, and mountain ranges are the basis of the state's beef cattle industry. Understanding the nutritional quality of these forages is important for their effective use (George et al., 2001a; Waterman et al., 2014). The objectives of this research were to investigate the nutritional characteristics, and *in situ* digestibilities in Angus beef cattle, of common California annual and perennial grasses: wild oats (*Avena barbata* and *Avena fatua*), soft chess (*Bromus hordeaceus*), filaree (*Erodium botrys*), Italian ryegrass (*Lolium multiflorum*), blue wildrye (*Elymus glaucus*), creeping wildrye (*Leymus tritichoides*), melic (*Melica californica*, *Melica imperfecta*, *Melica torreyana*), foothill needlegrass (*Stipa lepida*), purple needlegrass (*Stipa pulchra*). Nutritional composition as a percentage of dry matter (crude protein, CP; neutral detergent fiber, NDF; acid detergent fiber, ADF; and acid detergent lignin, ADL) and digestibilities were compared at four growth stages: late vegetative (LV), early reproductive (ER), late reproductive (LR), and dry (D). Plant samples were collected in San Luis Obispo County, CA. Crude protein concentrations decreased, and fiber concentrations increased, with maturity ($P \leq 0.05$). Perennial grasses contained more NDF and ADF than annual grasses, across all growth stages ($P \leq 0.05$). Annual grasses were significantly higher than perennials in dry matter digestibility (%DMD) at the 48 h incubation, when averaged across all growth stages ($P \leq 0.05$); and at the LR and D stages, when averaged across all incubation periods ($P \leq 0.05$). Within the annual grasses, %DMD was similar between ER, LR, and D stages. Within the perennial grasses, %DMD was similar between the LR and D stages ($P \leq 0.05$).

PLANT COMMUNITY COMPOSITION AND VARIATION IN SOIL ORGANIC CARBON IN CALIFORNIA RANGELANDS. Elizabeth L. Porzig*¹, Chelsea Carey², Nathaniel Seavy², Wendell Gilgert², Thomas Gardali²; ¹Point Blue Conservation Science, Petaluma, CA, ²Point Blue Consvr Sci, Petaluma, CA

ABSTRACT

Rangeland managers are increasingly prioritizing ecological functions of soil. Soil organic carbon is central to these efforts because it plays a fundamental role in soil fertility, soil stabilization, and water holding capacity. On grazing lands, influencing soil organic carbon via vegetation management is one strategy through which managers may be able to affect change. For example, promoting deep-rooted perennial grasses is hypothesized to increase soil carbon. However, dynamics between soil organic carbon and the vegetation community are complex, and there is a need to understand broad patterns in soil organic carbon concentrations in relation to plant community composition. In 2016, we surveyed the herbaceous plant community and soil organic carbon at 220 locations in 15 counties in California. Using multiple regression on distance matrices, we found a significant relationship between vegetation community composition and percent soil organic carbon while controlling for geographic location, average annual precipitation, and soil texture. Using indicator species analysis, we found that plant species associated with high soil carbon included several functional groups, including perennial grasses, and plant species associated with low soil carbon were primarily annual forbs. This survey of plant community composition and soil organic carbon provides context for setting management objectives and generating mechanistic hypotheses about plant-soil interactions.

ASPEN CLIMATE RESILIENCE IN AN OREGON BUNCHGRASS ECOSYSTEM. Andrew D. Neary*¹, Ricardo Mata-Gonzalez¹, Heidi Schmalz²; ¹Oregon State University, Corvallis, OR, ²The Nature Conservancy, Enterprise, OR

ABSTRACT

Quaking aspen, *Populus tremuloides*, has experienced severe declines in recent years in part due to the effects of changing climate and drought. As the dominant deciduous tree in Western North American, aspen plays a critical role in biodiversity and ecosystem function. Therefore, the persistence of this species under changing climate patterns is a topic of critical concern. While previous research has investigated the effects of drought on aspen decline, few studies have sought to integrate this approach with physiological indicators to characterize aspen resiliency under specific site conditions. This presentation will detail the initial findings of a study of aspen communities on a pacific northwest bunchgrass prairie in northeastern Oregon. Here, aspen stands are found in topographical niches associated with late season snow patches and provide key ecosystem function to this rangeland ecosystem. Field measurements of soil moisture, physical soil characteristics and drought stress were collected over the course of the 2017 growing season and will be analyzed to assess the climate resiliency of aspen stands across the study site. Additionally, using historical spatial imagery to detect changes in late-season snow cover, the project seeks to assess the relationship between snow cover and seasonal soil moisture availability. Ultimately, these modeled relationships will be used to predict which individual sites have the greatest potential for sustaining aspen. By underscoring the importance of aspen communities in rangeland systems and the threats to these systems by climate change, this project seeks to use applied ecological science to help land managers strategically direct conservation efforts in a grassland system.

EVIDENCE FOR THE OCCURRENCE OF BIOCRUSTS ACROSS THE GREAT BASIN AND MOJAVE ECOREGIONS

. Lea A. Condon*¹, David A. Pyke²; ¹US Geological Survey, Corvallis, OR, ²U.S. Geological Survey, Corvallis, OR

ABSTRACT

Although biological soil crusts (biocrusts) are known to occur globally in arid and semi-arid environments, the question arises as to if they occur in the Great Basin ecoregion. Most studies looking at these organisms in the Great Basin occur on the edges of region, with minimal work being done within the state of Nevada, the geographic core of the Great Basin. For this reason, we assess the presence of biocrusts in both the Great Basin and Mojave Desert ecoregions, addressing the unstudied area of Nevada in its entirety. We mapped the presence and absence of mosses and lichens across both regions using Assessment, Inventory, and Monitoring Strategy data (AIM) from 3655 plots. AIM data is collected by the Bureau of Land Management (BLM) to provide consistent data on core quantitative indicators of rangeland health on BLM lands, including basal ground cover provided by lichens and mosses. The observed occurrences of both organisms were mapped by Major Land Resource Area (MLRAs). Preliminary results show that mosses were observed on a greater proportion of plots within the more northern to easterly MLRAs: the Malheur High Plateau, Owyhee High Plateau, Snake River Plains and Great Salt Lake. Lichens were observed on a greater proportion of plots within the more centrally located MLRAs: the Central Nevada Basin and Range, Fallon-Lovelock and Humbolt Areas. The Mojave Desert and Southern Nevada Basin and Range MLRAs had the greatest proportion of plots without mosses or lichens. Globally, work on ecosystem function and recovery from disturbance incorporates the presence of biological soil crusts. Given our demonstration of the presence of biological soil crusts across the Great Basin and Mojave ecoregions, we hope to call attention to the need to include them in studies on ecosystem function, recovery from disturbance and restoration in these regions.

COMMON GARDEN COMPARISONS OF REPRODUCTIVE, FORAGE AND WEED SUPPRESSION POTENTIAL OF RANGELAND REHABILITATION GRASSES OF THE GREAT BASIN. Dan N. Harmon*¹, Charlie D. Clements²; ¹USDA-ARS, Reno, NV, ²USDA, Reno, NV

ABSTRACT

Common garden experiments are a means to remove environmental effects. Using 8 species of perennial rangeland grasses, we established a common garden (3 reps x 28 plants = 84 plants/species). We found that 'Hycrest' crested wheatgrass (*Agropyron cristatum*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) produced the greatest amount of seed (6,117 and 4,415/ plant) compared to other species such as Squirreltail (*Elymus elymoides*) (2,172/plant). Monthly, we randomly harvested one plant/rep to estimate biomass. We compared only the 5 mid-sized grasses excluding the large basin wild rye (*Leymus cinereus*), the small Sandberg bluegrass (*Poa secunda*) and the root creeping wild rye (*Leymus triticoides*). June biomass of crested wheatgrass was significantly larger than all other grasses except bluebunch wheatgrass which was similar. Comparing soil moisture we found only crested wheatgrass, bluebunch wheatgrass, and Basin wildrye consistently depleted soil moisture significantly from control plots (bare soil) (e.g. June soil 4-15cm depth; crested wheatgrass = 3.7%, Thurbers needlegrass (*Achnatherum thurberianum*) (= 8.95% and control = 10.9%). Results on available soil nitrogen uptake were similar to soil moisture. The suppression of weeds like cheatgrass (*Bromus tectorum*) by perennial grasses is thought to occur by the perennial grass competing for and limiting available soil moisture and nitrogen to the annual cheatgrass. These results emphasize the importance of considering the potential of a species to achieve specific goals such as cheatgrass suppression and strengthen the concept of the introduced grass, crested wheatgrass, being an ecological equivalent, and functionally very similar to the native bluebunch wheatgrass.

THE EFFECT OF CATTLE DIGESTION AND RUMINATION ON SERICEA LESPEDEZA SEED GERMINATION. Nolan Craun*, Eric Duell, Cooper Sherrill, Catherine Haviland, Ryan Reuter, Laura Goodman; Oklahoma State University, Stillwater, OK

ABSTRACT

Sericea lespedeza (*Lespedeza cuneata*) is a non-native legume invading rangelands in the southern Great Plains. Herbicides offer short-term control with long-term negative effects on native forbs. Increasing cattle consumption by burning and mowing has been proposed to suppress plant growth but little is known about the effect of digestion on sericea seeds. Our objective was to identify the effect of cattle digestion on sericea lespedeza seed germination. Sericea seeds were subjected to one of the following treatments: 1) passage through the complete digestive tract by feeding 500 g of seeds with 1.8 kg of dried distillers grains to 4 steers; 2) digestion in only the rumen by placing in-situ bags containing 100 g of seed in 4 cannulated steers; or 3) no digestion. At 12, 24, 36, 48, and 60 hours post feeding, fecal samples were collected from each steer and sieved for seeds. Following surface sterilization, seeds were placed on germination paper in a growth chamber with germinated seeds counted on day 3, 7, 14, and 21. Analysis of variance was used to model germination percentage as a function of exposure type and seed condition. Full digestion and rumination increased germination ($P < 0.002$, $P < 0.05$; respectively) by 17% and 12% over the 4% germination rate of the control seeds. The number of seeds in fecal collections declined over time ($P < 0.01$) and as time in the digestive tract increased, percentage of seeds with an intact endocarp decreased ($P < 0.04$). Hulled seeds germinated at a 15% greater rate than seeds with intact endocarps ($P < 0.05$). We recommend grazing sericea-infested pastures prior to flowering and penning cattle that have been grazing sericea-infested pastures for 4 to 5 days before grazing a sericea-free pasture.

INTEGRATION OF PATCH-BURN GRAZING AND HERBICIDES TO CONTROL *LESPEDEZA CUNEATA* IN TALLGRASS PRAIRIE. Valerie K. Cook*¹, Karen R. Hickman¹, Samuel D. Fuhlendorf¹, Bob Hamilton², D. Chad Cummings³; ¹Oklahoma State University, Stillwater, OK, ²The Nature Conservancy, Pawhuska, OK, ³Dow AgroSciences, Perry, OK

ABSTRACT

Sericea lespedeza (*Lespedeza cuneata*) is an invasive legume rapidly establishing and spreading throughout the tallgrass prairie landscape. Allelopathic polyphenols in sericea displace native plants, alter soil chemistry and microbial communities, and reduce forage availability, but traditional sericea control efforts have been independently ineffective: fire promotes germination, grazing pressure is limited by condensed tannin levels, and herbicides provide only short-term control. We suggest the integration of mechanical, biological, and chemical management tools increases the efficacy of sericea management efforts, while improving ecosystem function and minimizing collateral impacts to the native plant community. We sought to determine the environmental and management factors most influential on sericea control. We established 21, 14, and 12 permanent transects in 2010, 2011, and 2012, respectively, within recently burned patches at the Tallgrass Prairie Preserve of Oklahoma. Within 16, 1-m² quadrats along each transect, we quantified initial sericea density, percent canopy cover, and stems grazed. Following seasonal fire and [steer] grazing, one fourth of each transect received a spot-spray treatment of early- or mid-season triclopyr, late-season metsulfuron-methyl, or no treatment. Using ANOVA and multiple regression, we analyzed sericea control as the proportion of initial stem density each growing season after treatment (GSAT). One GSAT, densities were 0.42, 0.46, 0.80, and 1.86 times the initial density for early-, mid-, late-season spray, and control treatments. Two GSAT, densities were 0.71, 0.55, 1.39, and 2.86 times the initial density for respective treatments. At 2 GSAT, we found spray timing, pasture burn treatment, initial density, and fire return interval (FRI) were best predictors of sericea control. Preliminary results indicated greatest control was attained with a 3-yr FRI receiving both spring and summer burns and mid-season treatments of triclopyr. Final results and management implications from the comprehensive dataset will be presented.

BATTLING THE SECOND GREEN GLACIER: AN ANALYSIS OF SERICEA LESPEDEZA (*LESPEDEZA CUNEATA*) MANAGEMENT PRACTICES. Cooper W. Sherrill*, Samuel D. Fuhlendorf, Laura Goodman; Oklahoma State University, Stillwater, OK

ABSTRACT

Sericea lespedeza (*Lespedeza cuneata* [Dum.-Cours] G. Don) is invading rangelands of the southern Great Plains and is believed to have negative impacts on livestock production and biodiversity. Historically, research efforts have focused largely on testing the efficacy of selective herbicides and more recently, the use of prescribed fire to alter grazing patterns on *sericea lespedeza* (patch burning). We present research on a unique long-term data set on landscapes where patch-burn grazing [Bison (*Bison bison*) and cattle (*Bos* spp.)] and herbicides have been variably applied. The research was conducted at The Nature Conservancy's Joseph H. Williams Tallgrass Prairie Preserve (Pawhuska, Oklahoma) and at Oklahoma State University's Range Research Station (Stillwater, Oklahoma). At the Tallgrass Prairie Preserve, we re-sampled 151 of the 10x10m vegetation monitoring plot that were established in 1999, with a special focus on a select group of forbs because of their importance to biodiversity. At Oklahoma State's Range Research Station, the (3) .80 x .80 km patch burn pastures along with the (3) .80 x .80 km traditionally managed pastures (spring fire every third year) were sampled to determine *sericea lespedeza* invasion over the past 20 years and the effects the treatments have had on the native plant community. Analyzed data from the Tallgrass Prairie Preserve suggests that the long-term use of patch-burn grazing and herbicide application have variable effects on the invasion of *sericea lespedeza* as well as the maintenance of native plant biodiversity. At Oklahoma State's Range Research Station, the patch-burn pastures have a significantly lower canopy cover of *sericea lespedeza* when compared to that of the traditionally managed pastures, suggesting that the patch-burn treatment is more effective at slowing the invasion rate of *sericea lespedeza*.

NATAL GRASS [*MELINIS REPENS* (WILLD.) ZIZKA] IN CHIHUAHUA, MEXICO; AN ANALYSIS OF ITS DISTRIBUTION AS WELL AS MORPHOLOGICAL AND NUTRITIONAL CHARACTERIZATION. Raul Corrales¹, Carlos Morales¹, Alan Alvarez², Federico Villarreal*¹; ¹Universidad Autónoma de Chihuahua, Chihuahua, Mexico, ²Student, Chihuahua, Mexico

ABSTRACT

Plant descriptors contribute to the identification of a species with characteristics expressed according to variables of topography, climate, and geology, among others. Some grasses are naturally differentiated or have been modified and selected by specific characters that differ physically or chemically. Intraspecific differences expressed lead to a plant species being reclassified into varieties. Natal grass is an introduced species that became invasive. In America it is one of the most invasive grasses due to its establishment capacity. This species has the capacity to invade and displace native species of high ecological importance. The variability of this species is unknown, since it has a relatively short time of being naturalized in Mexico. The objective was to know the distribution and characterize wild populations of Natal grass through physical and chemical descriptors, to determine their morphological diversity and nutritional composition in Chihuahua, México. The characterization was performed on 13 populations in mature phenological stage. The location of the populations collected were in the north, center, south and west of the State. A total of 20 quantitative morphological variables and 16 qualitative variables were measured on 65 individuals. The nutritional value was determined based on the fiber content with the Ankom protocol, based on the Van Soest method. In addition, crude protein (CP) was determined with the LECO protocol based on the DUMAS combustion method. Morphological data were analyzed through Correlation Analysis, Principal Components, Cluster and MANOVA. Structural fibers and CP were analyzed with ANOVA and comparison of means with the Tukey test. The morphological characteristics of Natal grass were determined. No diversity was found in the Rosado grass populations of the State of Chihuahua. Nutritional content was determined and difference ($p < 0.05$) of CP was found among populations. Based on the nutritional contribution, the forage value for this species was estimated from regular to good.

Key words: diversity, alien species, wild populations.

EFFECTS OF FULL AND HALF-RATE OF SELECTED HERBICIDES TO LEAFY SPURGE INVADDED RANGELANDS FOLLOWING A SPRING APPLIED FIRE. Tracy Ellig*¹, Kevin Sedivec¹, Dennis Whitted², Ryan Limb¹, Kent Belland³; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Walcott, ND, ³North Dakota Army National Guard, Bismarck, ND

ABSTRACT

Leafy spurge (*Euphorbia esula L.*) is a costly noxious weed to manage and control. Leafy spurge invades rangelands and displaces native and desirable vegetation. The most common type of management for leafy spurge control is the use of herbicides. Herbicides can be costly, especially if applying to large areas. Our over-arching objective was to test the recommended full rate and half rate of selected herbicides applied in September following a spring burn on leafy spurge and its associated plant community. Specific study objectives were to 1) determine if a late spring burn followed by fall applied herbicide treatments will have a greater effect on controlling leafy spurge density using a half and full rate compared to unburned plots, and 2) determine if a late spring burn followed by fall applied herbicide treatments will impact the existing plant communities compared to unburned plots. We selected three herbicide treatments and treated the two study blocks (replicates) with the recommended rate and half the recommended rate following a spring burn. Quinclorac, aminocyclopyrachlor + chlorsulfuron, and picloram + imazapic + 2, 4-D were the three herbicide treatments using a nested randomized block design with a between factor (burning) and a within factor (herbicide and rate combination). The study was conducted on the Gilbert C. Grafton Military Training Base (South Unit) near McHenry, ND. Plant composition was determined by collecting graminoid species presence/absence using 0.1m² every 2 m, and density of leafy spurge and other broad leaf forbs using a 0.25m² plot every 2 m along a 20 m transect. Data is currently being analyzed.

**EFFECT OF WEEDY GRASSES ON STOCKING RATE AND LIVESTOCK PRODUCTION
GRAZING CA ANNUAL GRASSLAND**

. Larry Forero*¹, Josh S. Davy², Philip Brownsey³, Jeremy James⁴; ¹UCCE, Redding, CA,
²University of California, Red Bluff, CA, ³UCCE, Sacramento, CA, ⁴University of California,
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ABSTRACT

Much of California's annual rangeland has become infested with weedy grasses. These weeds adversely affect the rangeland forage quality. This paper considers yearling stocking rates and performance to determine the influence weedy grasses have. For three years, replicated experimental pastures received light disking, a glyphosate and annual Transline treatment and were seeded with Gulf annual ryegrass at 20 lbs/acre. Cattle were weighed and introduced to the plots in March and removed in late May. Grazing metrics include cattle gain and AUM /acre harvest. Forage biomass, species and quality data were collected. Costs were calculated and economics considered in the analysis.

GRAZING BY FREE-ROAMING HORSES REDUCES BUFFELGRASS (*PENNISETUM CILIARE*) DISTRIBUTION

. Thomas Krebs*; Salt River Pima-Maricopa Indian Community, Mesa, AZ

ABSTRACT

Prediction of invasive species requires delineation of the fundamental niche and has included development of Habitat Suitability Models. Buffelgrass (*Pennisetum ciliare*, synonym *Cenchrus ciliaris*) is a non-native invasive perennial in the arid southwest. Perennial grasses such as buffelgrass can have their geographic distribution constrained by repeated grazing. Grazing can play an important part in integrated weed management programs as a biological control. Free-roaming horses overlap buffelgrass populations in specific areas. In these areas, what is the effect of horses in the control of buffelgrass? The objective of this study was to quantify the effect of horse grazing on buffelgrass. We asked the question: what is the fundamental niche of buffelgrass in the lower Sonoran Desert of Mesa, Arizona? And do horses constrain the potential habitat of buffelgrass, creating a realized niche of less geographic area? We performed an observational study to answer these two questions. Data collection was performed between November 20-30, 2016. Chi-square analyses were used to test the assumptions that buffelgrass has a fundamental niche along the study highway and that horse grazing creates a niche contraction that hinders further buffelgrass expansion. The study showed that buffelgrass is significantly less frequent in areas grazed by horses than in areas ungrazed by horses. The result suggests that horses may be an effective tool against the expansion of buffelgrass populations into areas susceptible to its establishment. Further study is recommended.

TUMBLEWEED CONTROL ON CALIFORNIA'S CENTRAL COAST. Devii R. Rao*¹, Elise Gornish², Richard Smith³, Josh S. Davy⁴; ¹UC Cooperative Extension, Hollister, CA, ²University of Arizona Cooperative Extension, Tucson, AZ, ³University of California Cooperative Extension, Salinas, CA, ⁴University of California, Red Bluff, CA

ABSTRACT

Tumbleweed (*Salsola sp.*) was introduced to the United States, initially in South Dakota, from Russia in the 1870s. It was first observed in California in 1895. This plant is widespread across the western United States and is of concern to livestock producers because it can grow in dense stands, outcompeting plants that provide better forage for livestock. Because limited research has been conducted on tumbleweed control in rangelands, we deployed an experiment to test whether cattle grazing, herbicide, or seeding would control tumbleweed. Nine replicates were installed across two ranches in San Benito County, California. Each replicate includes a grazed section and an ungrazed section. Treatments for both sections were: 1) no herbicide, no seeding, 2) no herbicide, native seeding, 3) no herbicide, forage seeding, 4) herbicide, no seeding, 5) herbicide, native seeding, 6) herbicide, forage seeding. Plots on Ranch A were grazed by stocker cattle from September 2015 to May 2016 and September 2016 to June 2017. Stocker cattle grazed plots on Ranch B from December 2015 to June 2016 and November 2016 to June 2017. The herbicide treatment was applied in spring 2016. Seeding was conducted in fall of 2016. *Elymus glaucus* (Blue wildrye), *Bromus carinatus* (California brome grass), and *Poa secunda* (Pine bluegrass) were seeded into the native seeding subplots. Forage subplots were seeded with *Festuca arundinacea* (flea grass). Initial observations suggest that strong grass growth during the spring of 2017 had a limiting effect on tumbleweed; seeded species were able to germinate and grow; tumbleweed cover was less in grazed subplot compared to ungrazed subplots, and less in the herbicide subplots compared to subplots not treated with herbicide. Overall, cover of tumbleweed was lowest in subplots that received both the grazing and herbicide treatments.

TIMING OF HUISACHE (*ACACIA FARNESIANA*) CONTROL IN SOUTH TEXAS
. Pablo Teveni*, Robert D. Cox, Ronald Sosebee; Texas Tech University, Lubbock, TX

ABSTRACT

Huisache (*Acacia farnesiana* [L.] Willd.) is expanding in range and density and displacing more desirable forage species in South Texas. We characterized optimal timing and environmental conditions for effective herbicide control by analyzing root Total Nonstructural Carbohydrate (TNC) content and mortality of sprayed trees over two years. Each month between April 2012 and November 2014, five shrubs in each of four different study sites were excavated, and the root crowns were collected and analyzed for TNC. In addition, two herbicide formulations were foliar-applied to five to ten shrubs every month at the four sites from July 2012 to November 2014, and mortality was evaluated following two growing seasons. Data were analyzed using a randomized complete block design ANOVA, and Akaike's Information Criterion (AIC) was used to determine the best-fit model for mortality. We found significant TNC increases (compared to the prior month) during May, August, and December. Herbicide-induced mortality was greatest during the months of May, October, November, and September. The best fit model for mortality was a sixth-order polynomial function of mortality vs. month; when month was removed as a parameter, the best fit model was a quadratic function of mortality vs. soil temperature, combined with a quadratic function of mortality vs. phenology. These results indicate two windows in which to chemically treat huisache to achieve high mortality in the coastal plains of South Texas: spring (especially May) and autumn (especially October and November). Besides month (which can have variable environmental conditions), high huisache mortality rates can also be expected when soil temperature at 0.3 m is at or near a peak of 24.5°C, during the full canopy stage.

AMINOPYRALID IN COMBINATION WITH PICLORAM AND FLUROXPYR FOR
PICKLYPEAR CONTROL IN TEXAS. James R. Jackson*¹, Morgan Russell², Charles R. Hart³;
¹Texas A & M AgriLife Extension Service, Stephenville, TX, ²Texas A&M Agrilife Extension,
San Angelo, TX, ³Dow AgroSciences, Stephenville, TX

ABSTRACT

Pricklypear cactus (*Opuntia* spp.) is a common invading species on central, south and west Texas rangelands that limits forage production and decreases grazeable acres. Traditionally pricklypear has been controlled by applications of picloram (Tordon 22K) or picloram plus fluroxypyr (Surmount). In the fall of 2013 research was started to analyze the effects of aminopyralid when mixed with Tordon 22K or Surmount. The objectives were to evaluate the speed of desiccation with the addition of aminopyralid and if equivalent mortality could be achieved with lower rates of Tordon or Surmount herbicides when combined with aminopyralid. Trials were conducted in 2013 and 2014 using various tank mix combinations of picloram, fluroxypyr and aminopyralid on pricklypear applied by individual plant treatment, ground broadcast and aerial applications. Based on results obtained from 2013 and 2014 trials, a proprietary formulation (GF-2969, Dow AgroSciences) containing a mixture of aminopyralid, picloram and fluroxypyr was tested. Trials were established in 2015 and 2016 to test the speed and efficacy of pricklypear control with GF-2969. Treatments were applied by Individual plant treatment, ground broadcast, and aerial application methods. All trials were evaluated for percent desiccation at 4, 8, 12 and 24 months after treatment. Results for the tank mix trials in 2013 and 2014 trials indicate that the addition of aminopyralid with Tordon 22K and Surmount resulted in reduced usage rates while maintaining a high rate of efficacy. Results of the 2015 and 2016 trials indicate that a higher level of efficacy is achieved with lower use rates of GF-2969 as compared to Surmount. GF-2969 also outperformed Tordon 22K at equivalent rates with both greater efficacy and speed.

ESTABLISHED ALIEN INVADER TREES AND PROBABLE INVADER TREES IN ARIZONA. John H. Brock*; Arizona State University Polytechnic, Mesa, AZ

ABSTRACT

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Four alien trees have established in Arizona wildlands, often in riparian habitats. These trees include: (*Ailanthus altissima*) tree-of-heaven, (*Elaeagnus angustifolia*) Russian olive, (*Tamarix ramosissima*) salt cedar and (*Ulmus pumila*) Siberian elm. Saltcedar and tree-of-heaven can be found over most of the state, while Russian olive and Siberian elm are in cooler landscapes of northern Arizona. Ecological characteristics of these species will be described. These trees invade sites with more soil moisture compared upland areas and especially compete with native riparian vegetation. In dense stands, the alien trees lower biodiversity, alter stream flow and watershed yield. Mechanical and/or chemical treatments are used to manage these woody plants. Biological control using (*Diorhabda sp.*), a leaf eating beetle, was released for saltcedar control by the US Department of Agriculture in 2002. The results are interesting. Six alien trees, mostly confined to urban/residential sites in the Phoenix area are displaying invasive behavior. These species include: (*Acacia stenophylla*) shoestring acacia, (*A. saligna*) Australian golden wattle, (*A. farnesiana*) sweet acacia, (*Leucaena leucocephala*) lead tree, (*Rhus lancea*) African sumac and (*Ulmus parvifolia*) Chinese elm. Some of these species are observed at considerable distances outside of the urban/residential areas, indicating their invasive nature.

DEVELOPMENT OF AN AUTOMATED METHOD TO QUANTIFY BEEF CATTLE DRINKING ACTIVITIES IN EXTENSIVE GRAZING SYSTEMS. Lauren R. O'Connor*¹, Greg J. Bishop-Hurley², Dave L. Swain³; ¹CQUniversity Australia, Rockhampton, Queensland, Australia, ²CSIRO, St Lucia, Australia, ³CQUniversity Australia, Rockhampton, Australia

ABSTRACT

Development of an Automated Method to Quantify Beef Cattle Drinking Activities in Extensive Grazing Systems

Lauren O'Connor, Greg Bishop-Hurley and Dave Swain*

Introduction

Regular access to drinking water for cattle is essential for optimum production. Basic information about how much water cattle consume and how often they drink under varying conditions of climate, pasture and water availability in extensive grazing systems is not well documented. This research aimed to develop a practical and inexpensive method to record grazing beef cattle drinking activities to understand how they use water points and develop guidelines for adequate water point distribution.

Drinking frequency effects on cattle performance

In the first phase, a systematic review methodology was used to analyse the literature for drinking frequency effects on cattle performance. Under controlled experiment conditions, beef cattle with access to water once daily were reported to drink 15-25% more than cattle with access to water once every second or third day and had 9-16% higher feed intakes (Williams *et al.* 2016).

Investigation of cattle drinking activities using remote weighing technology

The second phase used Radio Frequency Identification (RFID) reader data from remote weighing technology to investigate the timing and frequency of cattle visits to water points at three sites in northern Australia. Most cattle visits to water occurred during daylight hours. Cattle visit frequency ranged from 0.6 to 2 visits per day between grazing sites and was influenced by month of the year, time of day and maximum temperature. Differences in cattle visit frequency between sites reflected paddock size and permanent water availability.

Quantification of drinking behaviour using accelerometers and RFID

In the third phase a combination of technologies was used to record grazing cattle drinking behaviour. RFID recorded when cattle entered an enclosed water point. Collar mounted accelerometers identified drinking head-neck posture and movement (Williams *et al.* 2017). A water flow meter measured intake. Preliminary analysis suggests that individual drinking behaviour was successfully quantified.

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USE OF AN UNMANNED AERIAL VEHICLE (UAV) TO EVALUATE GRAZING STRATEGIES IN THE NEBRASKA SANDHILLS. Amanda E. Shine Sanford*; University of Nebraska, Lincoln, NE

ABSTRACT

Nutrient inputs are commonly modeled at the pasture level as if cattle dung and urine deposition were spatially uniform. However, nutrient return by cattle on grazinglands is patchy and is influenced by a variety of factors, including variation across a pasture in vegetation quality and species composition, location of water and mineral sources, shade availability, and pasture topography. Stocking rate and grazing strategy also affect dung and urine distribution, leading to significant variation both temporally and spatially in nutrient return to rangelands, but these effects are not yet well known or described in the scientific literature. In order to gain more insight into the spatial dynamics of nutrient return on grazinglands, an unmanned aerial vehicle (UAV) with a 4-band multispectral sensor was used to monitor the effects of stocking density on the spatial and temporal changes in dung distribution on pastures grazed by yearling cattle on a sub-irrigated meadow located in the Nebraska Sandhills. Different stocking densities were created by implementing two different grazing strategies in a 60-day grazing season: a four-pasture grazing rotation with one 15-day occupation per pasture and a 120-pasture mob grazing system with one 0.5-day occupation per pasture. Stocking densities were 7,000 kg/ha and 225,000 kg/ha, respectively, for the treatments. Dung was identified through image analysis techniques and then mapped using a geographic information system (GIS). The resulting distribution maps were analyzed using spatial statistics to identify clustering patterns and then evaluate how patterns differed between strategies, over time within the same groups, and over the course of the grazing season. Results of this study are being used to develop and inform a nutrient cycling model which accounts for patterns of dung distribution tied to different grazing strategies when estimating the pulses of nitrogen, phosphorus and carbon being returned to the grazed ecosystem.

ESTIMATING FORAGE BIOMASS AND UTILIZATION IN A DESERT GRASSLAND WITH SMALL UNMANNED AERIAL SYSTEM IMAGERY. Jeffrey K. Gillan*¹, Mitch McClaran¹, Tyson Swetnam¹, Phil Heilman²; ¹University of Arizona, Tucson, AZ, ²USDA-Agricultural Research Service, Tucson, AZ

ABSTRACT

Forage biomass and utilization are important indicators for evaluating livestock and range management in dryland ecosystems. Traditional field methods are typically obtained from few locations within a management unit because of large investment in travel and field time. This small spatial coverage and few samples can limit the accuracy of representing these indicators in a large management unit. To address this challenge of efficiently covering large areas without diminishing the quality of information, we deployed a small unmanned aerial system equipped with high resolution true color camera, operated with autonomous mission planning, and processed the data with advanced image analysis capable of estimating indicator values.

Our work occurred at the Santa Rita Experimental Range, a desert grassland savanna in southern Arizona. Prior to and immediately after a month-long grazing rotation of 80 head of cattle in an 150 ha pasture, we acquired very high-resolution RGB imagery (~ 1 cm GSD). We used structure-from-motion photogrammetry methods to create 3D point clouds, digital surface models (DSMs), digital terrain models, and orthomosaics. Utilization was estimated by differencing the pre and post grazing DSMs. Imagery-based indicator values were compared to field methods known as comparative yield (biomass) and ungrazed plant method (utilization) for transects, plots, and the entire pasture.

The high-resolution 3D models represented approximately 40% of the grass heights which contains 80% of the biomass. Preliminary results show 1) realistic estimates of biomass based on image-based extrapolations of volume based on field estimates and 2) estimates of utilization that are closely related to field methods at both the transect and plot scales. Our preliminary results are consistent with the promise of more efficiently obtaining high-resolution information for larger area than traditional field methods that under-sample the large of extent of rangelands.

ANNUAL, HIGH RESOLUTION, PERCENT VEGETATION COVER MAPS OF US RANGELANDS FROM 1984-2015. Matthew O. Jones*, Brady Allred, Dave Naugle; University of Montana, Missoula, MT

ABSTRACT

Land cover maps are essential tools for tracking land surface changes, informing land management, monitoring environmental conditions, and assessing conservation efforts. Current products, however, lack essential spatial or temporal resolutions required for such efforts. The categorical classes in a majority of these maps also fail to capture the inherent heterogeneity of the land surface. To address the need for high spatial and temporal resolution land cover maps that capture natural landscape variation, we produced annual, 30 meter, continuous land cover maps for U.S. rangelands from years 1984 to 2015. We used over 23,000 vegetation plots from the NRCS National Resources Inventory and BLM Landscape Monitoring Framework spanning years 2004-2014 to train and validate an assortment of machine learning regression models. We capitalized on a cloud-based platform for planetary-scale geospatial analysis with massive computational capabilities (Google Earth Engine) to process and store over 250 spatially contiguous gridded climatic, biotic, and abiotic spatiotemporal variables (inclusive of satellite remote sensing data) to drive the model. The resulting yearly maps provide percent cover of annual and perennial herbaceous vegetation, shrubs, bare ground, and litter for U.S. rangelands, inclusive of the Great Plains. The modeling framework allows for annual generation of land cover maps into the future. These maps provide essential information for rangeland management and conservation, and will be used to create a 30 meter spatial resolution primary productivity model optimized for rangeland vegetation.

TESTING THE ECOLOGICAL SITE GROUP CONCEPT

. Shawn W. Salley*¹, Jonathan J. Maynard¹, Travis W. Nauman², Curtis J. Talbot³, Joel R. Brown³; ¹USDA-ARS, Las Cruces, NM, ²US Geological Survey, Moab, UT, ³USDA-NRCS, Las Cruces, NM

ABSTRACT

The 2016 “Ecological Sites for Landscape Management” special issue of *Rangelands* recommended an update to our thinking of Ecological Sites, suggesting that in our desire to make Ecological Sites more quantitative, we abandoned consideration of Ecological Sites’ spatial context. In response, Ecological Site Groups (ESGs) and associated general state-and-transition models were proposed as a framework for describing landscape-level processes occurring across multiple ecological sites, and thus integrating multiple ecological sites from similar landscapes into common behavioral units. We hypothesized that the spatial distribution of ESGs could be predicted using readily available geospatial data due to the theoretical association between ESGs and landscape biophysical properties. Here we test ESG concepts with a spatial modeling framework using machine learning algorithms, a SSURGO modified NASIS point dataset, and a suite of remote sensing-based spatial covariates (e.g., hyper-temporal remote sensing, terrain attributes, climate data, land-cover, and lithology). Our modeling approach was tested on two Major Land Resource Area (MLRA) study areas within the western U.S., representing 6.1 million ha within MLRA 35 and 7.5 million ha within MLRA 42. Results show our approach was effective in mapping ESGs, with a 64% correct classification based on 1,406 point observations across 8 expertly-defined ESG classes in MLRA 35 and a 75% correct classification based on 2,626 point observations across 9 expertly-defined ESG classes in MLRA 42. National coverage of the training and covariate data used in this pilot study provides opportunities for a consistent national-scale mapping effort of ESGs.

CHARACTERIZATION OF DIFFERENT RANGELAND SITES IN SEMI-ARID AREAS OF SUDAN USING REMOTE SENSING TECHNIQUES

. Nancy I. Abdalla*, Abdelaziz K. Gaiballa; Sudan University of Science and Technology, Khartoum, Sudan

ABSTRACT

This study was conducted at North Kordofan State in the semi-arid areas of Sudan, to provide information for identifying characteristics of different range sites using remote sensing data based on understanding the interactive relationships that include topographic, soil feature and vegetation cover. Three sites representing the main range types in the study area were selected according to variations in soil type (flat sandy sites, sand dune site and hard clay site). Vegetation measurements mainly cover, biomass and trees density were measured. Remote Sensing data in form of MODIS/TERRA surface reflectance at 250 m spatial resolution was used to study seasonal vegetation variability between different rangeland sites using the Normalized Difference Vegetation Index (NDVI) for five years (2010-2014). The study results showed variations among different rangeland sites with different NDVI values and pattern of monthly changes, where hard clay site showed high NDVI values early and late in the rainy season for the five years. Late in the season sand dune sites showed the highest NDVI values along the five years. The sand sheet site tends to reflect lower NDVI values during September and October. Variations of plant cover, biomass and tree density during the growing season and as dictated by different soil types at each site are the main factors behind variations in values of NDVI. On other hand, soil characteristics influence plant cover quantitatively and qualitatively. Values of Normalized Difference Vegetation Index (NDVI) and their pattern along months of year can be used for characterization of rangelands sites as part of range classification and for understanding spatial change in rangeland types.

Key words: Rangelands – Site characteristics, Rangelands classification

HISTORICAL TRENDS OF THE DISTRIBUTION OF SAND SHINNERY OAK PRAIRIE IN THE SOUTHERN HIGH PLAINS

. Carlos A. Portillo-Quintero*¹, Zhanming Wan¹, Blake Grisham¹, David Haukos², Clint Boal¹, Christian Hagen³; ¹Texas Tech University, Lubbock, TX, ²Kansas State University, Manhattan, KS, ³Oregon State University, Bend, OR

ABSTRACT

We investigated historical trends of the extent and geographical distribution of sand shinnery oak prairies (SSOP) on the Southern High Plains in New Mexico and Texas. Our objective was to create a baseline dataset on land cover change in the historical distribution of SSOP that facilitates future investigations into how vegetation heterogeneity could have shaped lesser prairie-chicken (*Tympanuchus pallidicinctus*) habitat and population demography in the SSOP. We analyzed historical maps and documentation prior to the 1930s and remotely sensed data (aerial photography and satellite imagery) collected from 1930 to 2015. Land cover and land use maps from 19th and 20th centuries were digitized into a Geographic Information System. The presence of sand shinnery oak (*Quercus harvardii*), sand sagebrush (*Artemisia filifolia*) and grasses was identified through photo interpretation of canopy shape and texture information in 120 aerial photomosaics from 1930-1970 that were acquired for 22 sites within the study region. Distribution of the SSOP was analyzed using satellite imagery (Landsat time series) from 1975 to 2015. For New Mexico, results show that sand shinnery oak, sand sagebrush and grass associations have been reduced from an approximate potential extent of ~1,800,000 ha by the late 19th century (mostly Lea, Eddy, Chaves and Roosevelt counties) to ~900,000 ha in 1977 and then to ~600,000 by 2015, with decreasing dominance of sand shinnery oak in the last 40 years. In Texas, sand shinnery oak prairies have been reduced to less than 25% of its historical potential extent (from 2,000,000 ha to 430,000 ha). Remnants are found mostly in the Yoakum, Terry, Cochran, Hockley, Andrews and Gaines counties. Results from aerial and satellite image analysis show a decrease (35%) in areas dominated by sand shinnery oak during the last four decades in Texas, with isolated recovery of mixed vegetation communities in Cochran and Terry counties.

CLASSIFYING IMAGES: FROM MILLIMETER PIXELS TO TWENTY MILLION ACRES
. Anne Blackwood*¹, Eric D. Sant², Timothy M. Bateman³, Gregg E. Simonds⁴; ¹Open Range Consulting, Island Park, ID, ²Open Range Consulting, Preston, ID, ³Open Range Consulting, Logan, UT, ⁴Open Range Consulting, Park City, UT

ABSTRACT

Since 2010 Open Range Consulting has been taking overhead pictures of vegetation throughout the Western United States. These images which are up to 20 million pixels a piece now number over 5,000. These images have a classification accuracy of greater than 90 percent. The classified images are used to create landscape wide maps covering millions of acres. They are highly accurate and depict functional vegetation cover attributes which are vital to land management. These maps we develop are used by agencies, businesses, and ranch personnel to report on vegetative characteristics and drive management decisions. Accurately classifying each image was taking an hour per image, this is a problem. Streamlining this process could significantly reduce costs and the timeliness of this product.

APPLICATION OF VIRTUAL REALITY TECHNOLOGIES IN SUPPORT OF REDD RELATED WOODLAND INVENTORIES. Robert A. Washington-Allen*¹, Natasha S. Ribeiro², Paulo A. Raposo³, Connor W. Vermilyea⁴, Robert Friedrichs⁵, Aires Banze⁶, Kyle Landolt⁴; ¹University of Nevada, Reno, Reno, NV, ²Eduardo Mondlane University, Maputo, Mozambique, ³University of Tennessee, Knoxville, TN, ⁴Oak Ridge National Laboratory, Oak Ridge, TN, ⁵Oak Ridge National Laborator, Oak Ridge, TN, ⁶Universidade Nova de Lisboa, Lisbon, Portugal

ABSTRACT

We have been conducting the monitoring, verification, and reporting (MRV) of carbon dynamics for a Level II Reduction of Emissions from Deforestation & Degradation in Developing Countries (REDD) related project in the 14th largest protected area in the world: the 42,000 km² Niassa National Reserve's (NNR) in northern Mozambique. We have conducted this study for an 11-year period, between 2005-2015, and have found that anthropogenic fires, declining elephant herbivory (due to increased poaching between 2009 to 2015), and water limitations drive the Miombo woodland's carbon dynamics. We collected data on miombo woodland structure (including fuel extraction and elephant and fire damage), composition, demographics including recruitment and mortality, biomass, and vegetation and soil carbon stock density (CSD) using traditional forest inventory methods in fifty 30-m diameter circular sample plots. In 2015, we tested a new survey technology: a 1550-nm wavelength terrestrial laser scanner (TLS) with a 2.25-mm laser spot size and a ranging accuracy of ± 2 mm over 350-m to collect three-dimensional (3-D) virtual woodland structural data in 35 of the 50 plots at a sampling rate of 976,000 points sec⁻¹ at a spacing of 8-mm 10 m⁻¹ range. The resulting GPS positioned 5 scans per plot were registered and consolidated into a single 3-D ~23 million points cloud for each period with a mean spacing of 1-cm. We compared TLS data for 11 of these plots to field collected tree height and DBH for 10 to 15 trees per plot. We both manually and automatically measured forest parameters in the 3-D virtual environment using commercial and open source software. Manual measures of tree height and DBH were also taken directly from the trees within the 3-D TLS environment projected onto reality by a Microsoft HoloLens. We found that the HoloLens augmented TLS measures of DBH and height were highly related to field measures ($r^2 > 0.85$). We estimated overall mean tree density was > 550 trees ha⁻¹ distributed across 79 species. Consistent with broadscale remote sensing studies of "greening trends in Africa", above ground biomass is increasing over the last 11 years suggesting that NNR represents a potential carbon sink.

THE HERBAGE ASSESSED REMOTELY TO PREDICT ENVIRONMENTAL RISK
(HARPER) PROCESS IMPROVES EFFECTIVENESS OF RANGELAND MONITORING.

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Management, Paso Robles, CA

ABSTRACT

Monitoring herbage that exists in the fall after grazing or during drought situations on large rangeland pastures is an important but time-consuming process. The HARPER process improves the accuracy and efficiency of field time required for monitoring of rangelands by utilizing LANDSAT 8 satellite imagery to identify areas of unacceptably low herbage and areas of high herbage. The process is somewhat similar to the widely used comparative-yield herbage assessment process. The difference is that instead of identifying herbage classes and training rangeland managers to estimate the percent of a limited number of small 1 foot square plots that are within a given herbage class, the rangeland manager uses information that is generated by a satellite that has been trained to estimate the percent of ¼ acre plots for the entire pasture that are within each identified herbage class.

The HARPER process requires five steps. The initial identification of representative herbage classes for the rangeland area being monitored. The development of signatures based on identified herbage classes. Acquisition of recent Landsat 8 imagery, that is now available at no charge every 16 days. Classification of imagery that can be done with ESRI on desktop computers. Field review of the classified imagery to verify consistency of the classification. Initial results indicates the HARPER process that uses Landsat 8 imagery increases the rangeland managers ability to identify and map areas of undesirably low herbage levels while also locating and identifying areas of high herbage. Surveys on large areas with difficult access can be evaluated as easily as road side areas. Multiple evaluations at 16-100 day intervals, at relatively low cost, can be conducted once the initial herbage classes have been identified and signatures developed.

DELPHINIUM CHEMOTYPES, THEIR BIOGEOGRAPHY AND POTENTIAL TOXICITY.
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ABSTRACT

Larkspurs (*Delphinium*, Ranunculaceae) are poisonous plants found on rangelands throughout Western North America. Two main structural groups of norditerpene alkaloids, the *N*-(methylsuccinimido) anthranoyllycoctonine type (MSAL-type) and the non-MSAL type, are responsible for larkspur-induced poisoning. Information on the alkaloid composition is lacking for a number of *Delphinium* species. The objective of this study was to profile the alkaloid composition of several *Delphinium* species. Not all *Delphinium* species contain alkaloid profiles that pose the same toxic risk. Two species, *D. ramosum* and *D. occidentale*, are represented each by two alkaloid profiles, where one profile from each species contained significantly greater concentrations of the MSAL-type alkaloids than the other. Plants containing each respective alkaloid profile were unique in their geographical distribution. Populations of these chemotypes will likely differ in their toxic potential and consequently pose different risks of poisoning when grazed by livestock species. This information has important implications in grazing management decisions on *Delphinium*-infested rangelands and demonstrates that botanical classification alone is not an adequate indicator of relative risk of toxicity.

STUDY USING SOIL SURVEY TO HELP PREDICT SONORAN DESERT TORTOISE
POPULATION
DISTRIBUTION AND DENSITIES

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ABSTRACT

We completed a soils and vegetation attribute study, in relation to Sonoran Desert Tortoise (SDT) (*Gopherus morafkai*) habitat, from December 5, 2009 to January 19, 2010 and again from March 29 to April 1, 2015 in Mojave County, Arizona on behalf of the Mojave Livestock Association. The survey covered approximately 956 square miles or 611,840 acres located from 5 to 80 plus miles south of Kingman, Arizona. The objectives of this study were to compare site specific landform, soils and vegetative characteristics to SDT density and distribution and attempt to identify detailed and quantifiable soils and landform characteristics that may be used to predict the distribution and densities of resident SDT, overlapping inhabitant Mojave Desert Tortoise (MDT)1 and any hybrids produced from the union of the SDT and MDT2. An assessment of livestock use and potential competition for forage or habitat were considered. Similar efforts were completed in 19923 in Piute Valley, Clark County, Nevada for the MDT and in 19974 for 10 MDT study plots and surrounding areas located in Nye, Clark and Lincoln Counties in Nevada showing clear and definable relationships between soils, geomorphic surfaces (geomorphology), vegetation, and the distribution and densities of burrowing animals such as the MDT.

The resultant soils classification criteria were evaluated by the National Resources Conservation Service (NRCS) who developed soils criteria and a soils report called WLF-Desert Tortoise.

The information collected and analyzed from the Piute Valley study in the 1997 effort as revised in 20104 were compared with four existing SDT study plots that had previously been established on federal land within this study area in Mojave County, Arizona by the Bureau of Land Management (BLM) and the Arizona Game and Fish Department (AGFD). The agency study plots are named East Bajada, Buck Mountain, Hualapai Foothills and Arrastra Mountain.

EXPERIMENTAL DROUGHT IMPACTS ON COLORADO PLATEAU ECOSYSTEMS.
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ABSTRACT

Increasingly severe drought and associated reductions in water availability to plants and ecosystems have emerged as predominant climate characteristics of the southwestern U.S. (SW) at the beginning of the 21st century. This growing aridity and likely changes in precipitation seasonality and intensity represent substantial challenges to SW land managers tasked with sustaining or restoring these important ecosystems. These challenges are further complicated by significant landscape-level heterogeneity in soil-geomorphic properties that mediate vegetation responses to multi-temporal climate drivers. Understanding how broad-scale climate drivers will impact ecosystems at local scales is therefore of paramount importance for designing effective management strategies to mitigate and minimize undesired ecosystem changes. The response of SW ecosystems to droughts of the 20th and 21st centuries provides clear examples of variability in climate-plant relationships that are mediated by soil-geomorphic unit vulnerability. Here, we present results from two ongoing drought experiments near Moab, UT. In one study, we are imposing a chronic but subtle drought (35% precipitation reduction) using passive removal shelters, across a wide geographic region. Over seven years, we have been examining plant cover changes and mortality of four dominant plant functional types: C3 grasses, C4 grasses, C3 shrubs and C4 shrubs. Results from this long-term experiment show varying resistance and resilience to chronic drying among dominant functional types, with cool season grasses showing lowest resistance and resilience. Second, we report results from a more recent study in which we are imposing extreme seasonal drought (66% reductions in the summer or winter) in a grassland system and have found dramatic shifts in species abundance following only two years of seasonal droughts. Taken together, results from these experiments suggest that both chronic and seasonal changes in water availability can alter the structure and function of the Colorado Plateau ecosystem by differentially impacting key plant functional types.

POTENTIAL CONSEQUENCE OF REPEATED SEVERE DROUGHT FOR SHORTGRASS STEPPE SPECIES. Renee J. Rondeau*¹, Karin Decker², Georgia Doyle²; ¹Colorado State University, Hesperus, CO, ²Colorado State University, Fort Collins, CO

ABSTRACT

Future climate projections indicate temperatures in the shortgrass steppe region are likely to warm by up to 3°C by mid-century, with a corresponding reduction in soil moisture even without precipitation deficit. Although periodic drought is a natural disturbance in shortgrass rangeland, negative effects on characteristic shortgrass species are likely as the frequency and severity of drought events increase in comparison to recent historic norms. As part of a study intended to detect vegetation changes at a shortgrass steppe site on Colorado's eastern plains, frequency and canopy cover percentage were measured in 37 permanently marked plots over a period of 17 years. The study period included the two lowest total annual precipitation years (2002 and 2012) in the period of record for regional weather stations, exceeding even the lowest precipitation years of the extended 1930s drought. Growing season mean temperatures during those drought years were 1°C and 1.6°C above the 1971-2000 average, respectively. Three of the six perennial grass species monitored showed a decline over the period of the study. Blue grama (*Bouteloua gracilis*), a dominant and important forage species in the shortgrass steppe, declined in both cover and frequency, while alkali sacaton (*Sporobolus airoides*), not an important forage species, slightly increased. In addition to changes in graminoid dominance, we observed an increase in cholla (*Cylindropuntia imbricata*) and a decrease in sandsage (*Artemisia filifolia*) and Rabbitbrush (*Chrysothamnus nauseosus*) shrub densities between 1999 and 2015. Even if total productivity of the shortgrass steppe is maintained under warming and drying conditions, changes in species composition have implications for rangeland quality with regard to its use for livestock grazing.

UNCOVERING THE RELATIONSHIP BETWEEN DROUGHT INDICES AND RANGELAND PRODUCTION. Matt C. Reeves*; USDA Forest Service, Florence, MT

ABSTRACT

Drought is a normal experience for rangelands of the United States and poses one of the primary risks faced by managers and producers. Drought planning is therefore an important tool for minimizing drought-related losses, for both managers, planners and policy makers. Approaches to responding to drought are highly variable given the complexity of landscapes and operations and due to the different types and intensities of droughts. Drought indices are often used as indicators for extent and intensity of drought but relationships between the various monitors and rangeland production at regional scales is relatively undescribed. In this paper we quantify relations between 6 drought monitors including the U.S. Drought Monitor (USDM), Evaporative Demand Drought Index (EDDI), Standardized Precipitation-Evapotranspiration Index 12, (SPEI12), Standardized Precipitation-Evapotranspiration Index 6, (SPEI6), Palmer Drought Severity Index (PDSI) and the Self-Calibrated Palmer Drought Severity Index (PDSIsc) with annual rangeland productivity from 2000 to 2016. In this assessment we answer 5 basic questions including:

1. What vegetation types exhibit the highest correlation between drought monitors and annual production?
2. What monitor exhibits the highest correlation with rangeland production?
3. What combination of monitors produces the best correlation between rangeland production and drought monitors?
4. What lag times exhibit the highest correlation between rangeland production and drought monitors?
5. What vegetative and regional characteristics enable high correlations between rangeland production and drought monitors?

PLANT COMMUNITY RESPONSE TO TEMPORAL DISTRIBUTION OF PRECIPITATION

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ABSTRACT

Drought is a common occurrence in the Great Plains and an understanding how temporal precipitation patterns affect range plant communities is critical in grazing management decisions. Current rainfall models project that rainfall events will increase in intensity and decrease in frequency. Our objective was to evaluate the effects of differing rainfall amounts at different time intervals on above-ground plant production and plant community composition on Nebraska Sandhills rangelands. Using rainout shelters, total exclusion of rainfall was implemented from May 9 through August 22 during the 2017 growing season. Using an irrigation system, simulated rainfall was applied to individual rainout shelters on a sands ecological site to determine the effects of temporal distribution of precipitation. Water amounts were applied at 50% of average annual rainfall and at 125% of average annual rainfall at intervals of once every week, once every three weeks, and once every five weeks. There were five replications of all intensity-by-frequency combinations. A control treatment of excluding all rainfall (0% of average annual rainfall) also was included as a baseline. Plant response was measured as basal cover by plant species, using the line-intercept method, and above-ground plant production as measured by hand-clipping in August. Soil moisture was measured weekly in each plot using Time-Domain Reflectometry (TDR) at depths of 0-20 cm, 21-40 cm, 41-60 cm, 61-80cm and 81-100 cm. The volumetric water content of the once-per-week plots were similar or greater than the three and five-week plots through the growing season for both watering intensities. Treatment plots steadily decreased across all treatments through the duration of the experiment except for the 125% weekly watering treatment. Plant production data is in the process of being analyzed and will be presented.

INCREASED SOIL WATER AND SPECIES CHANGE COMBINE TO ENHANCE GRASSLAND BIOMASS-CO₂ RESPONSE

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ABSTRACT

Atmospheric carbon dioxide (CO₂) concentration has risen by 40% since industrialization and is projected to exceed 2X the pre-industrial level this century. Across regional gradients in precipitation, elevated CO₂ stimulates grassland primary productivity more when precipitation is relatively scarce by increasing plant production per unit of transpiration (water use efficiency; WUE). At local scales, however, the productivity-CO₂ response to seasonal or inter-annual declines in precipitation may be positive, negative, or neutral, dependent on variation in other mediators of ecosystem CO₂ responses. Integrating mediators of CO₂ responses, such as soil texture and plant species abundances, into predictive models is crucial to forecasting primary productivity at the scales at which land managers operate. We show that, in contrast with results from across spatial gradients in precipitation, increasing CO₂ from pre-industrial to elevated concentrations increased aboveground net primary productivity (ANPP) of perennial C₃/C₄ grassland communities grown on clay, sandy loam, and silty clay soil types more when soil water was relatively plentiful. Greater water availability contributed to increase ANPP by as much as 50% at elevated CO₂ by both directly stimulating ANPP and amplifying an increase in abundance of a productive C₄ tallgrass species, *Sorghastrum nutans*. Combined, positive effects of species shifts and increased water outweighed a negative legacy effect of prior-year ANPP on the ANPP-CO₂ response across soil types and a decade of CO₂ treatment. Assessments that fail to account for positive water effects and compositional shifts may underestimate the magnitude of past and future CO₂ effects on grassland productivity.

COMPETITION OF NATIVE AND NON-NATIVE GRASSES IN TERMS OF BELOWGROUND BUD BANK AND TILLER DEMOGRAPHY

. Surendra Bam*¹, Jacqueline P. Ott², Jack L. Butler², Lan Xu¹; ¹South Dakota State University, Brookings, SD, ²US Forest Service, Rapid City, SD

ABSTRACT

In the northern Great Plains, the resilience of perennial grasslands largely depends on successful tiller recruitment and establishment from belowground bud banks. However, over the decades, these grasslands are rapidly invaded by introduced perennial grasses *Bromus inermis* and transforming larger tracts of native prairies by replacing native perennial grasses, such as *Pascopyrum smithii*, reducing biodiversity and quality of habitats, and increasing vulnerability of grasslands to other environmental disturbances. Therefore, this study aimed to understand effects of intra- and inter-specific competition between native *P. smithii* and invasive *B. inermis* on belowground bud banks and tiller demography under frequent water and constant temperature condition. A greenhouse experiment was consisted of five treatments including single *B. smithii*, single *P. smithii*, pairwise mono of *B. inermis*, pairwise mono of *P. smithii*, and pairwise mixed of *B. inermis* and *P. smithii* with 30 replications for each treatment. Double-leaf seedlings of each species were transplanted to individual potting-soil filled pot (16.5-cm dia.) based upon designated treatments. Each pot was watered every other day with 72-ml tap water for 98 days after transplanting. At the end of 98 days, plants within each pot were carefully harvested and underground structures were washed free of soil. Each plant was dissected and classified into different generations. Within each generation, crown tillers, rhizome tillers, and buds were counted, and rhizome lengths were measured. Relative interaction index (Rii) of bud and tiller demography was used to calculate the competitive effect of the intra- and inter-specific competition between two species. Results from this study will enhance our understanding the potential utilizing reproduction and demography traits as important attributes of plant in response to disturbance. It will provide insights for developing strategies for sustainably manage non-native invaded perennial grasslands in remnant prairies of northern Great Plains.

SEED DISPERSAL PATHWAYS OF WESTERN AND UTAH JUNIPER: ROLES OF FRUGIVOROUS BIRDS AND GRANIVOROUS RODENTS. Lindsay A. Dimitri*¹, William S. Longland¹, Stephen B. Vander Wall²; ¹USDA-ARS, Reno, NV, ²University of Nevada, Reno, Reno, NV

ABSTRACT

Western and Utah juniper (WJ and UJ) woodlands have been expanding in range and infilling. Extensive resources have been spent managing these woodlands, so understanding seed dispersal is critical in identifying mechanisms behind expansion. Junipers produce female cones (“berries”) that are consumed by frugivorous birds and mammals in many species, but the role of scatterhoarding rodents is unclear. Juniper cone and seed traits vary, with some species producing juicy cones (WJ) while others are dry (UJ), and some cones having multiple, smaller seeds (WJ) while others have fewer, larger seeds (UJ). We hypothesized that this variation has favored differing seed dispersal pathways. In northeastern California, we compared removal of whole WJ cones, hand-cleaned WJ seeds and bird-passed WJ seeds by rodents and birds. Birds preferred whole WJ cones while rodents preferred seeds. We also performed a seedling emergence experiment with the same three seed treatments and found that successful establishment requires WJ seeds to be removed from cones and buried. Additionally, we documented distributions of WJ seeds in four microsites after bird dispersal and subsequent seed removal by rodents. Juniper canopies had the most WJ seeds, and rodents depleted most seeds between winter and summer. To understand the impact of seed and cone traits on dispersers, we monitored removal of WJ and UJ cones and hand-cleaned seeds at a WJ site and a UJ site. Dispersers preferred cones of the local juniper species but seed removal was similar. Finally, to clarify the role of rodents as dispersers, we followed removal of radioactively labeled WJ and UJ seeds and found that rodents, especially piñon mice, cached WJ and UJ seeds in microsites suitable for seedling establishment. Overall our research indicates that WJ seeds are dispersed by frugivorous birds and by scatterhoarding rodents, while UJ seeds are primarily dispersed by scatterhoarding rodents.

MUTUALISTIC INTERACTIONS BETWEEN GRANIVOROUS HETEROMYID RODENTS AND INDIAN RICEGRASS (*ACHNATHERUM HYMENOIDES*): IMPLICATIONS FOR ARID-LAND RESTORATION

. Bill Longland*¹, Lindsay A. Dimitri²; ¹USDA, ARS, Reno, NV, ²USDA-ARS, Reno, NV

ABSTRACT

Granivorous heteromyid rodent species and Indian ricegrass (*Achnatherum hymenoides*), a perennial grass common on sandy soils, are both widely distributed throughout North American deserts. Previous research demonstrated that the vast majority (~95%) of Indian ricegrass seedling recruitment occurs from seed clusters cached in shallowly-buried scatterhoards by heteromyids, especially Merriam's kangaroo rat (*Dipodomys merriami*). Here, we discuss how emergence of seedlings in aggregated clusters from caches affects subsequent seedling survival and establishment. In two western Nevada field studies, we monitored single Indian ricegrass seedlings and clumped seedlings in caches over the course of a year. Individual seedlings within clumps generally had higher survival rates than seedlings growing singly, and whole caches routinely had higher survival than single seedlings. We followed these observational studies with a field experiment in which Indian ricegrass seedlings were transplanted inside fenced plots either singly or in clumps of 25 or 35 seedlings and survival was compared through their first winter. Individual seedlings within clumps had higher survival than seedlings growing singly, and seedlings within clumps of 35 generally had maximum survival. These results suggest a mutualism involving heteromyid rodents and Indian ricegrass. Indian ricegrass seeds provide a highly preferred food resource to heteromyids, while benefits to Indian ricegrass extend beyond seed dispersal and seedling emergence into the longer-term survival of the plant. Finally, by broadcast seeding commercial seeds (millet) as an alternate resource for rodents, we tested whether such 'diversionary seeds' can enhance seedling recruitment resulting from Indian ricegrass seeds that had been cached by rodents by reducing numbers of these caches that rodents recover for consumption. Seedling recruitment was greater where diversionary seeds were applied, indicating that this mutualism can be applied in an arid-land restoration context.

TALL FORB PLANT COMMUNITY AND GROUND COVER DYNAMICS - WITH AND WITHOUT LIVESTOCK GRAZING. Aimee M. Zobell-Cameron*¹, Sherel Goodrich², Aaron Zobell³; ¹Uinta-Wasatch-Cache National Forest, Mountain View, WY, ²Ashley National Forest, Vernal, UT, ³Bridger-Teton National Forest, Kemmerer, WY

ABSTRACT

Tall Forb communities have a complex history of grazing within the Intermountain West. This complex history of grazing in conjunction with current plant community and ground cover dynamics in many Tall Forb types combined with an increase in public interest in tall forb types has resulted in a need to better understand the effect grazing may have had various tall forb types and the resiliency of these types post-grazing. Of particular interest is the effect grazing may have had or continues to have on plant community and ground cover dynamics. This PowerPoint presentation focuses on two areas of current interest within our National Forest Lands – the Wyoming Range of the Kemmerer Ranger District; and the Uinta Mountains of the Evanston-Mountain View Ranger District. Specifically this monitoring presentation (1) provides findings of more than a decade of monitoring as they relate to plant species composition and ground cover; (2) identifies current drivers affecting plant community and ground cover dynamics within these tall forb types; and (3) discusses the current effect grazing may be having within these Tall Forb types as they relate to these two criteria. A key part of this presentation includes new and/or updated findings as they relate to relic and reference areas for tall forb communities.

MONITORING RANGELANDS TO MAINTAIN GOALS FOR A WATER AGENCY.
. Theresa Becchetti*¹, Scott Oneto²; ¹University of California, Modesto, CA, ²UCCE,
Jamestown, CA

ABSTRACT

East Bay Municipal Utility District (EBMUD) owns the Mokelumne Watershed surrounding Pardee and Camanche Reservoirs in the central foothills of California with a long history of cattle grazing. Pardee Reservoir provides drinking water for 1.4 million people, making water quality the top priority for the agency. EBMUD recognizes the value of maintaining grazing to manage the watershed for multiple goals. With changes in the grazing program to ensure high water quality, EBMUD engaged University of California Cooperative Extension (UCCE) to develop a new monitoring program that can help provide information on the watershed scale to aid management decisions. After four years of Residual Dry Matter (RDM) mapping in every pasture, UCCE is transitioning the mapping process to EBMUD staff. In doing so, UCCE has begun collecting field data using Collector for ArcGIS on an iPad. Collector speeds data collection and when downloaded to the Cloud, field data is automatically created into maps, saving time and the need for GIS knowledge to create RDM maps. Using these maps, UCCE has been able to have discussions about management options such as adding offsite water or supplement placement to improve distribution or invasive weed management control with both EBMUD staff and the ranchers. RDM mapping allows for quick visual for distribution and use of the pasture. Management changes were implemented in some pastures and can be seen by following year's RDM maps.

MONITORING THE IMPACTS OF CONSERVATION PRACTICES ON ECOSYSTEM HEALTH IN THE RIO PUERCO WATERSHED. Jeremy W. Schallner*¹, Amy C. Ganguli¹, Richard Strait², Nicole Pietrasiak¹; ¹New Mexico State University, Las Cruces, NM, ²USDA-NRCS, Albuquerque, NM

ABSTRACT

The Rio Puerco Watershed (RPW) is a highly dynamic and diverse ecological system that has a long history of anthropogenic alterations. This landscape has been degraded through historic overutilization exacerbated by periods of prolonged drought. At present, the NRCS and BLM use conservation practices, namely prescribed grazing and brush control throughout the region to improve ecological stability and ecosystem health of private and public lands. The conservation practice of herbicide application serves primarily to decrease brush species while allowing for an increase in herbaceous cover and a decrease in erosion risk. The objectives of this project are to develop a comprehensive monitoring program to investigate the effects of this conservation practice on the plant and soil biological communities and the hydrology of the RPW. Changes to plant and soil biological communities are being monitored utilizing multiple transects across two herbicide-treated areas and two untreated reference areas. To examine the impacts to hydrology and soil health, soil sampling points along with six runoff plots and associated local weather stations were established in the research areas to provide key parameters controlling site potential and erosion risk. The runoff plots employ Upwelling Bernoulli Tubes to measure surface flow that can be linked directly to local precipitation quantities. All field measurements will be used to calibrate a Gridded Surface/Subsurface Hydrologic Analysis for the RPW to illustrate the potential impacts at a larger scale. We will demonstrate how integrating and expanding the plot-level measurements to the watershed-scale provides a better understanding of how this system reacts to conservation practices and can serve as a basis for future range management decisions. If conservation practices on rangelands within the RPW can decrease potential runoff and sediment load, the improvement of the ecological health of the system would provide valuable resources and ecosystem services across the region.

EFFECT OF CLIMATE CHANGE ON RANGELAND IN SUDAN: REVIEW

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ABSTRACT

The importance of rangeland basically comes from its environmental, economic and social importance. The secession of Sudan into two countries has remarkably reduced rangelands areas and shortened mobility of livestock, while arid and semi-arid lands increased as a percentage of total country area. This situation makes the country more affected by climate change as rain-fed subsistence farming and livestock rearing are the main livelihood means for the majority of rural communities. This means that more than 70% of Sudan's population depends directly on resources that are climate sensitive. Estimated area of rangelands in the country, is close to 68.6 million hectares, supporting livestock estimated as 107 million head. Impacts of the climate change on rangeland include Land degradation resulting from imbalanced utilization levels linked with the condition of people displacement. The impact of deterioration of vegetation cover has led to low ability of range to accommodate the number of animals. Preparation of review on *Effect of Climate Change on Rangeland in Sudan*, is rather important because the information available are scattered or with gaps that need to be addressed and will help to identify important research directions. This will also contribute to identifying and explaining justification for strategies to be adopted in relation to handling climate change related issues along differed mitigation and adaptation options and will inform research directions.

Key words: *Climate Change, Rangeland, Pastoralism,*

DEGRADATION AND VULNERABILITY TO CLIMATE CHANGE IN HIGH ANDEAN RANGELANDS

. Samuel E. Pizarro, Javier A. Naupari*; Universidad Nacional Agraria La Molina, Lima, Peru

ABSTRACT

This work seeks to identify the most important factors that causes the degradation process of rangelands, assess the degree of degradation and vulnerability to current climate change of these ecosystems; and determine if there is a relationship between the degree of rangeland degradation and vulnerability to climate change in high Andean rangelands. The study was located in the puna region of Ancash, Junín, Pasco, Huancavelica and Lima and involved the design of a framework to assess rangeland degradation based on field information and Landsat satellite products that was, contrasted with socioeconomic, ecological and location variables. The estimation of vulnerability to climate change was assessed with the Analytic hierarchy process (AHP) in a Geographic Information Systems (GIS) platform. The main factors in order of importance associated with the serious and extreme degradation process were the loss of vegetation fractional cover (VFC) from previous years, increments in the annual average temperature, high animal density, poor protection policies, high population density and low rock weathering index. Around 80% of the rangelands were classified as extreme and serious degraded, where the district of Santa Ana, Huancavelica, was the most degraded (extreme), and the district of Olleros, Ancash, less degraded (serious) with a tendency to increase the degraded areas. Extreme and heavy vulnerability was around 85%, and the main factors in order of importance associated with this index were low FCV, high slope, low rock weathering index, low precipitation, long distance to water sources, high population density, high annual average temperature and high animal density. Tomas district, Lima, was the most vulnerable, and Canchayllo, Junín, the least vulnerable, with a vulnerability tendency to keep increasing. Lastly we found a positive spatial correlation between degradation and vulnerability to climate change in high Andean rangelands (Pearson = 0.67, Spearman = 0.61).

ELEVATED DUST EMISSIONS ON THE COLORADO PLATEAU: ROLE OF GRAZING, VEHICLE DISTURBANCE, AND INCREASING ARIDITY. Travis W. Nauman*¹, Michael C. Duniway¹, Nicholas Webb², Jayne Belnap¹; ¹US Geological Survey, Moab, UT, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Dust from drylands are of major concern to human society. Dust deposition onto snowpacks can hasten melt rates, resulting in lowered inputs into major rivers. Blowing dust can result in traffic accidents, respiratory disease, and high economic costs. To abate dust emissions, it is necessary to examine suspected sources such as unpaved roads and grazing lands. We measured aeolian sediment mass fluxes in low elevation rangelands and unsurfaced roads on the Colorado Plateau in Utah, USA. Empirical spatial modeling suggests that rangelands are producing ~92-93% of regional dust and roads ~7-8%. Measured 'hot spots' in sediment mass flux at 100 cm height rival the highest ever recorded including 7,460 gm-2day-1 (spring 2009) in an off-highway vehicle (OHV) area near Hanksville, UT, but were more commonly 50-2,000 gm-2day-1 in areas with heavy grazing or OHV use. The overall mean measured rangeland sediment mass flux at 100 cm height was 5.14 gm-2day-1, considerably lower than grazed areas (~8-20 gm-2day-1) and OHV areas (414 gm-2day-1). In contrast, a similar area monitored with minimal soil disturbance averaged 1.60 gm-2day-1 from 2007-2015. Annual sediment mass fluxes on all rangeland land use types (light/not grazed, moderately and heavily grazed, and OHV) generally increased with increasing annual temperature, increased winds, and decreasing precipitation. Mass fluxes measured just downwind of unpaved road sites averaged 13.14 gm-2day-1 with a maximum observed seasonal flux of 128.0 gm-2day-1 along a producing oil well access road. Four of the five highest road flux values (n=33 total) measured were adjacent to roads primarily used to access oil or gas well-pads, while one was a road servicing both recreation and well-pads. These findings suggest that predicted future regional mega-droughts may increase dust emissions already elevated due to land management, potentially further compromising air quality, hydrologic cycles, and other ecological services linked to dust.

LINKING NATIVE AMERICAN CULTURE WITH THE RANGELAND RESOURCE ON THE WIND RIVER RESERVATION OF WYOMING

. Colleen T. Friday*, John D. Scasta; University of Wyoming, Laramie, WY

ABSTRACT

The Wind River Indian Reservation (WRIR) in Wyoming is more than 2.2 million acres and shared by the Eastern Shoshone and Northern Arapaho tribal nations. In 1960, an inventory was conducted of the plants in Paradise Basin and Saint Lawrence Basin in the Wind River Mountain Range of the WRIR. This initial inventory is severely lacking in applicable value for several reasons including that the inventory: (1) only included the presence or absence of 74 species, (2) made no estimate of species abundance, (3) made no differentiation between the two basins relative to the presence of a species, and (4) did not measure any other ecological explanatory information to explain species occurrence. In the time since this inventory, researchers, policy makers and natural resource managers have begun to recognize the long-term value of using Traditional Ecological Knowledge (TEK) for the management of natural resources. TEK is an accumulation of place-based knowledge, practice, and belief about relationships between living beings and their environment that is transferred to subsequent generations. On the Wind River Indian Reservation (WRIR), TEK is structured from an indigenous paradigm that respects and represents the cultural and linguistic specificity of the two tribes. The Bureau of Indian Affairs at Wind River Agency has a trust responsibility to assist the tribes in land and resource management. Data which explains rangeland plant communities in these high elevation basins and includes abundance data to assess rangeland health and condition increases the agency's ability to fulfill this trust responsibility. We are conducting a vegetation inventory to enhance rangeland management of these high-elevation basins and to facilitate the documentation and sharing of TEK within the Wind River tribal community.

TESTING RANGELAND HEALTH THEORY IN THE NORTHERN GREAT PLAINS. Kurt O. Reinhart*, Matthew J. Rinella, Lance T. Vermeire; USDA-ARS, Miles City, MT

ABSTRACT

Correctly assessing whether rangeland ecosystem services are stable, improving, or degrading is of local to global importance. In the USA, several plant and soil properties are measured as part of a standardized system for assessing rangeland health. Here a series of field experiments were used to test the reliability of a primary putative indicator (i.e. soil aggregate stability) of rangeland management and ecosystem function in the Northern Great Plains. First, we tested whether livestock grazing pressure consistently reduced soil aggregate stability. Second, we tested whether appreciable variation in soil water transport (infiltration) was explained by aggregate stability. Data from a multi-factor field experiment was used to determine the best predictor(s) of infiltration and contributed to a meta-analysis that tested the generality of the expected positive aggregate-infiltration association. In one of two field experiments, livestock grazing pressure tended to reduce the stability of small (easily erodible fraction) macroaggregates (0.25-1 mm). In the other experiment and for larger macroaggregates (1-2 mm), grazing had no appreciable impact on aggregate stability. The multi-factor field experiment affected several plant and soil properties. Multiple regression analyses of these data determined that variation in infiltration was best explained by plant community composition variables but not soil properties. 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 soil health indicators but support plant species-infiltration linkages consistent with bioturbation theory. Designing rangeland health monitoring systems with empirically validated predictors of ecosystem function is a logical next step towards better health assessment.

DIMA.TOOLS: AN R PACKAGE FOR WORKING WITH THE DATABASE FOR INVENTORY, MONITORING, AND ASSESSMENT. Nelson Stauffer*, Sarah McCord; USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

The Database for Inventory, Monitoring, and Assessment (DIMA) is a Microsoft Access database used to collect, store and summarize monitoring data. This database is used by both local and national monitoring efforts within the National Park Service, the Forest Service, the Bureau of Land Management, Agricultural Research Service, non-profit organizations, and land management agencies globally, including Mongolia. The Access format permits long-term storage of large datasets and enables electronic data capture in the field, sophisticated error checking procedures, and a graphical user interface, however analysis of large amounts of data in one or more DIMAs is difficult. Therefore, further analysis and the production of quality monitoring information often requires interacting with DIMA via other software interfaces such as R.

Here we present an package for R, *dima.tools*, containing functions which simplify direct user access to raw data tables within DIMAs and combining data from multiple DIMAs. Additionally, common data manipulation functions are available in the package for low-level tasks like tidying data and joining data to metadata as well as higher-level functions for tasks like producing standard indicators and quality assurance and quality control checks. Together, these provide a reproducible framework for users to compute their own custom indicators and to complete complex analyses using other functions and packages in R.

SMALL SCALE RESTORATION: IMPROVING NATURAL BEAUTY AND WILDLIFE HABITAT THROUGH LARGE SCALE STUDENT INVOLVEMENT

. Mitchell J. Greer*¹, Curtis J. Schmidt², Morgan A. Noland¹; ¹Fort Hays State University, Hays, KS, ²Sternberg Museum of Natural History - Fort Hays State University, Hays, KS

ABSTRACT

Numerous studies have shown that students who work actively to research, discuss, and perform experiments gain a deeper understanding of concepts within the field of rangeland sciences. To increase the number of students reaching this deeper level of understanding in the rangeland program at FHSU, we implemented a small-scale restoration project that allows students to experience firsthand the research design and data collection process, practice species identification of numerous organisms, gain field experience and skills, and relate information learned in classrooms to real world settings. The Howard Reynolds Natural Area (HRNA) was created on Sternberg Museum of Natural History property in 2010 and since its establishment has been in a continual state of decline. The HNRA is currently undergoing numerous restorations activities to increase the ecological integrity of the area and make it more appealing to both the citizens of Hays and native wildlife. Our objective is to determine if these restoration activities will have an influence on any of the biological communities present in the area. To determine these restoration activities have an effect on the small mammal community preliminary trapping data was collected. Our trapping seasons resulted in the capture of five different species. Initial data collection has been expanded to include amphibians and reptiles, ground beetles, ants, mosquitos, plants, and soil microbial communities. These restoration and data collection efforts have engaged seven different undergraduate student researchers who have or will present their results at professional meetings and over forty student volunteers. This project is a win-win-win-win situation for the students, the HNRA, the community of Hays, and the biological communities. This ongoing project will provide years of research and field experience to the undergraduate and graduate students as well as opportunities to mentor younger students and educate the public.

SAGE GROUSE HABITAT CONSERVATION AND RESTORATION THROUGH CONSISTENT, COLLABORATIVE MONITORING

. lee turner*; nevada department of wildlife, reno, NV

ABSTRACT

One aspect of many habitat restoration projects that is sometimes overlooked or may be removed from restoration project activities given the current status of federal, state agency or other project proponent budgets is implementation of a statistically robust and ecologically meaningful monitoring protocol. In Nevada, the Nevada Department of Wildlife houses the Nevada Partners for Conservation and Development (NPCD). The NPCD is implementing vegetation, avian and species specific monitoring pre and post restoration treatment across Nevada using the Utah Watershed Restoration Initiative's (WRI) example. In Utah, the WRI implements a state wide vegetation and animal monitoring program largely focused on habitat projects. Utah's Division of Wildlife Resources has a long history of providing a variety of monitoring services to the various land management and private entities in Utah. Developing a coordinated and well thought out monitoring program provides a number of important services. First, this gives States an opportunity to provide leadership on habitat projects and encourages better communication with private and federal partners. Second, the monitoring program allows us to bring researchers, graduate students and undergraduates into habitat projects providing valuable, real world experience. Third, NDOW/NPCD is providing important project effectiveness information to agencies so that the best science is being used for a variety of land management decisions. Finally, by rigorously monitoring outcomes of projects, we can better guide future restoration design and implementation.

LONG-TERM EFFECTS OF BIOSOLIDS APPLICATION ON GRASSLAND SOIL QUALITY AND PLANT SPECIES COMPOSITION. Emma M. Avery*¹, Maja Krzic¹, Brian Wallace², Reg Newman²; ¹University of British Columbia, Vancouver, BC, ²Ministry of Forests, Lands, Natural Resource Operations and Rural Development, Kamloops, BC

ABSTRACT

The land application of biosolids (composted sewage solids) has been shown to improve forage production on semi-arid grasslands. In 2002, an experiment was established on a ranch in the central interior of British Columbia to evaluate the long-term effects of a one-time biosolids surface application on grassland soil quality and the plant community. Two treatments were evaluated: surface biosolids application at 20 Mg ha⁻¹ and a control (no biosolids). Both treatments were replicated in four blocks which were excluded from grazing. Soil samples were collected in April, June, August and October 2016, while plant species composition and above ground biomass were assessed in June 2016. Fourteen years following the biosolids application, aboveground plant biomass was almost two times greater on treatment with biosolids application than on control. Despite differences in aboveground biomass there was no difference in total soil C. However, biosolids amended soil did exhibit significantly stronger aggregates in the October sampling event (though not in the other three sampling events), and a greater ability to retain soil water at high tensions. Available P was the only macronutrient that was significantly higher in the biosolids treatment 14 years after application relative to the control. The increased soil water and nutrients from the biosolids may have benefitted an exotic agronomic perennial, Kentucky Bluegrass, which now covers 25.83 ±13.83% of the biosolids blocks and 0.13 ±0.13% of the control. This study showed that a single biosolids application led to greater forage yields and improved aspects of soil quality 14 years following that application; however, this also led to a change in plant species composition, which may be less desirable from a restoration perspective.

RESPONSE OF ARID RANGELANDS TO DEFERRED GRAZING IN SOUTHERN TUNISIA

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ABSTRACT

Rangelands in north Africa and the near east in general provide numerous goods and services that have great economic, social, cultural, and biological values. For centuries, inhabitants of rangelands have engineered pastoral and farming systems that have sustained their livelihoods in these harsh and dry environments. Unfortunately, these rangelands have undergone profound socio-economic changes where traditional grazing systems (transhumance and nomadism) which had historically allowed for grazing deferment were abandoned. Almost all rangelands are now grazed continuously without any restriction in space or in time. To address the negative effects of overgrazing and also the recurrent droughts, a study was carried out in southern Tunisia aiming at assessing the effect of deferred grazing on plant cover dynamics and productivity. Percent plant cover, species composition, plant density and rangeland production were estimated inside the rested sites (1 year, 2 years and 3 years), controlled grazing sites (one and 2 years after 3 years rested sites) and free grazed sites, considered as control. Preliminary results showed considerable positive effects of the applied restoration technique (rest). The 2 years resting followed by controlled grazing showed a speedy recovery of these degraded ecosystems. Such low cost restoration technique would be considered as an efficient option given the limited or even lack of financial resources to rehabilitate arid rangelands. In addition, it has the advantage of conserving the biodiversity, improving forage production, reducing feed cost and mitigating the negative impact of climate change. **Key words:** deferred grazing, dry lands, ecosystem services, transhumance, biodiversity, restoration

EVALUATION OF THE AUTOMATED REFERENCE TOOLSET FOR OIL AND GAS RECLAMATION ON COLORADO RANGELANDS. Sean F. Di Stefano*¹, Colby Brungard¹, Jason W. Karl², Nelson Stauffer³, Sarah McCord³; ¹New Mexico State University, Las Cruces, NM, ²University of Idaho, Moscow, ID, ³USDA-ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Rangelands are characterized by low precipitation and low biomass, making them susceptible to disturbance and difficult to reclaim. Considering the widespread and significant impact of oil and gas development on rangelands, effective reclamation is vital. Thus, it is important that land managers understand the ecological context of a reclamation site so that management outcomes can be correctly interpreted. This is often accomplished through comparison of reclamation areas to reference sites which are selected by their similarity to the reclamation area's pre-disturbance condition, so that the relative condition of a reclamation site can be determined. Reference site selection is normally expert driven on a site-by-site basis, and thus can be inconsistently applied and ineffective in helping to meet reclamation goals over large landscapes. The Automated Reference Tool (ART) was developed to improve the efficiency and efficacy of reference site selection by selecting reference sites of similar land potential to the reclamation area based on soil texture, topography, and geology. However, ART has not been previously evaluated in a management context. Our objectives were to evaluate ART within this context and determine if existing reference sites are appropriate reference sites for well-pads. We applied the ART to oil & gas reclamation sites managed by the Bureau of Land Management's (BLM) White River Field Office, Colorado, to their reference sites and to nearby sites from the BLM's Assessment, Inventory, and Monitoring (AIM) program. Both existing reference sites and nearby AIM sites varied in their similarity to reclamation sites according to ART and in terms of vegetation composition from field sampling. Based on these results, ART can complement expert-driven reference site selection, making reference site selection quicker, more quantitative, and defensible, helping land managers better meet their reclamation needs.

COMPLETING THE KNOWLEDGE CYCLE: DERIVING IPM KNOWLEDGE DIRECTLY FROM PRACTITIONERS ON WORKING LANDSCAPES. Tracy Schohr*¹, Leslie Roche², Julea Shaw³, Julea A. Shaw⁴, Kenneth W. Tate⁵, Elise Gornish⁶; ¹UC Cooperative Extension, Quincy, CA, ²University of California, Davis, CA, ³UC Davis, Davis, CA, ⁴University of California - Davis, Davis, CA, ⁵University of California, Davis, Davis, CA, ⁶University of Arizona Cooperative Extension, Tucson, AZ

ABSTRACT

Practitioners hold one of the most voluminous caches of field-tested integrated pest management (IPM) experience. However, this information is generally not available in a synthesized, organized format for researchers and other managers to learn from. In one of the first coordinated efforts in the state, our research team has analyzed decision making surveys of practitioners from across California and conducted semi-structured interviews with ranchers and agencies, to mine knowledge from over 200 IPM practitioners on rangelands. Survey and interview findings elucidate factors that realistically contribute to IPM adoption and success, and showcase field-tested best management practices to control invasive species with managed grazing, seeding, herbicides and prescribed fire. There are many stakeholders who are vested in re-establishing ecosystem health and productivity on rangelands. Results from this work will inform on-the-ground management strategies with case studies from dozens of practitioners. The project assess the effectiveness of different pest management tools and provides a data-driven description of IPM practices that maximize cost effectiveness while conserving diversity, and promote productivity.

EFFECTS OF MEDUSAHEAD ON BEEF CATTLE GAINS

. Jeremy J. James*¹, Josh S. Davy², Larry Forero³, Theresa Beccehti⁴, Philip Brownsey⁵, Matthew Shapero⁶, Emilio Laca⁷; ¹Center Director, Browns Valley, CA, ²University of California, Red Bluff, CA, ³UCCE, Redding, CA, ⁴UCCE, Stockton, CA, ⁵UCCE, Sacramento, CA, ⁶UUCE, Ventura, CA, ⁷UC Davis, Davis, CA

ABSTRACT

The invasive grass medusahead dominates millions of acres of rangeland across the West. While the ecological impacts of medusahead on rangeland ecosystem function have been well-demonstrated the economic impact of this and similar invasive species has never been quantified, severely limiting cost:benefit assessment of different management decisions. The objective of this study was to quantify the relationship between medusahead abundance and beef cattle gain. We experimentally manipulated medusahead abundance in 9, 5-acre pastures for two years (2013-2014) using fire, seeding, herbicide and grazing to reduce medusahead abundance in some pastures while increasing medusahead abundance in other pastures. In March 2016, and again in March 2017 we stocked pastures with 6 steers (approximately 650 lbs. starting weight) in each of the 9 pastures. Pastures were grazed from March to beginning of May and we adjusted stocking rate (removing or adding animals) to achieve equal utilization across pastures by the end of the growing season (target 800 lbs. per acre dry matter). We quantified forage production and utilization monthly across 10 transects as well as forage composition as frequency in mid spring and total animal gain across the grazing period. There was little evidence that medusahead abundance influenced average daily gain in this trial ($P > 0.05$) but across both years increasing medusahead abundance reduced carrying capacity. On average a 10% increase in medusahead abundance decreased gains by 30 lbs per acre over the growing season. Modest per acre inputs or changes in management that can progressively lower medusahead abundance are likely to produce a measurable economic and ecological benefit.

SPATIAL AND TEMPORAL ASSESSMENT OF MEDUSAHEAD USING REMOTE SENSING

. Timothy M. Bateman*; Open Range Consulting, Logan, UT

ABSTRACT

Medusahead is an unpalatable, aggressive annual that has been invading and degrading western rangelands. This characteristic has negative effects on plant diversity and ecosystem function, promoting the creation of homogeneous landscapes. The costs to wildland systems, agriculture, and the public are high and land managers face resource constraints that can limit successful management. Management plans need to be practical, cost-effective, and sustainable if they are to reach specific targets. Supplementing management plans with remote sensing can provide rapid and cost-effective datasets that can provide unique information that can be beneficial to land managers threatened by medusahead. Research has been successful in creating large datasets that include a 30+ year time line of changes in medusahead in eastern Washington.

THE LONGEVITY OF A CONTROLLED BURN'S IMPACTS ON SPECIES COMPOSITION AND BIOMASS IN NORTHERN CALIFORNIA ANNUAL RANGELAND DURING DROUGHT

. Josh S. Davy*; University of California, Red Bluff, CA

ABSTRACT

Controlled burning timed in early summer can dramatically change the species composition of annual rangeland the following season. Although this has been well documented, the longevity of these shifts has not. Presented is a case study of a single 200 hectare burn to begin to understand how long plant communities and biomass production remain diverged between burned and unburned annual rangeland. Species composition and biomass production were monitored before and for three years after burning. Burning drastically reduced medusahead (*Taeniatherum caput-medusae*; $P < 0.01$) the following year from 69% in the control to 4% cover in the area burned. In the same year, filaree (*Erodium spp*; $P < 0.01$) filled in the area left vacant, subsequently lessening production ($P < 0.01$) in the burn area by over half that of the control. No difference existed in the occurrence of native wildflower species due to fire. Three consecutive drought years following the burn shifted the control from medusahead dominance to filaree in a linear fashion. At the same time, in the burned area medusahead cover increased fourfold between one and three years after the burn. By three years post-burning the burned area had 4% more medusahead cover than the control and was equal in filaree, rose clover (*Trifolium hirtum*), and soft brome (*Bromus hordeaceus*) cover. Our results suggest that a controlled burn followed by drought can cause the divergence in species composition and production to become void in as little as three years after a well-timed burn in a low elevation annual rangeland system.

GRAZING ROTATIONS ON RESTORED LAND AS A NEW TOOL FOR MEDUSAHEAD CONTROL. Casey Spackman*¹, Clint Stonecipher², Kip Panter², Juan Villalba³; ¹Utah State University, 84333, UT, ²USDA, Logan, UT, ³Utah State University, Logan, UT

ABSTRACT

Grazing animals represent a sustainable tool to control invasive species like medusahead (*Taeniantherum caput-medusae* (L.) Nevski), although the low nutritional quality of this weed constrains its use by herbivores. We hypothesized that the nutrients from Siberian wheatgrass and forage kochia provide the appropriate nutritional context to enhance use of medusahead by cattle. Beef cows (12) were assigned to two treatments in 6 plots (2 animals/plot) on private land in the scablands of eastern Washington: 1) Treatment animals grazed improved rangeland for 45 min/d and then they grazed medusahead-infested rangeland (SUP; n=3 plots) for 8 h/d and 2) Control animals grazed medusahead-infested rangeland only for 8 h/d (CTRL; n=3 plots) during 10 consecutive days in October of 2016. Individual heifers were focally sampled for successive 5-min periods through the bite count method for use of medusahead (MH), annual grasses (AG), perennial grasses (PG), green forbs (GF), dried forbs (DF), and thatch (TH) in the plant community. Preliminary data shows that grazing the improved pasture (SUP) slightly enhanced the subsequent use of MH in the medusahead-infested plant community relative to the CTRL (31.6 ± 4.4 vs $27.3 \pm 3.7\%$ of bites/day, respectively). There was no difference between treatments in grazing of AG, GF, DF, and TH, but SUP animals also utilized medusahead in the improved pasture ($42.4 \pm 0.09\%$ bites/day, respectively) and consumed less PG in medusahead-infested rangeland than CTRL animals ($6.4 \pm 1.5\%$ vs. $13.1 \pm 2.8\%$ of bites/day, respectively). Preference for PG and reluctance to consume MH is often the reason for medusahead spread. The reduced consumption of PG and the increased preference for MH by SUP cows contributes to reverse this trend. Therefore, rotations from improved pastures to medusahead-infested pastures may be used as a tool to mitigate medusahead spread in the invaded scablands of eastern Washington.

VALIDATING A TIME SERIES OF HERBACEOUS ANNUAL COVER MAPS IN THE SAGEBRUSH ECOSYSTEM

. Stephen P. Boyte*¹, Bruce K. Wylie², Donald J. Major³; ¹SGT, Inc. -- U.S. Geological Survey EROS Center, Sioux Falls, SD, ²U.S. Geological Survey EROS Center, Sioux Falls, SD, ³Bureau of Land Management -- Idaho, Boise, ID

ABSTRACT

We developed a time series (2000 – 2016) of spatially explicit herbaceous annual maps in 1% increments that emphasize annual grass cover in the sagebrush ecosystem. The study area includes the Great Basin, the Snake River Plain, the state of Wyoming, and contiguous areas. We integrated remotely sensed data (250-m eMODIS NDVI) with land cover (National Land Cover Database), biogeophysical (e.g. soils, topography), and 30-year precipitation data into regression-tree software to develop an herbaceous annual mapping model. In sagebrush ecosystems, annual grasses, especially cheatgrass (*Bromus tectorum*), result in grass-fire cycles that endanger human-built structures, compromise recreational and hunting resources, destroy wildlife habitat, and reduce air quality. We applied a mask to areas above 2250-m elevation because cheatgrass is unlikely to exist at substantial cover above this threshold. To target likely sagebrush ecosystems, the mask also hid pixels classified as something other than shrub or grassland/herbaceous by the NLCD. We validated the model in two ways. We used 1) accuracy assessment data that the regression-tree software generated for training and independent test data sets. This assessment includes a correlation coefficient (r) value, an average absolute error, a relative absolute error, and a mean average error (MAE) and standard deviation based on nine model boot-strap randomizations. 2) High resolution remotely sensed herbaceous annual data spatially averaged to 250 m and BLM Terrestrial Assessment Inventory and Monitoring (AIM) data. These data were compared to the herbaceous annual cover maps in corresponding years, and we calculated r -values and the MAE. This time series of maps illustrates the spatio-temporal variability of annual grasses in the sagebrush ecosystem and can be accessed at [doi:10.5066/F71J98QK](https://doi.org/10.5066/F71J98QK).

ESPLANADE 200SC: A NEW LONG-TERM CONTROL STRATEGY FOR MANAGING INVASIVE WINTER ANNUAL GRASSES ON RANGELAND

. Derek J. Sebastian*¹, Harry Quicke², Scott Nissen³, Shannon Clark³; ¹Bayer, Greeley, CO, ²Bayer, Windsor, CO, ³Colorado State University, Fort Collins, CO

ABSTRACT

Invasive winter annual grasses such as cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*), and ventenata (*Ventenata dubia*) are a threat to native ecosystems throughout the US. Cheatgrass out-competes native vegetation with devastating consequences including more frequent and more intense wildfires, degraded wildlife and pollinator habitat, loss of diversity, and inferior recreation experiences. For decades, land managers have been attempting to recover cheatgrass dominated sites; however, there are currently limited management options that work consistently, provide multiple years of control, and do not injure desirable plant communities. While glyphosate, imazapic (Plateau®, BASF), and rimsulfuron (Matrix®, Bayer) are herbicides commonly recommended to control invasive annual grasses, short-term control results in rapid reinvasion of treated areas via the soil seed bank (<5 years). Indaziflam (Esplanade® 200SC, Bayer) is a cellulose biosynthesis inhibiting (CBI) herbicide that is a unique mode of action for resistance management. Multiple field studies at Colorado State University have shown Esplanade 200SC provides long-term (3+ years) cheatgrass control with a single application. In addition, Esplanade 200SC promoted the reestablishment of the co-occurring plant community by increasing perennial grass (36-fold) and forb biomass (5-fold), and plant diversity (richness) over time. Esplanade 200SC research trials have been conducted throughout the western US including Washington State University and Utah State University. These studies have resulted in >99% ventenata and medusahead control the second year after treatment. In a greenhouse study, indaziflam applied preemergence was on average 12 times more active than imazapic on six invasive annual grasses including cheatgrass, medusahead, and ventenata. Indaziflam could potentially be used to eliminate the soil seed bank of these invasive grasses, decrease fine fuel accumulation, and ultimately increase the competitiveness of perennial co-occurring species on western rangelands. Bayer is currently conducting the studies necessary to establish a grazing tolerance for use on sites grazed by domestic livestock.

DOES A DRY HERBICIDE DELIVERY SYSTEM PROVIDE INCREASED CHEATGRASS CONTROL BENEATH A SHRUB CANOPY? Clay W. Wood*¹, Brian A. Meador²; ¹University of Wyoming, Laramie, WY, ²University of Wyoming, Sheridan, WY

ABSTRACT

Imazapic is commonly used to manage cheatgrass (*Bromus tectorum*) on rangelands where cheatgrass-fueled fires threaten sagebrush conservation. However, the amount of herbicide reaching its target site may be reduced via shrub canopy interception. We evaluated two formulations of imazapic – liquid and granular – for cheatgrass control beneath shrub canopies in greenhouse and field studies. In the greenhouse, we applied both imazapic formulations at five preemergent rates to pots seeded with cheatgrass – with and without a sagebrush canopy. Cheatgrass biomass did not differ between formulations ($p>0.2$) or canopy cover treatments ($p>0.6$) in the greenhouse. We aurally applied liquid imazapic at 123 g ai·ha⁻¹ and granular imazapic at 135 g ai·ha⁻¹ at four field sites: Hyattville, Pinedale, Saratoga, and Sheridan, WY. We collected cheatgrass biomass beneath shrub canopies and within shrub interspaces at all sites one year after treatment (YAT) and two YAT at Saratoga and Pinedale. Cheatgrass biomass reductions were not observed one YAT at Hyattville or Sheridan for either herbicide formulation ($p>0.4$). No differences were detected between cheatgrass biomass beneath shrubs or in interspaces one YAT at Saratoga or Pinedale ($p>0.68$). Herbicide treatment was the only factor affecting cheatgrass biomass one YAT at Saratoga and Pinedale ($p<0.05$). One YAT at Saratoga, both imazapic formulations similarly reduced cheatgrass biomass, but at Pinedale, the liquid formulation reduced cheatgrass biomass more than the granular. Saratoga was the only site with biomass reduction beneath shrubs for both formulations two YAT ($p<0.05$). We quantified herbicide deposition at the soil surface at Hyattville and Sheridan during aerial herbicide applications. Liquid imazapic coverage (%) was greater in interspaces than under shrubs ($p<0.001$). Granular imazapic weight (g·ha⁻¹) was consistent at both sites ($p>0.7$). Our results indicate that although a granular formulation may provide greater herbicide deposition beneath shrub canopies than liquid, similar reductions in cheatgrass biomass may be achieved.

PROACTIVE STEPS TAKEN BY THE SEED INDUSTRY TO ADVANCE THE NATIONAL
NATIVE SEED STRATEGY. Ed S. Kleiner*; Comstock Seed, Gardnerville, NV

ABSTRACT

Scientific advancement in plant genetics is revealing diversity within species across their geographic distribution. There is consensus between scientists and the federal land agencies that this diversity should be taken into account when choosing seed sources for restoration work. The National Native Seed Strategy lays out a path to move towards developing seed sources to reflect this diversity. The seed industry has partnered with the Plant material centers to isolate and increase native seed inventories to reflect this diversity. In turn, these increases can be moved into the private sector for largescale cultivation and marketing. Scientists are developing seed transfer zones (STZ's) for important species that will define and limit the areas where seed can be moved. These seed transfer zones are also being used for the movement of native collections directly to the market. There is also a proliferation in local source collection contracts in the immediate vicinity of projects such as mines, highways, fires, and other disturbances. This presentation briefly reviews examples of these activities and the proactive roles that the seed industry can play in moving the national seed strategy forward.

SAGEBRUSH RESTORATION FOR GREATER SAGE-GROUSE HABITAT: GLEANING WHEN, WHERE, AND HOW FROM PAST SUCCESSES. Robert S. Arkle*¹, David S. Pilliod¹, Justin L. Welty², Matthew J. Germino¹, David A. Pyke³, John B. Bradford⁴, Michael C. Duniway⁵, Daniel Manier⁶; ¹US Geological Survey, Boise, ID, ²Dept. of Interior USGS, Boise, ID, ³U.S. Geological Survey, Corvallis, OR, ⁴US Geological Survey, Flagstaff, AZ, ⁵US Geological Survey, Moab, UT, ⁶US Geological Survey, Fort Collins, CO

ABSTRACT

Despite decades of sagebrush restoration efforts spanning millions of hectares, information on the likelihood, rate, and factors governing post-fire sagebrush establishment is still lacking. Using field data from over 150 sites across the Great Basin, we examined how post-wildfire sagebrush establishment was influenced by pre-treatment vegetation, sagebrush seed source, climate, post-treatment weather, soils, topography, fire history, and treatment implementation method. Preliminary results indicate that big sagebrush is difficult to restore at most seeding sites and takes decades to provide cover meeting habitat guidelines for Greater Sage-grouse. However, successful establishment of sagebrush did occur at many sites and was related to microsites left by pre-fire sagebrush, post-treatment temperature and precipitation, and treatment implementation methods. About 10% of plots at sites where sagebrush successfully established were used by Greater Sage-grouse based on fecal pellet surveys. These findings could help guide decisions regarding when, where, and how to invest limited resources in post-wildfire big sagebrush restoration for the benefit of sagebrush obligate species like the Greater Sage-grouse.

SEEDING BIG SAGEBRUSH (*ARTMEISIA TRIDENTATA*) IN UTAH. Kevin Gunnell*, Danny Summers; Utah Division of Wildlife Resources, Ephraim, UT

ABSTRACT

Big sagebrush (*Artemisia tridentata*) has been seeded on rangeland treatments and wildfires throughout Utah for the enhancement of watersheds and wildlife habitat. Examination of vegetation data collected from across Utah has shown limited success from seeding of big sagebrush when seeded following a rangeland treatment or wildfire. To test the impact of seeding rate and timing we seeded Wyoming big sagebrush over the winters of 2015-2016 and 2016-2017 at 12 different rates every two weeks from fall through spring at two locations. Seedlings were counted in the spring of 2016 and 2017 to determine the impact that seeding rate and timing had on germination rates. Initial results show that timing and rates likely influence big sagebrush seeding establishment and success, and that some recommended current practices may need to be revised for increased success of sagebrush seedings.

EMERGING SEED ENHANCEMENTS TO IMPROVE SAGEBRUSH POST-FIRE/RESTORATION SEEDING SUCCESS

. Ryan Call*, Matthew D. Madsen; Brigham Young University, Provo, UT

ABSTRACT

Abstract: The sagebrush steppe is undergoing rapid ecological change and the loss of sagebrush rangelands contributes to more than 350 species of animals and plants being listed as species of conservation concern, as well as, a decrease in recreational activities, reduced forage production, degraded water resources and an increase in fire frequency. In the sagebrush steppe, success rates for seeding are notoriously low. Seedlings are exposed to numerous stresses of which can have compounding effects on their survivability. To reduce the associated stresses with seedling development we use seed enhancement technologies. Seed enhancement technologies allow for the physical manipulation and application of materials to the seed that can influence germination, emergence, and/or early seedling growth. Timing emergence and germination of seedlings can reduce some of the environmental stresses during early development. Seed coating and enhancement strategies with sagebrush present a difficulty amongst themselves due to the small size of sagebrush seeds. We proposed the idea of agglomerating sagebrush seeds to provide a means that enhancements can be applied. In turn we created a method that improves delivery and flow through standard seeding equipment. We will present on our findings for agglomerating sagebrush seed and controlling germination timing using plant regulatory growth hormones. The potential outcomes of these strategies can have significant impact on future seeding attempts by increasing overall success rates, which in turn can reduce overall costs.

A NOVEL APPROACH TO MODEL GERMINATION TIMING OF NATIVE PLANT SPECIES IN THE GREAT BASIN. William C. Richardson*, Bruce A. Roundy, Zachary Aanderud, Kylar Sant, Matthew D. Madsen; Brigham Young University, Provo, UT

ABSTRACT

The Great Basin of North America has been identified as an area that suffers from elevated levels of degradation, and is difficult to restore via seeding practices. Seedbed freezing conditions during the winter have been shown to limit seedling establishment. Mortality may also occur over the winter period to seedlings from drought, pathogens, and expenditure of seed food resources. Hydrothermal models have been used in the past to effectively predict when seeds will germinate. By understanding when seeds will germinate during the year we can further understand what limitations affect seedling establishment and develop restoration practices that can help seedlings overcome these barriers. We germinated seeds from 10 different native species in the Great Basin at 5, 10, 15, 20, and 25 °C. From germination count data, thermal-time germination models were calculated using a new Microsoft Excel workbook we developed called "Auto-Germ." Auto-Germ uses germination count data obtained from laboratory trials performed over a range of constant temperatures to calculate thermal-time germination models and a suite of other germination indices. Auto-Germ also provides the user with an interface to apply the thermal-time germination models to estimate germination timing from simulated planting dates. Models developed from the species test in our trial had sufficient accuracy ($R^2 = 0.60- 0.98$) to predict germination timing. The application of these germination models to historic soil moisture and temperature data over a 6-year period across 10 sites throughout the Great Basin indicated variation in germination timing between the species. Most species germinated rapidly, within fall to early winter period, which may limit their survival. These results indicate that more research should be conducted to understand how germination timing influences seedling survival and if practices could be developed to either push germination to more suitable conditions or help seedlings overcome environmental barriers.

EFFECTS OF NEIGHBORING PLANTS AND DEFOLIATION ON GRASS SEEDLINGS AFTER FIRE IN SAGEBRUSH COMMUNITIES. Jeffrey M. Gicklhorn*¹, Beth A. Newingham²; ¹University of Nevada, Reno, Reno, NV, ²USDA-ARS, Reno, NV

ABSTRACT

Native perennial bunchgrass species are often seeded after wildfire in the Great Basin to stabilize soils and resist invasive species establishment. Domestic livestock grazing is typically postponed for two growing seasons to allow for seedling establishment. Seeding failures may occur due to unsuitable abiotic conditions or inappropriate post-fire grazing management leading to seedling mortality. We explored how post-fire grazing management and neighboring plant communities affect the efficacy of post-fire seeding treatments in *Artemisia tridentata* ssp. *wyomingensis* communities. We implemented plant removal treatments at the beginning of the first growing season to vary the relative density of adult and seedling perennial bunchgrasses. Growing and dormant season defoliation treatments were used to simulate livestock grazing and examine the appropriate time to reintroduce livestock after fire. We repeatedly sampled perennial seedling tiller stem length, leaf and flower production, and timing of senescence during the first three growing seasons to quantify plant-level responses. We sampled end-of-season perennial bunchgrass plant density and foliar cover for the first three years to quantify treatment effects on community structure. Adult and seedling removal decreased plant density and foliar cover in the first year after fire. Foliar cover in adult removal treatments recovered as compared to neighbor removal control treatments by the second year, while seedling removal cover remained reduced in through the duration of the study. Fall and spring defoliation within seedling removal hastened senescence following defoliation, while spring defoliation decreased inflorescence production during year two only. Seedling mortality did not differ by treatment, and none of our treatments reached the recommended benchmark for livestock reintroduction of 20% bunchgrass foliar cover after three growing seasons post-fire.

STRAW MULCH EFFECTS ON POST-FIRE RESTORATION IN EASTERN NEVADA

. Burgess B. Munyer*¹, Camie M. Dencker¹, Jeffrey M. Gicklhorn¹, Lara D. Derasary², Beth A. Newingham³; ¹University of Nevada, Reno, Reno, NV, ²Eastern Nevada Landscape Coalition, Ely, NV, ³USDA-ARS, Reno, NV

ABSTRACT

Land managers often apply straw mulch after wildfire to reduce soil erosion and potentially increase soil moisture. Increased soil moisture and reduced soil erosion may foster plant recruitment; however, little is known about mulch treatment effects in Great Basin ecosystems. We examined the effects of straw mulch treatments on the Black Fire, which burned in July 2013 in Great Basin National Park and the Ely, Nevada BLM District. The Ely District fire management program aerially applied certified weed-free native grass straw mulch with *Leymus cinereus* and *Elymus elymoides* seeds. Canopy and ground cover, plant density, basal and canopy gaps, and soil stability were measured during the growing season annually from 2014 to 2017 in treated and control areas. Mulch significantly increased canopy cover from 2014 to 2016, but there was no significant effect of mulch on canopy gap. Perennial grass cover and straw mulch grass species were significantly greater in treated sites than controls in 2016. Soil stability decreased over the three years in treated plots. Mulch significantly increased canopy cover while decreasing bare ground. Basal gap increased in mulch sites from 2014 to 2016; the increased basal gap in mulch application over time may be due to mulch washing or blowing away, or being incorporated into the soil surface. Additionally, the mulch treatment showed no significant effects on cheatgrass, *Bromus tectorum*, cover. Our results suggest that post-fire mulch application promotes vegetative growth and decreases bareground and soil stability over time. The post-fire mulch treatment significantly increased straw mulch species but did not suppress invasive species' cover. Therefore, additional methods should be considered for restoration treatments seeking to stabilize soils and limit invasion.

TECHNIQUES TO IMPROVE THE QUALITY OF CHEATGRASS DOMINATED RANGELAND AND WHEATGRASS PASTURES. Matthew J. Ricketts*¹, Jim Jacobs²; ¹Triple R Bar S consulting, Livingston, MT, ²Retired USDA Plant Materials Specialist, Bozeman, MT

ABSTRACT

Winterfat (*Krascheninnikovia lanata*), a North American native, and forage kochia (*Bassia prostrata*), native to Eurasia, share a similar ecological niche and serve similar conservation and nutritional functions. Our objective was to quantify the establishment of these two species broadcast onto four seedbed treatments (1-none, 2-harrow, 3-disk, and 4-disk-seed-then-roll) at three sites in south central Montana. Site 1 was established in 2011 during above normal precipitation on a disturbed area with cheatgrass (*Bromus tectorum*) grading to native western wheatgrass (*Pascopyrum smithii*)/needle and thread (*Hesperostipa comata*) range. Sites 2 and 3 were established in 2012 during below normal precipitation on crested wheatgrass (*Agropyron cristatum*) pastures. Each site was divided into three replications to allow statistical evaluation using analysis of variance (ANOVA). Each replication was divided into four randomly arranged seedbed treatments; no treatment, harrow, disk, and disk and roll.

The establishment of winterfat and forage kochia was measured by counting the number of seedlings within ten 4.8 square foot hoops placed every three paces through the plot.

Establishment of both species was poor on the no seedbed and harrow treatments, improved slightly on the disked plots, and significantly improved where the seedbed was disked-seeded-and rolled. The results demonstrate the importance of good seed/soil contact for the establishment of conservation seeding's. Disking followed by broadcast seeding and rolling seeds of these species, and others with similar seed ecology (like big sagebrush-*Artemisia tridentata*), is a method to improve species diversity, wildlife habitat, and summer/fall/winter forage quality on sites dominated by cheatgrass or crested wheatgrass.

Winterfat densities in the disk-and-roll treatments were statistically greater than the densities of forage kochia, but the frequency was not statistically different. This suggests winterfat and forage kochia can be introduced into pasture/range sites when broadcast on a disked seedbed, and that rolling after seeding will improve establishment.

PROPAGATION PROTOCOLS FOR *YUCCA ELATA* AND *MENODORA SCABRA* FROM THE CHIHUAHUAN DESERT. David E. Prado-Tarango*¹, Alicia Melgoza-Castillo², Ricardo Mata-Gonzalez¹; ¹Oregon State University, Corvallis, OR, ²Universidad Autonoma de Chihuahua, Chihuahua, Mexico

ABSTRACT

We conducted three germination experiments to develop propagation protocols for *Yucca elata* (Engelm.) Engelm. and *Menodora scabra* A. Gray. Experiments were: seed germination under osmotic stress at 0, -0.5, -1.0 and -1.5 MPa in a growth chamber; germination and establishment in seed beds under four (high, medium, low and lowest) simulated rainfall wet-dry sequences as irrigation treatments; and germination, survival and biomass allocation in plastic pots under four simulated rainfall wet-dry sequences on controlled greenhouse conditions. Sequences represent the common precipitation patterns of the Chihuahuan desert in central Chihuahua, Mexico. Each sequence represents 20% of probability of a wet, normal, dry or very dry year to occur. Germination of *Y. elata* was not inhibited at -1.5 MPa (13% of germination), but it was negatively affected in *M. scabra*. In the seed bed experiment *Y. elata* had 33% germination and *M. scabra* had 20% germination on the high irrigation sequence vs 1.90% and 0.00% on the lowest irrigation sequence. However, establishment for both species was only achieved in the high and medium sequences. Temperature in this experiment rose to 45°C as the maximum temperature, which is common in the Chihuahuan desert. Finally, we assessed the responses of both plants in terms of plant biomass and seed germination strategies. Plants of both species produced more aboveground biomass as soil moisture increased and more belowground biomass as soil moisture decreased. *Y. elata* is a slow-germinating species, while *M. scabra* is a fast-germinating species. Implications are that both species can be seeded in the field and we can expect 40% of germination and establishment. However, we recommend germination and establishment under controlled conditions to increase success up to 80%. This study provides evidence on germination strategies and growth under different conditions that can increase success in restoration programs of arid zones.

DOMESTICATING NATIVE SHRUBS. James P. Muir*¹, Forrest F. Smith², William D. Pitman³, Jose C. Dubeux, Jr.⁴; ¹Texas A&M AgriLife Research, Stephenville, TX, ²Texas A&M Kingsville, Kingsville, TX, ³Louisiana State University Agricultural Center, Rosepine, TX, ⁴University of Florida, Mariana, TX

ABSTRACT

Enhancing rangeland plant diversity is a positive step to increasing animal diversity and productivity. Adding or strengthening a shrub canopy, defined as 1-3 m, may compliment diversity beyond the traditional herbaceous or arboreal layers. As an example, the wide range of native perennial, shrubby legumes in Texas indicates untapped potential for multiple uses such as forage, ecosystems services, wildlife habitat, fuel, and possibly pulse crops. There are over 30 shrub or short tree legume genera in Texas, many with multiple species. Our program seeks to identify, collect, characterize, domesticate and commercialize native Texas shrub legumes that could lead to multiple benefits in rangeland ecosystems. This could foster greater ruminant species diversity on rangelands, ranging from selective to bulk browsers and grazers that could specialize in herbaceous, shrub and arboreal canopies, each contributing to greater herbage and animal productivity than mono-canopy systems. This approach could be applied in many rangeland ecosystems in North America and throughout the world. Information on Texas native shrub species is sparse but builds on previous research on *Desmanthus* spp., *Leucaena retusa* (golden-ball leadtree) and woody ecotypes of *Acacia angustifolia* var. *hirta* (prairie acacia). The latter is currently grown commercially for seed production as shrubby Rio Grande Germplasm and herbaceous Plains Germplasm. The greatest successes have come from managing these for monoculture seed harvest or white-tailed deer plots rather than reseeding degraded rangeland or re-establishing native savannahs. Challenges identified to date include extensive armor (thorns), chemical protection (anti-quality factors such as condensed tannins), poor seed germination, slow establishment, low feed value (e.g. lignins), and limited market to motivate commercial seed companies. Our native legume shrub domestication program is currently in the early identification and collection phases while characterizing the agronomy of select genera including *Sephora*, *Styphnolobium*, *Gleditsia*, and *Leucaena* spp.

MORPHOLOGICAL, NUTRITIONAL, STOMATAL AND MOLECULAR
CHARACTERIZATION OF M1 MUTANTS OF WILMAN LOVEGRASS (*ERAGROSTIS
SUPERBA*)

. Alan Alvarez¹, Carlos Morales², Raul Corrales², Federico Villarreal*²; ¹Student, Chihuahua, Mexico, ²Universidad Autónoma de Chihuahua, Chihuahua, Mexico

ABSTRACT

Wilman love grass (*Eragrostis superba*) is a species used worldwide to rehabilitate degraded grasslands. Although this species could present lower nutritional quality and water stress tolerance than other grass species. Thus, the aim of this study was to characterize the morphological, nutritional, stomatal and molecular diversity induced through gamma radiation in Wilman lovegrass. With this, new materials with potential for grasslands rehabilitation could be selected based on their agronomic and ecological importance. Seeds were irradiated through gamma radiation with ⁶⁰Co. The doses evaluated were 0 (control), 100, 200, 300, 450, 600, 900, 1400 and 2000 (Gy). Ten plants were evaluated per irradiation dose under greenhouse conditions, through 10 morphological characters related to forage quality. This was performed at the flowering and maturity stages. Individuals with outstanding characteristics were selected and characterized nutritionally, stomatally and molecularly by AFLP molecular markers. All the selected mutants presented less lignin ($P<0.01$) than the control, in the two phenological stages evaluated. The mutants 200-3 and 200-7 showed a higher ($P<0.01$) protein content during maturity than the control. In addition, there were differences ($P<0.01$) among the mutants and the control on stomatal density and area. Also, the mutants were genetically wide different compared to the control, with genetic distances from 0.37 to 0.57 according to the Dice coefficient. The resulting phenotypic and genetic variability allowed selecting M1 mutants with better nutritional quality and stomatal characteristics. In the case these characteristics get fix in the following generations, new genetic material of agronomic and ecological interest will be available. Such material can be used on the rehabilitation of degraded grasslands.

DEVELOPING A LOW-COST, OPEN-SOURCE THERMOCOUPLE DATALOGGER FOR RANGELAND SURFACE FIRES

. Brittany N. Poling*, Devan A. McGranahan; North Dakota State University, Fargo, ND

ABSTRACT

To quantify rangeland fire behavior, thermocouple datalogger systems are used to measure flame temperature. Current systems are either small and operate few thermocouples or operate many and are large; all of these systems are moderately to very expensive/unit and constrained to few replicates, which limits insight into spatial variability. Open source microcontrollers provide low-cost solutions for collecting environmental data, but have not been developed specifically for fire science. We conducted trials between two different systems, a commercial data logger (Campbell Scientific CR1000) and an open-source microcontroller (Arduino). Using eight k-type thermocouples/system exposed to temperatures expected in wildland fire conditions, we compared the systems in terms of (1) their response to changing temperatures with a Bunsen burner and burning plant material (e.g. grass, twigs), and (2) consistency in logging a constant temperature for four settings on a drying oven. These trials demonstrate the systems are consistent in their sensor performance and response with greater variability occurring among thermocouples than between the systems. The affordability, portability, and accuracy of open-source systems in measuring temperature introduces the ability to place more sensors across a landscape to measure spatial variability, and allows for better understanding of fire behavior in heterogeneous grassland fuelbeds.

EVALUATING THE EFFICACY OF INTENSIVE EARLY STOCKING IN MAINTENANCE OF THE FIRE-GRAZER INTERACTION

. Edward J. Raynor*¹, Heidi Hillhouse¹, Walt Schacht², Diane Debinski³, James R. Miller⁴;
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ABSTRACT

The maintenance of a historic grassland disturbance, the fire-grazer interaction, through patch-burn grazing is a tool for maintaining heterogeneity in mesic grasslands. However, the efficacy of different grazing strategies for preserving or enhancing the utility of patch-burn grazing (PBG) management remains mostly untested. Season-long stocking (SLS) is the primary grazing strategy employed in PBG yet how a modified grazing regime such as intensive early stocking (IES) affects PBG is unknown. Stocking at twice the normal season-long rate for the first half of the season with no grazing during the last half, IES takes advantage of early summer high-quality forage and provides an ecosystem service in the form of invasive species control. If IES can reduce cover of invasive plants that inhibit fire spread to a higher degree than SLS, IES could be an excellent tool for conservation. To determine the efficacy of IES within PBG pastures to both 1) control an invasive plant and 2) maintain or enhance the utility of PBG, we evaluated tall fescue (*Schedonorus phoenix*) cover in IES pastures relative to SLS pastures and compared pasture heterogeneity (i.e., variance in vegetation structure) between IES and SLS pastures. Because tall fescue growing season overlaps with timing of prescribed spring burns, this grass creates a discontinuous fuel load and reduces fire spread in tallgrass prairie, thus inhibiting the fire-grazer interaction and PBG-driven pasture heterogeneity. We report on the usefulness of this grazing strategy in maintaining pasture heterogeneity in the Grand River Grasslands of southern Iowa and northern Missouri, where IES began in 2014. July vegetation structure and tall fescue cover collected among IES and SLS pastures revealed patch contrast (heterogeneity) of IES pastures reached SLS levels by 2016, whereas tall fescue cover in IES pastures was 18% lower than SLS by the end of the three-year PBG cycle.

GRASSLAND STANDING CROP CAN BE ESTIMATED USING LEAF AREA INDEX AHEAD OF PRESCRIBED FIRE

. Micayla R. Lakey*, Devan A. McGranahan, Kevin Sedivec; North Dakota State University, Fargo, ND

ABSTRACT

Knowledge of aboveground biomass, or standing crop, is required in many agricultural and rangeland applications, as standing crop constitutes both amount of forage available for grazing and fuel available for burning. But measurement can be tedious, time-consuming, and doing so directly involves clipping and removal of biomass. Many non-destructive biomass sampling methods are either imprecise or require too broad of an area to sample experimental plots. We sought to develop a method of non-destructive biomass sampling that is both rapid and precise enough to accurately represent standing crop at fine spatial scales in northern mixed grass prairie. We measured leaf area index (LAI) based on above- and below-canopy photosynthetically active radiation (PAR) readings using a ceptometer (Accupar LP-80). High-biomass plots generate a larger difference in above- and below-canopy PAR and a greater LAI value: the greater the leaf area in a plot, the less radiation hits the below-canopy sensor. We purposely sampled quadrats along a gradient of low to high biomass. Canopy cover of functional groups, visual obstruction, litter depth, and degree of biomass “uprightness” were also measured on each quadrat, to identify additional factors that could improve fit in linear models. We clipped and sorted biomass into live and dead categories by functional groups, dried, and weighed. Preliminary analysis indicated that leaf area index alone is a good predictor of biomass ($R^2 = 0.85$). Further analyses will extend calibration work to additional prairie types and will test whether structural and compositional variables improve linear model fit. This non-destructive method will allow us to determine fuel loads immediately ahead of prescribed fire.

LANDSCAPE AND FIRE FREQUENCY AS DRIVERS OF SAVANNA STRUCTURE AND COMPOSITION IN LIMPOPO NATIONAL PARK

. Natasha S. Ribeiro*¹, Navashni Govender², Valerio Macandza¹, Gernot Ruecker³, Aniceto Chauque¹, Romana Bandeira¹, Aurelio Pais¹, Domingo Machava¹, Bernabe Langa¹; ¹Eduardo Mondlane University, Maputo, Mozambique, ²Conservation Management, Sukukuza, South Africa, ³Zebris GBR, Munchen, Germany

ABSTRACT

Savannas cover 60% of the land in southern Africa, with fires and herbivory playing a key role in their ecology. The Limpopo National Park (LNP) is a 10.000 km² conservation area in southern Mozambique and key to protect savannas in the region. Fire is an important factor, but little is known about its interactions with the ecosystem. In this study we investigated the effects of fire frequency (FF) on vegetation and fauna of the LNP. To understand the FF, we used the MODIS burned area and active fire products for 10 years (2003-2013). A total of 6 ha was sampled to assess biodiversity across three landscapes (Nwambia Sandveld-NS, Lebombo North-LN and Shrub Mopane on Calcrete-C) and two FF levels (*low* - twice or less; and *high* - 3 times or more during 10 years). FF was higher in NS and LN landscapes, where 40% of the pixels burned in 10 years. The landscape type determined grass composition and biomass. The latter was higher in the sandy NS and under high FF. The three landscapes belonged to 3 different tree communities, but FF produced varied compositional responses in NS and LN. Low FF resulted in a higher plant abundance and phytomass of small trees (<2m) in LN and C. The composition of small mammals in the three landscapes was similar: *Aethomys chrysophilus*, *Mastomys natalensis* and *Elephantulus brachyrhincus*, but the relative abundance was higher in NS (41%).

Synthesis: This study revealed that grass and woody structure and composition in LNP are determined by the landscape, but FF imposes some important variations. These results indicated that, an increase in FF may result in a varied structure of the savannas, but at the current levels FF is not dramatically affecting the existence of this ecosystem in the LNP.

GOT SHRUBS? BURN SEVERITY EFFECTS ON CHAPARRAL PLANT COMMUNITY RECOVERY A DECADE AFTER FIRE.

. April G. Smith*¹, Beth A. Newingham², Andrew T. Hudak³, Benjamin C. Bright⁴; ¹USDA ARS GBRRU, Reno, NV, ²USDA-ARS, Reno, NV, ³USDA Forest Service, Moscow, ID, ⁴USDA Forest Service, Moscow, ID

ABSTRACT

Short-term post-fire field studies have shown native shrub cover in chaparral ecosystems is negatively associated with introduced forb and graminoid cover, which is influenced by burn severity, elevation, aspect, and climate. Previous long-term remote sensing studies found differences in shrub recovery depend on climate, while short-term remote sensing studies found differences in recovery depend on burn conditions which were influenced by weather. The 2003 Old and Simi fires in southern California burned across a gradient of vegetation types, elevation, aspect, and climate. We sought to understand the role of native shrubs in post-fire recovery across biotic and abiotic variables, linking long-term field and remote sensing data for these two fires. Using Normalized Burn Ratio (NBR) as an indicator of green vegetation derived from 1984-2016 Landsat imagery, we determined that sites burned at moderate and high burn severity have not returned to pre-fire levels of greenness, whereas sites that burned at low burn severity have. For ground reference, we estimated percent cover of functional groups in 2004 and 2015 at nested sampling sites distributed across gradients of burn severity, elevation, aspect, and time. Using non-metric multidimensional scaling, mixed effects models, and ANOVAs, we found that by year twelve, burn severity was no longer a significant predictor of native shrub cover but remained predictive for forbs and graminoid cover. This supports other long-term studies finding no or positive fire effects on shrubs, but negative or no fire effects on other functional groups over time. We also found high shrub cover to be a significant predictor of low introduced richness and high native cover, suggesting native shrubs may competitively exclude introduced species and facilitate native species.

UNGULATES AND FOREST MANAGEMENT: UNDERSTANDING INTERACTIONS BETWEEN LARGE HERBIVORES AND FUELS REDUCTION TREATMENTS ON SHRUB ASSEMBLAGES IN THE INTERMOUNTAIN WEST.

. Dallas K. Hall Defrees*¹, Josh Averett², Bryan A. Endress³; ¹Oregon State University, Corvallis, OR, ²Oregon State University, La Grande, OR, ³Oregon State University, la, OR

ABSTRACT

Upland deciduous shrubs represent keystone species that are pivotal to the biodiversity and resiliency of conifer forests in the interior Pacific Northwest. As an important forage species, deciduous shrubs are highly targeted by wild (elk, deer) and domestic (cow) ungulates, who in turn, are influential contributors to their prolonged arrestment. Moreover, episodic disturbances such as prescribed fire and stand thinning can often create conditions that facilitate heavy use by large herbivores as well as decrease potential refugia by eliminating coarse woody debris and other structural elements in the forest understory. Despite the growing scale of fuels reduction treatments, little is known about how such treatments influence herbivory by ungulates and subsequent impacts on deciduous woody species. This research aims to delineate these interactions, focusing our studies to mixed-conifer forests of the interior PNW. Our objectives were to (1) describe the structure and composition of deciduous woody plant assemblages in fuels treated and untreated stands, (2) document browse pressure by ungulates in fuels treated and untreated stands, and (3) explore the role of coarse woody debris and other forest understory structural elements and how they may affect browse rates and plant structure of deciduous woody species. 300 plots were sampled across untreated and fuels reductions treated mixed conifer stands in northeastern Oregon including 126 plots within ungulate exclosures serving as a reference for conditions in the absence of herbivory. Comparisons in height, richness, and diversity were analyzed using mixed models with both fixed (treatment) and random (site) effects. Multiple regression was used to analyze the influence of coarse woody debris on herbivory and growth. These findings can provide land managers with greater knowledge about the consequences of fuels reduction treatments and high levels of herbivory on these ecologically important deciduous woody species.

WYOMING BIG SAGEBRUSH NATURAL RECRUITMENT ALONG THE FIRE PERIMETER. Camie M. Dencker*¹, April G. Smith², Beth A. Newingham³; ¹University of Nevada, Reno, Reno, NV, ²USDA ARS GBRRU, Reno, NV, ³USDA-ARS, Reno, NV

ABSTRACT

Factors driving natural recruitment of Wyoming big sagebrush are poorly understood. Wyoming big sagebrush is a mid to late seral species, is not fire adapted, and can take decades to return to pre-fire densities. Wyoming big sagebrush communities have significantly declined due to changes in fire and climate regimes over the last century. We observed rare, natural recruitment events in 2016 and 2017 near Reno, Nevada, USA. We measured canopy gap, plant species and ground cover, shrub richness and size, distance to nearest adult sagebrush, and juvenile sagebrush density at fourteen paired burned and unburned sites. Additionally, seedlings were marked to determine survivorship and growth over time. Aspect, slope, and elevation were measured using a 10-meter elevation model. Seasonal temperature and precipitation were calculated using PRISM monthly models. The 2016 recruitment event was 136 times greater than 2017, but only 3% of the 2016 seedlings survived. Ninety-nine percent of seedlings were located within unburned stands. Growing season maximum temperature, winter precipitation, distance to adult sagebrush, and West-facing aspects were negatively associated with seedling density. Seedlings averaged 1.5 m from the nearest adult sagebrush, with a maximum distance of 14 m. When the high recruitment year (2016) was isolated, litter and rock cover had a positive effect on seedling density. Seedling height was positively associated with perennial, native species cover, which suggest more productive sites with low invasion promote growth. In two winters with above average precipitation, increased precipitation, presumably as snow cover, may have resulted in seed dormancy and reduced germination. Higher growing season temperatures and UV radiation on western slopes may have resulted in seed or seedling desiccation. We will continue monitoring sagebrush seedlings in relation to weather, topography, abiotic conditions, and plant community structure. Understanding the natural recruitment of sagebrush may inform restoration efforts.

EVALUATING THE IMPACT OF WYOMING BIG SAGEBRUSH FUEL LOADS ON BUNCHGRASS MORTALITY FOLLOWING A FIRE EVENT

. April Hulet*¹, Chad Boyd², Kirk W. Davies³; ¹University of Idaho, 83843, ID, ²USDA - ARS, Burns, OR, ³USDA - Agricultural Research Service, Burns, OR

ABSTRACT

Fire temperatures can vary spatially due to fuel loading characteristics and burn conditions. The influence of fuel loads, particularly that of sagebrush, on bunchgrass mortality following a wildfire is largely unknown. In this study, we quantified pre-burn shrub fuel loads and its impact on bluebunch wheatgrass and Idaho fescue mortality. We used a randomized complete block design with varying amounts of shrub fuel loads per plot. Within each plot and for each bunchgrass species, two locations relative to sagebrush plants were selected: one within a sagebrush canopy and one in an interspace. Each bunchgrass was instrumented with four, type-K thermocouples immediately before the burn at the following locations: 2cm below the soil surface, at the growing point in the center of the plant, at the growing point within 2 cm of the edge of the plant, and 8-10 cm above the soil surface in the center of the plant. Preliminary results suggest that bunchgrass plants within sagebrush canopies were exposed to lethal temperatures ($>50^{\circ}$ C) longer than bunchgrass plants found in the interspace. Plots with greater sagebrush fuel loads, were more likely to create fire conditions severe enough to kill bunchgrass plants both within shrub canopies as well as interspace plants. As we increase our understanding regarding the influence of Wyoming big sagebrush on bunchgrass mortality, we can better prioritize fire rehabilitation efforts and identify communities where pre-emptive restoration practices can be implemented.

QUANTIFYING POST-FIRE RECOVERY OF RANGELAND PRODUCTIVITY. Matt C. Reeves*; USDA Forest Service, Florence, MT

ABSTRACT

Recovery of production after a wildfire event is essential for maintaining goods and services such as providing forage on a sustainable basis. Often general rules of thumb, such as waiting two years after a fire to return to pre-fire grazing intensity, are used for managing production of livestock on rangeland landscapes. However, quantitative guidelines indicating the length of time required for vegetation to return to pre-fire production levels are lacking for many vegetation types. Here we quantify the recovery periods for 23 vegetation types in the Intermountain region of the western United States. The program evaluates production recovery and quantifies the length of time needed until no significant difference between burned and unburned landscapes is observed.

THE GREAT BASIN FIRE ALLEY: ANALYZING DRIVERS BEHIND FIRE PRONE AREAS IN THE GREAT BASIN. Justin L. Welty*¹, Robert Arkle², Michelle I. Jeffries², David Pilliod²; ¹Dept. of Interior USGS, Boise, ID, ²Department of Interior, Boise, ID

ABSTRACT

Within the Great Basin, exotic annual grasses, especially cheatgrass (*Bromus tectorum*), have increased fire frequency and altered fire regimes such that large areas of native shrublands have converted to annual grasslands. This cheatgrass-fire cycle is well described, but less is known about the drivers of this fire regime change where it is most prevalent. Here, we examine the current fire regimes at the four most fire-prone Major Land Resource Areas (MLRAs) within the Great Basin: Humboldt Area, Malheur High Plateau, Owyhee High Plateau, and Snake River Plains. Preliminary results suggest that between 1980 and 2015, these 4 MLRAs, representing 41% of the Great Basin, have accounted for 53% of the 10,313 recorded fire polygons and 73% of the 13 million hectares burned. We combined data on seasonal weather, lightning strikes, wildfire start date, vegetation, and wildfire frequency to identify the primary drivers of wildfires in these focal areas. In addition, we created yearly predictive models, at the MLRA-level, to assist fire and fuels managers in identifying areas of elevated wildfire risk, information that might be useful for prioritizing fuel treatments or wildfire preparedness.

IMPACTS OF A SPRING PRESCRIBED FIRE IN CONJUNCTION WITH CATTLE
GRAZING ON GRAZING FREQUENCY AND NUTRITIONAL QUALITY OF WESTERN
SNOWBERRY (*SYMPHORICARPOS OCCIDENTALIS*). Haley M. Johnson*, Ryan Limb, Marc
Bauer, Kevin Sedivec; North Dakota State University, Fargo, ND

ABSTRACT

Woody encroachment, due to fire suppression, alters plant community composition in rangelands worldwide. Encroachment of western snowberry (*Symphoricarpos occidentalis*) has led to an alteration of many Northern Great Plains plant communities, consequently decreasing available and favorable forages for livestock consumption. Research on the effects of grazing western snowberry is limited, but show that grazing alone increases expansion because mature plants are not readily consumed. Cattle select for forages based on palatability and management. Fire removes old plant material and promotes new plant growth of higher forage quality plant material. Cattle are more likely to consume immature plants because of increased palatability. Our study objectives were to 1) evaluate rate of consumption within early-intensive grazing, season-long grazing, and patch-burn grazing management strategies and 2) evaluate the forage nutritional content of western snowberry following prescribed fire. Each treatment was replicated three times. Stem and bite counts of western snowberry were collected by placing four random 100 meter transects and placing a 1m² quadrat every five meters along each transects within each replicate. Grazing exclosures were utilized to evaluate western snowberry degree of disappearance due to grazing. Weekly samples of western snowberry were collected during the growing season to evaluate selected nutritional values for each treatment within current growing season, one year post burning, and growth after initial burning. One way analysis of variance was used to compare stem and bite counts across treatments. Linear regression was used to analyze change in forage quality over time. This study will address grazing frequency of cattle on western snowberry within each treatment and how burning affects the forage quality of western snowberry.

APPLYING DISTURBANCE HYPOTHESIS TO RANGELAND MANAGEMENT USING THE GRAZING MANAGER . Phillip S. Steigerwald*¹, Mort M. Kothmann²; ¹TAMU, Uvalde, TX, ²TAMU, College Station, TX

ABSTRACT

Vegetation on rangelands is a function of two primary anthropogenic disturbances, grazing and fire. Our hypothesis, that fire and grazing management can control the invasion of McCartney rose on Texas Coastal Prairie rangeland, was tested on the Duncan Spade Ranch from 2012-2017. The ranch's goal is to reduce McCartney Rose using grazing and prescribed burning to eliminate herbicide use for brush and weed control. The study area in Wharton County, Texas consisted of 900 acres fenced into five pastures and grazed rotationally by one herd of 150-160 cows. The average initial vegetation cover of McCartney rose was 23%. The Grazing Manager (TGM) was used to allocate forage for grazing and fuel for burning. Grazing was deferred during the summer and fall for pastures scheduled for prescribed burning in the winter. All prescribed burns were conducted during the winter dormant season. During the first three years, grazing was extended too far into the fall on pastures to be burned. This reduced the quantity and continuity of the fuel, decreasing the effectiveness of fire in reducing cover and stature of McCartney rose. During the 2015-16 and 2016-17 winters, grazing was excluded starting in July for the pastures that were burned. This practice improved range condition and increased the effectiveness of prescribed burns. McCartney rose cover in July 2017 averaged 8% and stature of rose plants was reduced. TGM was critical to allocate adequate fuel for effective burns and determine how much forage would be available for grazing to set herd size (stocking rate). We conclude that the effectiveness of McCartney rose control by prescribed burning depends on monitoring to allocate adequate biomass to fuel to achieve effective burns and to balance herd size with available forage.

POST-WILDFIRE LIVESTOCK GRAZING MANAGEMENT ON PUBLIC RANGELANDS IN NORTHEAST CALIFORNIA. Janyne Little*¹, Laura K. Snell², Elise Gornish³, David Lile¹, Leslie Roche⁴; ¹UCCE, Susanville, CA, ²University of California, Alturas, CA, ³University of Arizona Cooperative Extension, Tucson, AZ, ⁴University of California, Davis, CA

ABSTRACT

Unprecedented wildfires are burning on federal lands used for summer grazing by livestock across California. As a result, ranchers and other stakeholders have concerns about proper livestock grazing policy and management for rangelands after fire. A typical approach to post-wildfire grazing policy is to issue a blanket requirement for two years of grazing cessation following a burn. Some have argued for longer rest time frames, while others argue for no rest to reduce weed invasion and suppress fuel accrual. However, there is little to no scientific data to support either proposal. Some research has been conducted on grazing after relatively low severity prescribed fire, but little research has addressed grazing impacts after wildfire which commonly burn with much greater severity and during different seasons compared to managed prescribed fires. Here we estimate recovery trajectories of existing wildfire burned areas and develop key indicators to assess rangeland readiness following fire using chronosequence methods. We surveyed 134 sites on 21 fires in northeast California that occurred within the last 17 years. After avoiding seeded or salvage logged areas, unburned areas, and overlapping fires, we account for the following variables: year from fire, grazing management, fire intensity, resistance/resilience classes, and broad vegetation communities. This research offers insight into how quickly rangeland health will recover and become ready to support livestock grazing without risk of long-term natural resource damage following wildfire.

RELATIONSHIP BETWEEN CATTLE BODY SIZE AND TERRAIN USE IN EXTENSIVE AND MOUNTAINOUS RANGELAND PASTURES. Margaret R. Gannon*¹, Derek W. Bailey¹, Amy C. Ganguli¹, Colt W. Knight², Michael Millward¹; ¹New Mexico State University, Las Cruces, NM, ²University of Maine, Orono, ME

ABSTRACT

Manipulation of spatial grazing patterns of cattle in rangeland systems is essential for preventing resource degradation due to localized overgrazing. Practices such as fencing, water source development, and supplement placement have been used to manipulate distribution and prevent habitat degradation; however, these management actions can be cost prohibitive. Using genetic selection to breed cattle with desirable terrain use could be a more effective and less costly alternative. Furthermore, cow body size has steadily increased over the 40 years due to selection for higher weaning and yearling weights. For selection programs to be successful, the relationships between traits should be understood. Our study was conducted at the Chihuahuan Desert Rangeland Research Center, near Las Cruces, New Mexico to investigate the relationship between cow body size and terrain use. Fifteen Brangus cows (2 to 13 years of age) were tracked at 10-minute intervals in a 2635-ha pasture with rugged terrain for 12 weeks during the winter prior to calving. After fitting the statistical model for age, residual correlations were used to examine the relationship between cow weight, body condition score, linear measures of cow size, and terrain use metrics. Larger cows with bigger heart girths and heavier weights used areas farther horizontally from water than smaller cows and the associated residual correlations were 0.52 and 0.64, respectively. Cows with greater hip heights and heavier weights used areas farther vertically from water (residual correlations of 0.85 and 0.53, respectively). Although the number of cows in this study are limited, these preliminary results suggest that larger cows may be more willing to travel farther from water than smaller cows in extensive, rugged desert pastures during cool winter conditions.

REPEATABILITY OF TERRAIN USE BY CATTLE IN RUGGED RANGELAND PASTURES

. Tatjana J. Mercado*¹, Derek W. Bailey¹, Milton G. Thomas², Richard M. Enns², Scott E. Speidel²; ¹New Mexico State University, Las Cruces, NM, ²Colorado State University, Fort Collins, CO

ABSTRACT

Tracking collars are used to monitor cattle movements and allow us to make inferences about cattle behavior. However, few studies have evaluated the consistency of cattle movements over time in rugged rangeland pastures. A study was conducted at five locations in New Mexico and Arizona: the Chihuahuan Desert Rangeland Research Center (CDRRC), Evans Ranch, Wilbanks Ranch, Hartley Ranch and Todd Ranch. Eight to 19 randomly-selected cows from herds of 40 to 200 cows were tracked with GPS collars at each ranch. Cows were tracked at either 10- or 15-minute intervals. Terrain use was summarized by week. A repeated measures analysis was conducted on each ranch using the weekly average of slope use, elevation use, and distance from water as the dependent variables. Intraclass correlations of weekly averages of the three terrain use metrics were used to assess temporal consistency of grazing distribution traits. Week was a fixed effect and cow was a random effect. Intraclass correlations of terrain use by individual cows varied among ranches. The Wilbanks Ranch had the strongest intraclass correlations for slope, elevation, and distance to water of 0.60, 0.50, and 0.77, respectively. Intraclass correlations for elevation at the Hartley and Todd Ranches were strong, 0.61 and 0.71, respectively, but correlations for slope and distance to water were weak to moderate (0.18 to 0.30). In contrast, intraclass correlation at the CDRRC and Evans Ranch were weak (0.00 to 0.08). Our results suggest that consistency of terrain use by cattle can vary by location; however, these relationships are positive and moderate to strong at most ranches. Factors such as cattle familiarity with pastures and the nature of the terrain features may explain part of this variability, however additional research examining how temporal changes in terrain use affect this phenotype is needed.

OUR LOW-COST, OPEN-SOURCE LIVESTOCK GPS COLLARS WORK WELL, PROVIDE INSIGHT INTO SPATIAL DATA COLLECTION. Devan A. McGranahan*¹, Jonathan W. Spiess¹, Benjamin A. Geaumont²; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Hettinger, ND

ABSTRACT

Range scientists are interested in patterns of livestock use within grazed units, especially when forage resources are spatially heterogeneous. Quantifying space use is particularly important when research hypotheses or management plans predict specific patterns of resource selection. Direct observation of livestock is costly and time-consuming, and indirect measures are temporally imprecise, represent only samples of possible locations, and require worker hours to measure. Several commercial solutions based on Global Positioning System (GPS) technology fit animals with GPS receivers that record their location at programmed intervals, but the cost is often prohibitive. We designed our own solution around a low-cost, open-source microcontroller based on the Arduino system. Hardware includes a microcontroller and microSD card logger, GPS receiver, and lithium-poly battery. The system is programmed in C/C++ with templates freely available from the manufacturer. All software is open-source and user-customizable. We sealed the loggers in small rubberized plastic cases and strapped them to cattle and sheep at the Hettinger Research Extension Center in Hettinger, ND. The whole livestock-ready apparatus cost approximately \$125 per unit. Through the summer of 2017 we had approximately three dozen successful one-week deployments, with no equipment loss and only minor damage we learned to prevent. In addition to presenting the system, we also discuss data analysis to offer insight into the number of units and logging frequencies required of livestock GPS monitoring, regardless of system used. We ran three units per pasture logging at 20-second intervals, and analyze these data with respect to minimum number of units needed to estimate herd behavior and optimum logging patterns to infer behavior and extend battery life. Although power demands remain a limitation and priority for further development, our system is a viable solution for short-duration deployment on experimental rangelands with livestock handling facilities.

DATA CORRECTION AND ANALYSIS OF SPATIAL DATA USING LOWER-COST GLOBAL POSITIONING SYSTEM TRACKING COLLARS

. Colt W. Knight*¹, Derek W. Bailey², Kadee Grubbs², Walt Mandeville³, Jon Wilker³;

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ABSTRACT

Tracking collars utilizing GPS data loggers have become popular among cattle and rangeland researchers. These collars can be constructed at much lower cost than commercial collars, and a recent study has shown that metrics like distance traveled, elevation and slope are comparable. However, these lower-cost GPS collars do not come with software to identify and correct bad data. Past attempts to isolate bad data involved time consuming visual observation and removal using Geographic Information System (GIS) software. While this technique works well to find erroneous GPS point outside of pasture boundaries, points nested within the animal's normal range are undetectable. Single metric, such as distance traveled, sorting on spreadsheet software often results in loss of good data surrounding bad points. In this study, authors characterized differences between commercially available GPS tracking collars (Lotek) and tracking collars made from lower-cost GPS data loggers (Knight), describe methods to isolate and remove bad GPS points from the data set, and looked at times of day when inaccurate data occurred more frequently. Eleven Lotek and 6 Knight GPS tracking collars were placed on Gund Ranch cattle near Austin, Nevada for 140 d beginning 24 March 2016. Lotek collars had a fix rate of 86.9 %, missing 4.7% of scheduled observations, and inaccurate data points accounted for 0.54% of the observations while Knight collars were 73.1%, 26.4%, and 0.71%, respectively. An algorithm was developed to identify and remove bad data from Knight collar data sets using course change, rate of travel, and distance between points. For both Lotek and Knight collars, error frequency was highest in the morning before 0900 and at night around 2300. This algorithm allows researchers to readily identify inaccurate positions and remove them from tracking data, which makes the Knight collars more useful for cattle tracking studies.

TEMPORAL DISTRIBUTION OF PRECIPITATION IN THE SOUTHWESTERN US: IMPLICATIONS FOR GRAZING MANAGEMENT.

. Douglas R. Tolleson*; Texas A&M University, Sonora, TX

ABSTRACT

Annual and seasonal precipitation in the American southwest is highly variable and projected to become more so. Rangeland managers must cope with this variation in their stewardship efforts. The objective of this study was to quantify variation in precipitation at seasonal to annual intervals and relate these fluctuations to herbivore grazing management decisions. Standardized precipitation index (SPI) values were calculated from PRISM data for the Texas A&M Sonora Research Station in the Edwards Plateau region of southwest Texas from 1895 to present. Annual precipitation (55 ± 5.0 cm yr⁻¹) is typically bimodal with peaks in spring and fall. Annual precipitation extremes include a minimum of 20.8 cm in 1951 (SPI = -2.76) and maximum of 93.8 cm in 2007 (SPI = 2.02). Seasonal precipitation extremes range from a minimum of 0.4 cm in winter of 1974 (SPI = -2.60) and a maximum of 42.1 in spring of 1900 (SPI = 2.94). Decadal coefficient of variation (%) in annual SPI values average 28.4 and range from a minimum of 20.4 in the 1960's to a maximum of 51.4 in the 1950's. These values for the 1970's (21.2), 80's (24.0) and 90's (21.4) were all below average and have increased in the 2000's (34.0) and so far in the 2010's (34.4). In the most recent 50 years, annual SPI was used to create the following categories: > 0.50 = "wet", 0.49 to - 0.49 = "neutral" and < - 0.50 = "dry". Using these categories as a proxy for forage production and then determining stocking rate (SR) for the coming year from the previous year's SPI would have resulted in: 1) maintain SR, 42 %; 2) overestimate SR, 26 %; and 3) underestimate SR 32 %. Determining SR from previous precipitation is often a mismatch. If climate variability increases, probability of mismatch will increase.

FACTORS INFLUENCING HERBAGE YIELDS OF PLANT FUNCTIONAL GROUPS ON SANDHILLS RANGELANDS. Mitchell Stephenson*¹, Walt Schacht², Jerry Volesky³, Nevin Lawrence¹; ¹University of Nebraska - Lincoln, Scottsbluff, NE, ²University of Nebraska - Lincoln, Lincoln, NE, ³University of Nebraska - Lincoln, North Platte, NE

ABSTRACT

Botanical composition of grasses, forbs, and shrubs is strongly influenced by topographic position on the dunes on Sandhills rangeland. However, limited research has fully evaluated the influence of weather factors (e.g., spring precipitation and growing degree days) on herbage production of different functional groups at the topographic position scale. From 2000 to 2015, herbage production data, separated by cool- and warm-season grasses, forbs, sedges, and shrubs, were collected from dune top, north-facing slope, south-facing slope, and interdune topographic positions in the eastern Nebraska Sandhills. To evaluate the influence of current and previous year weather factors on herbage production, stepwise regression models were developed for each functional plant group and total plant production at the different topographic positions. Regression models explained a large range of variation in herbage production of different functional groups at different topographic positions ($0.04 < r^2 < 0.63$, $P < 0.05$). Regression models for total herbage production in August were the most consistent across topographic position and were influenced positively by growing season precipitation events and spring+summer precipitation and negatively by growing degree-days ($r^2=0.48$ to 0.5 , $P < 0.01$). This was likely related to the influence of these weather factors on warm-season grass growth from June to August. While regression models did not explain a large amount of the variation for some functional groups, they did identify the major factors that influenced herbage production at different topographic positions and identified the most important weather-related factors that can be used to estimate annual herbage production on mixed-grass, Sandhills rangelands.

POINT BLUE CONSERVATION SCIENCE'S RANGELAND WATERSHED INITIATIVE: REWATERING CALIFORNIA, ONE RANCH AT A TIME. Wendell C. Gilgert*¹, Geoff Geupel², Elizabeth Porzig², Bre Owens³, Kelly Garbach²; ¹Point Blue Conservation Science, Chico, CA, ²Point Blue Conservation Science, Petaluma, CA, ³Point Blue Conservation Science, Los Molinas, CA

ABSTRACT

Point Blue Conservation Science is collaborating with the USDA-Natural Resources Conservation Service (NRCS), cooperating ranchers, Resource Conservation Districts (RCD's) and several other conservation partners to improve foothill rangeland watersheds in California's Great Valley, Sierra Meadows, and Modoc Plateau that have experienced surface soil compaction, increased bare ground, and a shift in plant communities that is now dominated by annual vegetation. Point Blue Partner Biologists are partnering with NRCS and RCD Conservationists and are working closely with ranchers, land trusts, and some public lands to plan, design, and implement prescribed rangeland grazing and management practices. With financial support from NRCS Farm Bill programs, cooperating ranchers utilize technical assistance from Point Blue Partner Biologists, NRCS conservationists, RCD's and other conservation partners to increase soil water retention in foothill watersheds, increase livestock forage, improve water supply reliability both on-site and downstream, enhance ranching productivity, and expand riparian corridors and wetland habitat for migratory birds and other wildlife. In addition, we are partnering with and mentoring ranchers and other land managers as Leopoldian Land Stewards to ensure long-term stewardship of ecological and production benefits on their land.

Point Blue's companion effort, the Rangeland Monitoring Network (RMN) continues to measure hydrological function restoration and soil carbon, changes in vegetative trends, and the wildlife habitat benefits of the prescriptive grazing and associated conservation practices. Our multi-year study is providing empirical evidence on the effectiveness of prescribed grazing and rangeland management practices in providing reliable water supplies, improving soil quality, sequestering soil carbon, increasing vegetation functional group diversity, reducing invasive weeds, and improving wetland, riparian, and upland fish and wildlife habitats. The information derived from the implementation and subsequent monitoring is allowing us to provide timely monitoring data to inform management in the short term and to analyze long term trends that accrue from planned grazing management.

EFFECTS OF ANIMAL BEHAVIOR AND CORE-BODY TEMPERATURE ON PRODUCTION EFFICIENCY OF GRASS FINISH CATTLE

. Melelani A. Oshiro*¹, Mark S. Thorne², Chin N. Lee³, Yong S. Kim³, Glen K. Fukumoto⁴;

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ABSTRACT

Forage nutrient quality and consumption have major impacts on ruminant production. Energy requirements of the grazing animal are influenced by several factors such as increased foraging activity, frame size and physiological status, but is superseded by the requirement to maintain a homothermic balance. Therefore, we hypothesized that changes in grazing behavior activities would affect core-body temperature (CBT) and animal performance measures. A two-year study was conducted on 24 grass-finished cattle at the University of Hawaii, Mealani Agricultural Experiment Station. Animal behavior, CBT, weather variables, and forage quality were assessed during three daily observation periods (AM, NOON, PM) for the fall 2013, and summer and fall 2014 seasons. Over all seasons, active grazing (63.0%), standing (15.6%) and laying while chewing (10.4%) were the predominant behaviors observed. Grazing activity across daily periods were highest during the AM period, a time when mean CBT ($38.3 \pm 0.01^\circ\text{C}$) was lowest. The CBT varied for all animals across seasons and periods, and averaged $38.6 (\pm 0.03)^\circ\text{C}$ in 2013 and $38.4 (\pm 0.04)^\circ\text{C}$ in 2014. We did not find any significant relationship between CBT and grazing behavior. Forage quality varied seasonally, however crude protein (CP), relative feed value (RFV) and total digestible nutrients (TDN) were higher in summer 2014 compared to the fall seasons. Diurnal differences were observed in water-soluble carbohydrate (WSC) and non-fiber carbohydrates (NFC), which were higher in the PM across all seasons. Average Daily Gain (ADG) was not significantly greater ($P=0.78$) between the years 2013 ($0.58 \pm 0.06\text{kg/d}$) and 2014 ($0.56 \pm 0.05\text{kg/d}$). Animals were slaughtered at approximately $21 (\pm 0.15)$ months of age and an average live body weight of $527.1 (\pm 8.98)$ kg in both years. In 2013, 75% of the animals graded Choice or higher compared with 90% in 2014. The higher quality of forage in 2014 may have influenced beef quality.

COULD INSECT ACTIVITIES REDUCES GREENHOUSE GAS EMISSIONS FROM DUNG PATS ON NATIVE PASTURE? Xiyang Hao*¹, Ben W. Thomas², Jessica Stoekli², Kelvin Floate², Newton Lupwayi²; ¹Agriculture & Agri-Food Canada, Lethbridge, AB, ²Agriculture and Agri-Food Canada, Lethbridge, AB

ABSTRACT

The feeding and tunneling activities by insects alters the physical and chemical properties of cattle dung and potentially affect greenhouse gas (GHG) emissions. To determine the magnitude of these effects on semiarid pastures, we quantified GHG emissions (CO₂, CH₄ and N₂O) from beef cattle dung pats with or without insect activity (e.g., dung beetles) and with or without ivermectin. Ivermectin is a commonly used parasiticide to treat cattle and was added to the dung to reduce insect activity. Exclusion of insect activity was achieved by covering the chambers with a nylon mesh to prevent insects from interacting with the dung pats. The mesh did not affect gas exchange between the chamber and atmosphere. The GHG fluxes were measured over one year at weekly intervals in the grazing season and less frequently in the non-grazing season. Dung and soil samples were collected and analyzed for moisture and available C and N contents at weekly intervals for the first three weeks, and less frequently thereafter.

The CO₂ emitted from dung pats without insect activity was nearly double that of dung pats with insect activity. The CH₄ emitted from dung pats without insect activity was more than double that of dung pats with insect activity reduced by adding ivermectin, but with less differences when compared to dung pats without ivermectin. The N₂O emitted from dung pats without insect activity was more than double that of dung pats with insect activity. Ivermectin had limited effect on CO₂ and no effect on N₂O emissions. The CH₄ flux appeared to be responsive to both ivermectin and insect activity. More research is required to verify the results observed in this one-year study. The feeding and tunneling activities of insects appears to play an important role mitigating the GHG emitted from dung pats on semiarid pastures.

QUANTIFYING SHORT-TERM SOIL BIOLOGICAL AND VEGETATION FEEDBACK FROM HIGH-INTENSITY, SHORT-DURATION GRAZING VERSUS CONVENTIONAL GRAZING

. Emily P. Bean*, Linda Van Diepen; University of Wyoming, Laramie, WY

ABSTRACT

Soil degradation is a critical issue in agriculture, and restoration is necessary to reach global food security and production goals. There has been substantial debate over the merits or drawbacks of high-intensity, short-duration grazing versus low-intensity, continuous grazing. In addition, scientific literature presents conflicting information on the effect of animal impact on microbial biomass, diversity, and function. Though soil microorganisms are known to be important in all ecosystems for driving the critical processes of carbon and nutrient cycling, only recently soil biodiversity has been recognized as an important parameter of quantifying soil health, for a variety of environmental, agricultural and human health benefits. Is it therefore critical to understand how agricultural systems impact soil biodiversity and the soil microbial community. This study addresses that knowledge gap by quantifying soil microbial and biogeochemical responses immediately following grazing and linking plant-soil-microbe interactions by integrating immediate changes in vegetation growth. In this study, we implemented three grazing treatments on twelve ½-acre paddocks at the Laramie Agriculture Experiment Station in Laramie, Wyoming in a randomized complete block design: a high-intensity, short-duration treatment (50,000 animal lbs/acre; 12 hours grazing), low-intensity, medium-duration treatment (~3,000 animal lbs/acre; 6 days grazing), and a no-grazing control (zero grazing). Vegetation structure and soil biological parameters were quantified at four time points: 1 week before grazing, 24 hours after grazing, 1 week, and 4 weeks after grazing. A rising plate pasture meter was used to estimate vegetation structure, and was compared to traditional clipped dry matter biomass. Soil biological measurements included extracellular enzyme assays, soil microbial biomass, and soil biogeochemical measurements included dissolved organic nitrogen & carbon, pH, EC, and bulk density. These data will give valuable insight to short-term, system-level feedback that could assist producers in making management decisions on irrigated pastures.

RANCH-SCALE EVALUATION OF THE RELATIONSHIP BETWEEN SOIL HEALTH, FORAGE QUALITY/QUANTITY, AND MULTI-DECADAL GRAZING CAPACITY IN A HIGH-ELEVATION RANGELAND

. Timm M. Gergeni*; University of Wyoming, Laramie, WY

ABSTRACT

Soil health has been an evolving concept in agriculture yet practical and applied information for rangelands are lacking. Moreover, how soil health indicators relate to forage and grazing capacity in harsh and environmentally restricted rangelands of the western US has constrained the use of soil health measurements for management decisions. Also limiting application of soil health information on rangelands is the notion that small-plot studies are not representative of grazing management implemented by producers and the results may not be as transferrable to ranchers, or as readily accepted by ranchers. We use producer compiled data quantifying realized grazing days for 140 pastures (ranging in size from ~6 acres to >1200 acres) since 1989 from a private ranch in southwestern Wyoming. At this pasture scale, data includes: size (in acres), animal days per acre by year, and days in and out of pasture. Pasture-scale grazing data was then coupled with soil and forage sampling in the early-summer of 2017. Soil samples from the top 10 cm included: plant available nutrients, pH, EC, organic matter and biological parameters. Forage biomass was measured and forage quality samples were taken from the main forage species western wheatgrass (*Paspopyrum smithii*) and analyzed for a range of quality parameters including protein, digestibility, and nutrient content. Sampling was restricted to upland, non-irrigated native pastures with a range of animal days per acre from 4.0 to 5.4. We use univariate and multivariate statistics to compare soil, forage, and grazing variables in a bottom-up approach to suggest that if soil health metrics can be improved, what then will be the production-centric outcomes. Our results suggest that ranchers desire to have soil health information that is relevant at the pasture scale and informative for grazing management.

GRAZING DRIVES SOIL WARMING IN HERBACEOUS RIPARIAN WETLANDS. D. Terrance Booth¹, Samuel E. Cox², Jay B. Norton*³, John C. Likins⁴; ¹USDA-ARS (retired), Cheyenne, WY, ²USDI-BLM, Cheyenne, WY, ³University of Wyoming, Laramie, WY, ⁴USDI-BLM (retired), Lander, WY

ABSTRACT

Uncontrolled grazing exacerbates climate-warming effects on riparian soil functions. Temperature is an important driver of evapotranspiration and decomposition and therefore can be a sensitive indicator of management effects on soil water storage and loss. Beginning in 2015, soil temperature was monitored early spring through late summer inside and outside six long-term grazing exclosures (8 to 30 years old) in herbaceous riparian wetlands in the headwaters of the Sweetwater River, Wyoming. This area is part of a large, multi-permittee allotment administered by the Bureau of Land Management and was subjected to season-long grazing for many decades. Sensors installed at 3-, 20-, 40-, and 60-cm depths recorded soil temperature at two-hour intervals from May to August in 2015 and from February to August in 2016 and 2017 at three locations inside and outside of each exclosure. Results indicate consistent differences inside and outside exclosures across years and at each depth. Temperatures were slightly cooler outside exclosures in February, March, and April, then significantly warmer outside than inside across all depths from May through August. Averaged across locations, August soil temperatures differed the most between inside and outside exclosures, with inside temperatures ranging from 15.2 degrees C at 3 cm depth to 11.9 degrees C at 60 cm depth, compared with outside temperatures of 16.8 degrees C at 3 cm depth to 13.4 at 60 cm. The largest difference occurred at 40 cm depth, averaging 1.68 degrees C warmer outside than inside exclosures. The largest temperature differences occurred in August at 40 cm in the 30-year-old exclosures, ranging from 2.5 to 4.5 degrees C warmer outside than inside exclosures. Soil warming is part of a complex feedback relationship among surface residues, plant community composition and productivity, evapotranspiration, and organic matter mineralization that results in less water storage and summer release to downstream aquatic systems.

STREAM TEMPERATURE DYNAMICS IN A SEMIARID RIPARIAN ECOSYSTEM IN NORTH CENTRAL OREGON

. Nicole M. Durfee*¹, Carlos G. Ochoa², Serkan Ates², Todd Jarvis²; ¹Oregon State University (graduate student), Corvallis, OR, ²Oregon State University, Corvallis, OR

ABSTRACT

An improved understanding of the factors that influence stream temperature in rangeland environments can better enable the protection of stream ecosystems. The objectives of this study were to determine stream temperature-vegetation shading relationships and characterize other factors, such as subsurface flow and ambient conditions, on stream temperature in a semiarid watershed. Data collection occurred at four observation sites in the Fifteenmile Creek subwatershed in north central Oregon. Three of the observation sites were located along Fifteenmile Creek and one was located along Ramsey Creek, a tributary of Fifteenmile Creek. Air and stream temperature measurements were recorded at all sites. Intensive data collection occurred along a 1-km riparian corridor of Fifteenmile Creek. Riparian vegetation composition and cover was analyzed using field surveys along this corridor. Shallow wells were used to characterize subsurface flow temperature from an intermittent tributary stream along this reach. Stream temperature data was collected using standalone sensors beginning in the spring of 2014 and using Distributed Temperature Sensing (DTS) in the summer of 2015. Comparisons of stream temperature data from standalone sensors and DTS found both to be in close agreement. No significant differences in stream temperature were found between sensors located in shaded and non-shaded regions of the stream ($P \leq 0.05$). Fluctuations in stream temperature followed those observed in ambient temperature. Shallow groundwater temperatures in the intermittent stream were cooler than main stem stream temperatures in the summer and warmer during winter months, indicating the tributary may have a moderating effect on stream temperature. The results of this research indicate that factors in addition to riparian shading, such as groundwater inputs and stream velocity, may significantly influence stream temperature in this study area. Future research includes the use of Unmanned Aerial Vehicles (UAVs) to collect information about vegetation and ambient conditions.

IMPLICATIONS OF FALL GRAZING AS DISCUSSED IN *RIPARIAN AREA MANAGEMENT* (BLM TR 1737-20). D. Terrance Booth*¹, Samuel E. Cox², John C. Likins³, Jay B. Norton⁴; ¹USDA-ARS (retired), Cheyenne, WY, ²USDI-BLM, Cheyenne, WY, ³USDI-BLM (retired), Lander, WY, ⁴University of Wyoming, Laramie, WY

ABSTRACT

Practitioners' views should be made public and entered into land-management discussions. When those views contrast, wholly or partly, with the best science there is an understandable reluctance to discuss the contrast for fear of inhibiting further practitioner contributions. Silence, however, simply promulgates error or an incomplete representation of an issue—doing no good for science or practitioner. With that understanding, we here respond to a view published in the subject technical reference (pages 58-59). The view is expressed by the managers of a ranch on the headwaters of the Rio Grande River, 2743-m (9000-ft) elevation, that it is desirable to fall graze riparian pastures. They offer as evidence an on-ranch, 1 May, photographic comparison of two pastures, one grazed with 1000 pair for 30 days the preceding fall and the other rested. The photos show the grazed pasture green and growing while the rested pasture is brown and dormant. Early spring green-up may benefit grazing but it is not desirable for water-conservation. Two significant threats to water availability around the world are ground-water depletion as documented by NASA's 15-year GRACE mission, and loss of streamflow resulting from loss of mountain snow and ice as documented by numerous studies on multiple continents. Those world-wide shortages are true also of the lower Rio Grande River Basin encompassing the cities of Albuquerque, NM, and El Paso, TX, and the substantial food-producing Basin farmland. The Basin needs water. Dobrowolski and Engle recently observed that "...rangelands are valued increasingly for capture of surface and subsurface water leading to storage." Fall grazing mountain riparian areas hinders capture and storage of water by removing vegetation that would (1) slow spring runoff, (2) keep water-containing soil cold, and (3) add water-storing soil organic matter. Better arrangements are needed for compensating upstream landowners for water conservation benefitting downstream users.

DRAMATIC RIPARIAN AND RANGELAND RESTORATION: PROPERLY DESIGNED
GRAZING PLANS WITH CONSISTENT APPLICATION IS THE KEY. Matthew J. Ricketts*;
Triple R Bar S consulting, Livingston, MT

ABSTRACT

The Taylor ranch, of Edgar, Montana, has followed a 7 pasture deferred-rest rotation grazing system for 21 years.

*The change on the landscape has been remarkable. One example is in June of 2011 where Cottonwood creek, which runs through the ranch, experienced a 150 year flood. Head cuts formed above and below this property, but the head cuts stopped once they reached the Taylor place due to the outstanding condition of the riparian. A riparian forest exists where once only widely scattered 100 year old plains cottonwood (**Populus deltoides**) existed. Now the ranch has all size and age classes, and both plains and narrowleaf cottonwood (**Populus angustifolia**) along with preferred climax forb species like Maximilians sunflower (**Helianthus maximiliani**). Management has improved the forage productivity and forb diversity which benefits sage grouse, their chicks, and the insects they feed on. Not only are sage grouse benefiting from better nesting, brood rearing, and wintering habitat, but so are sharptail grouse, Hungarian partridge, non-game birds, deer, and many other wild species. Not to mention the health and productivity of the cattle.*

*Neighboring ranches have been watching. The Grewell ranch just downstream began a 9 pasture deferred rotation system in 2013. Already change is evident on both the riparian and the uplands. The fences on the upland are obscured by the improved growth of bluebunch wheatgrass (**Pseudoroegneria spicata**) and the stream channel is narrowing, with creeping spikerush (**Eleocharis palustris**) increasing dramatically along with plains cottonwood seedlings.*

Other ranches show improvement in both upland and riparian conditions with the application of deferred rotation and twice through grazing strategies over a 7 year time frame. These ranchers feel the most important thing they did to control weeds was to apply properly designed grazing management.

Properly designed grazing plans, with consistent application, are keys to ecological restoration.

WATERSHED ASSESSMENT: EVALUATING THE RELATIONSHIP BETWEEN RANGELAND HEALTH AND INTERMITTENT STREAM STABILITY. Garret A. Hecker¹, Miranda Meehan^{*2}, Jeffrey L. Printz³, Jack E. Norland²; ¹BKS Environmental, Gillette, WY, ²North Dakota State University, Fargo, ND, ³NRCS, Bismarck, ND

ABSTRACT

It is widely recognized that riparian health is inherently linked to watershed condition and the health of the adjacent ecological sites. Land management has the potential to impact riparian stability as different uses may alter the ecological function of ecological sites. To assess the relationship between the health of upland ecological sites and stream stability (stream type and risk of stream bank erosion), thirty-five reaches across five watersheds were sampled in Bowman County, ND. The major land use in the study area is grassland as livestock production is the primary use. The stream types were classified using Rosgen's classification of natural rivers which separates stream channels based on their dimensions. The Bank Erosion Hazard Index (BEHI) was used to determine stream bank's risk of erosion. Bank Height Ratio (BHR) was used to assess the risk of stream bank failure. The 17 Indicators of Rangeland Health (IRH) protocol was used to assess the ecological sites associated with each reach. IRH evaluates the ecological functions of an ecological site by using 17 indicators to measure departure of soil and site stability, hydrologic function, and biotic integrity from the reference state. A Nonmetric Multidimensional Scaling ordination was performed to analyze the data. Analysis indicated that IRH had the strongest relationship with BEHI and BHR. Streams with greater instability and high risk of erosion, F and G stream and those with a high BEHI ratings, were correlated with soils with increased compaction and decreased aggregate stability. Reaches with greater stability, E and C streams with low BEHI and BHR ratings, were associated with increased amounts of litter and minimal IRH departure. Based on these findings IRH can be useful tool to determine if a stream reach is at risk of transiting to an unstable state.

LONG-TERM MONITORING OF THE MAGGIE CREEK RIPARIAN AREA. Mike T. Anderson*¹, Eric D. Sant², Gregg E. Simonds³; ¹Open Range Consulting, Salt Lake City, UT, ²Open Range Consulting, Preston, ID, ³Open Range Consulting, Park City, UT

ABSTRACT

The Maggie Creek riparian area sits in northeast Nevada. With monitoring going back to the early seventies, Maggie Creek is a great example of long term data collection. Having rich data both spatially and temporally provides a unique opportunity to look at the effects of management. Open Range Consulting (ORC) has used Earth Sense Technologies (EST) to bring the monitoring of Maggie creek into the 21st century. Using remote sensing ORC accurately mapped current vegetation and used satellite imagery to look at vegetation changes through time.

SYMPOSIUM INTRODUCTION: ADDRESSING MANAGEMENT NEED: COORDINATED AND COLLABORATIVE STRATEGIC CONSERVATION AND RESTORATION INVESTMENTS IN THE SAGEBRUSH BIOME . Karen L. Prentice*¹, Ken Mayer²; ¹Bureau of Land Management, Washington, DC, ²Western Association Fish & Wildlife Agencies, Sparks, NV

ABSTRACT

Spanning eleven western states and two provinces, sagebrush has been called one of the most imperiled biomes in the world. Loss and degradation of sagebrush has caused corresponding declines in distribution and abundance of sagebrush dependent species. Numerous petitions to list individual species have been filed under the Endangered Species Act (ESA); listing petitions are often associated with species-specific conservation efforts. If current trends in habitat loss and degradation are not reversed, additional petitions, accompanied by additional species-specific conservation efforts, are anticipated. This species-by-species approach, driven by potential species listings or other “emergencies” is not a sustainable solution to conservation of the sagebrush biome. A more proactive, holistic, and enduring approach, that links local actions to biome-wide planning and objectives is needed. In this approach, human relationships, organizations, and social networks would be marshalled to address ecologically meaningful problems at the appropriate spatial and temporal scales. To be successful, these efforts will require a shared understanding of the condition of the sagebrush biome, threats to the biome, and opportunities to restore and conserve the biome. Additionally, the ability to link biome-wide science and data to local science and data is requisite. This Session will describe a new approach to managing the sagebrush biome that incorporates these ideas. Developed by a multi-partner team, the Science Framework for Conservation and Restoration of the Sagebrush Biome” presents a strategic, multi-scale science framework to target locations for management activities and determine effective management strategies. This new approach is resulting in a paradigm shift in the management of sagebrush ecosystems across the biome and is leading to new partnerships and human arrangements to support this effort.

USING RESILIENCE AND RESISTANCE CONCEPTS TO DEVELOP A COMMON SCIENCE FRAMEWORK FOR MANAGING THREATS TO SAGEBRUSH ECOSYSTEMS AND SAGEBRUSH DEPENDENT SPECIES

. Jeanne C. Chambers*; USDA Forest Service, Reno, NV

ABSTRACT

Sagebrush ecosystems and the species that depend upon them are at risk due to a suite of persistent ecosystem and anthropogenic threats, and managers and policy makers are seeking strategic, multiscale approaches for species conservation and ecosystem restoration. Recently, a *Science Framework for Conservation and Restoration of the Sagebrush Biome* has been developed that provides a science-based approach for prioritizing areas for management at large landscape scales and determining effective management strategies at project and site scales. An understanding of ecosystem resilience to disturbance, i.e., recovery potential, and resistance to invasive annual grasses underpins the approach. First, areas are prioritized for management using a geospatial process that overlays information on ecosystem resilience and resistance, species habitats, and predominant threats at the ecoregional/Greater sage-grouse management zone scale. A resilience and resistance habitat matrix helps decision makers evaluate risks and determine appropriate management strategies at these larger scales. Then, prioritized areas and management strategies are refined by managers and stakeholders based on higher resolution data and local knowledge at project to site scales. Ecological type descriptions and state-and-transition models characterized according to relative resilience and resistance are key tools in the step-down process. Factsheets, field guides, and field workshops have been developed through the Great Basin Fire Science Exchange and its partners to facilitate application of the approach. The geospatial data, maps, and models are provided through the U.S. Geological Survey (USGS) ScienceBase and Bureau of Land Management (BLM) Landscape Approach Data Portal, and a visualization tool for the different geospatial data layers and maps is under development. This approach was incorporated into the Subregional Greater Sage-grouse EISs and a BLM Fire and Invasives Assessment Tool used to prioritize sage-grouse habitat for targeted management activities. US Forest Service has used a similar, threat-based process.

THE NEED FOR A MULTI-SCALE, SCIENCE-BASED APPROACH TO MANAGE
THREATS TO SAGEBRUSH ECOSYSTEMS AND SAGEBRUSH-DEPENDENT SPECIES.
David A. Pyke*; U.S. Geological Survey, Corvallis, OR

ABSTRACT

Over 350 vertebrate species rely on sagebrush ecosystems for their existence within all or portions of their lifespans. The sagebrush ecosystem faces two types of threats – persistent ecosystem threats, those that are difficult to regulate and are managed via ecological approaches, and threats due to land uses and development, those threats that can be regulated, but due to population growth and resource demands will likely continue. Persistent ecosystem threats include the spread of invasive species, conifer expansion, altered fire regimes, and climate change. Land use and development threats include cropland conversion, energy development, recreation, wild horse and burro use, and improper livestock grazing. The importance of these threats and their priority for management across the sagebrush biome changes depending the location. Therefore, a biome-wide management or mitigation plan for dealing with these threats will likely be unsuccessful unless it incorporates a multi-scale approach. Similarly, management scenarios developed in isolation for a single local area, without considerations of the surrounding landscape, may mitigate a local threat, but may not benefit habitat improvement for a species that requires larger scale considerations. Fragmentation of sagebrush habitats may leave sagebrush-dependent species without sufficient habitat or habitat connections for genetic exchanges among surrounding populations, thereby leaving populations vulnerable to inbreeding depression and further jeopardizing the isolated populations. Mitigation plans for reducing threats and improving habitats will likely benefit sagebrush-dependent landscape species when habitat connectivity is included. Strategic decisions that assess threat mitigation at multiple scales may reduce costs relative to benefits gained in habitat improvement for sagebrush-dependent species.

MANAGEMENT TOOLS TO HELP GUIDE IMPLEMENTATION OF THE SCIENCE FRAMEWORK FOR CONSERVATION AND RESTORATION OF THE SAGEBRUSH BIOME. Peter S. Coates*¹, Kevin E. Doherty², Mark A. Ricca³, Jeanne C. Chambers⁴; ¹USGS Western Ecological Research Center, Dixon, CA, ²U.S. Fish and Wildlife Service, Lakewood, CO, ³USGS-Western Ecological Research Center, Dixon, CA, ⁴USDA Forest Service, Reno, NV

ABSTRACT

Conservation of the sagebrush biome has been driven by multi-stakeholder efforts to find science-driven solutions at the appropriate spatial scale. Chief among these is the Science Framework that links the U.S. Department of the Interior's Integrated Rangeland Fire Management Strategy with long-term strategic conservation actions. A spatially-implicit matrix combining categories of sagebrush ecosystem resilience to disturbance and resistance to invasion with sage-grouse breeding habitat probabilities comprises the root of the Science Framework, and provides a broad-scale means for identifying risks and appropriate management actions. Prioritized areas and corresponding management strategies can be further refined by local knowledge, and decision-support tools informed by more targeted and higher resolution data.

We provide a broad overview of decision-support tools available to help refine implementation of the Science Framework matrix at different spatial scales, with an emphasis on sage-grouse demographic and behavioral response to sagebrush ecosystem conditions. At larger scales we describe examples that include: 1) rangewide models of sage-grouse habitat suitability and variation in sage-grouse response to different habitat conditions and disturbances among sage-grouse management zones; 2) regional models depicting composite indices of habitat suitability and sage-grouse abundance that identify areas for targeted for management actions, particularly in relation to wildland fire risk; and 3) recent advances in high resolution mapping of shrubland, conifer, and annual grass cover across the sagebrush biome that can inform models of sage-grouse habitat suitability and relative risk. At smaller scales, we describe how spatially explicit tools informed by sage-grouse location and demographic data coupled with high-resolution land-cover can be used predict ecological benefits of targeted management actions (i.e., conifer removal and fire restoration) to sage-grouse, while accounting for sagebrush ecosystem resilience and resistance. These sets of tools highlight the importance of considering both sage-grouse and sagebrush ecological responses that lie at the heart of the Science Framework.

TAPPING SOIL SURVEY INFORMATION TO ASSESS RESILIENCE AND RESISTANCE OF SAGEBRUSH ECOSYSTEMS. Jeremy Maestas*¹, Steve Campbell¹, Jeanne Chambers², Mike Pellant³, Rick Miller⁴; ¹Natural Resources Conservation Service, Portland, OR, ²USDA Forest Service, Reno, NV, ³BLM (retired), Boise, ID, ⁴Oregon State University, Corvallis, OR

ABSTRACT

Emerging applications of ecosystem resilience and resistance (R&R) concepts in sagebrush ecosystems allow managers to better predict and mitigate impacts of wildfire and invasive annual grasses. Widely available soil survey information can be harnessed to spatially depict and evaluate relative resilience to disturbance and resistance to invasive species from regional to site scales. Using a newly aggregated data set of soil temperature and moisture regimes across the range of sage-grouse, we developed an abiotic index of R&R to facilitate landscape prioritization and triage that is now available online for practitioners to visualize and download. We also created a new soils report tool in Web Soil Survey that can be used to rapidly extract additional information, such as, soil textures, depths, and ecological sites to facilitate more detailed assessments of R&R at the project scale. Ecological site descriptions and associated state-and-transition models (STMs) available through soil surveys also provide important information for resilience-based management. Where site-specific STMs are not available, generalized STMs based on our R&R framework have been developed for the predominant ecological types across the sagebrush biome. Collectively, these new products and tools help managers read the landscape and inform rapid risk assessments, determine appropriate management strategies, and prioritize resources to maintain and restore functioning sagebrush ecosystems.

IMPLEMENTING ADAPTIVE MANAGEMENT AND MONITORING.

. Lief Wiechman*¹, David A. Pyke²; ¹USFWS, Fort Collins, CO, ²U.S. Geological Survey, Corvallis, OR

ABSTRACT

Monitoring programs designed to track ecosystem changes in response to both stressors and disturbances can use repeated observations of ecosystem attributes. Such programs can increase our understanding of how interactions among resilience to disturbance, resistance to invasive species, and a suite of ‘change agents’ (e.g., natural disturbances, management actions, or climate), influence resource condition (or status) and trends and subsequent outcomes of conservation and restoration actions. This type of monitoring information provides the basis for adaptive management. The overarching goals of an integrated monitoring and adaptive management program are to reduce the uncertainty in the effectiveness of management actions and to provide triggers that initiate modifications in management objectives, strategies, and actions to halt degradation before an environmental threshold is crossed. Such adaptive management works within the ecosystems resistances to invasive species and resilience from disturbances to allow ecosystem sustainability.

An integrated monitoring and adaptive management program includes a series of steps that are repeated over time and are designed to facilitate “learning by doing”. We will provide an example of unintended consequences of “doing without knowing”, in which a lack of monitoring can result in unintended consequences and may result in additional resource expenditures down the road.

We will present a 9-cell matrix that combines resilience and resistance information with that of modeled greater sage-grouse (*Centrocercus urophasianus*) breeding habitat – which, at a broad scale, can inform how treatment types, methods, and what the range of expected outcomes. These concepts have the potential to sustain resources, especially in the long term, as resources allocations become limited.

UNDERSTANDING CLIMATE ADAPTATION STRATEGIES

. Louisa Evers*¹, Linda Joyce², Jeanne Chambers³; ¹USDI Bureau of Land Management, Portland, OR, ²USFS Rocky Mountain Research Station, Fort Collins, CO, ³USDA Forest Service, Reno, NV

ABSTRACT

Management actions that promote resilience to disturbance are becoming increasingly important in the sagebrush biome. Throughout the U.S, temperatures have warmed over the last 50 years. Temperatures are likely continue to warm along with other changes in climate, such as greater numbers of extreme events. These potential changes require careful consideration in management actions for the sagebrush biome. The Science Framework for Conservation and Restoration of the Sagebrush Biome: Linking the Department of the Interior's Integrated Rangeland Fire Management Strategy to Long-Term Strategic Conservation Actions, provides a strategic, multiscale approach for prioritizing areas for management and determining effective management strategies across the sagebrush biome. Managing natural resources within the context of climate adaptation is consistent with the approach described in the Science Framework, but requires the necessary flexibility to modify management actions as environmental conditions change. A conceptual approach for addressing climate adaptation focuses on climate resistance, resilience, and response strategies. Using these concepts to manage for changes in climate involves examining whether current assumptions about the effects of weather and climate on environmental responses and underlying assumptions about the expected result of management actions are still viable in a changing environment. Assessing ongoing and projected climate change using the best available data is integral to evaluating priority areas for management at mid scales and to determining appropriate management treatments at local scales. An understanding of the rates and magnitude of projected change can help managers prioritize areas for different types of management actions. This presentation reviews the current understanding of how climate change is affecting drought, insects and disease, and fire regimes in the sagebrush biome. Climate change adaptation strategies for the sagebrush biome have been developed that build on the sage-grouse resilience and resistance habitat matrix and the sagebrush ecosystem management strategies.

IMPLEMENTING WILDFIRE AND VEGETATION MANAGEMENT STRATEGIES.
Michele Crist*¹, Jeanne Chambers²; ¹USDOI Bureau Land Management, Boise, ID, ²USDA
Forest Service, Reno, NV

ABSTRACT

Wildfire has always been an important ecosystem process across the sagebrush biome. Recently, the scale of sagebrush ecosystem loss and fragmentation has increased significantly due to a combination of uncharacteristic wildfire, invasive annual grasses, conifer expansion (primarily piñon and juniper), and anthropogenic use and development. A strategic approach to wildfire and vegetation management is now required that focuses available resources in places that will maximize conservation return on investment. Wildfire management integrated with vegetation management (fuels reduction and ecosystem restoration) has the potential to increase that return on investment by enhancing the resilience of native sagebrush ecosystems to stress and disturbance and/or resistance to invasive annual grasses. This integrated management aids in maintaining ecosystem connectivity and ecological processes. Similarly, vegetation management planned in conjunction with post-fire restoration helps maintain functionally diverse plant communities with the capacity to persist and stabilize ecosystem processes under altered disturbance regimes. When placed in the context of large landscapes, these actions collectively are part of a management strategy to maintain the necessary ecosystem processes and connectivity, protect vulnerable ecosystems and species from uncharacteristic wildfire cycles, and adapt to fluctuations in climate. An understanding of the linkages among ecosystem resilience to disturbance and resistance to invasion, priority areas and habitats for management, and the predominant threats can be used to effectively target wildfire and habitat management actions. The effects of wildfire processes on sagebrush communities depend on the communities' relative resilience to disturbance and resistance to invasive annual grasses. Geospatial analyses and mapping based on indicators of resilience and resistance, GRSB breeding habitat probabilities, and large wildfire probabilities, can be used to inform wildland fire management decisions related to preparedness, suppression, vegetation management, and post-fire restoration at multiple scales across the sagebrush biome.

MANAGING NONNATIVE INVASIVE PLANT SPECIES. Lindy Garner*¹, Michael Ielmini², Jeanne Chambers³, Ken Mayer⁴, Michele Crist⁵; ¹USDOI Fish & Wildlife Service, Great Falls, MT, ²USDA Forest Service, Washington, DC, ³USDA Forest Service, Reno, NV, ⁴Western Association Fish & Wildlife Agencies, Sparks, NV, ⁵USDOI Bureau Land Management, Boise, ID

ABSTRACT

One of the most significant stressors to the sagebrush biome is expansion and dominance of nonnative ecosystem-transforming species, particularly invasive annual and perennial plants. Each invasive plant differs in the magnitude of the risk or impact it poses to sagebrush ecosystems, depending on the site conditions and the species' characteristics. Invasive annual grasses, most notably cheatgrass (*Bromus tectorum*), medusahead rye (*Taeniatherum caput-medusae*), and red brome (*Bromus rubens*) are arguably the most widespread ecosystem disrupters across the sagebrush biome. Yet many other invasive species, such as leafy spurge (*Euphorbia esula*) and Russian knapweed (*Acroptilon repens*) are also responsible for environmental impacts to sagebrush communities. Invasive plant species colonize new areas rapidly, and once established, invasive plant species often continue to spread across the sagebrush communities where suitable conditions exist, capitalizing on disturbance, fire and various pathways and vectors. Land managers are tasked with controlling the various species of invasive plants, but limited resources are available for invasive plant management. The need to manage multiple invasive plants while considering ecological impacts and social and political priorities often results in substantial challenges in determining how to partition resources for invasive plant management. We suggest methods for fostering coordination and collaboration to leverage resources at the biome, regional and local scale. We outline data availability and needs for defining priority areas for management and current level of invasion, and discuss how resilience and resistance concepts can be integrated into invasive plant management. We suggest that the level of invasion and feasibility of control need to be evaluated in light of current ecological conditions to help inform management strategies and the associated return on investment.

APPLYING NATIONAL SEED STRATEGY CONCEPTS . Sarah M. Kulpa*¹, Fred Edwards², Francis F. Kilkenny³; ¹U.S. Fish and Wildlife Service, Reno, NV, ²Bureau of Land Management, Reno, NV, ³USDA Forest Service, Boise, ID

ABSTRACT

Native plant species are the foundation of sagebrush ecosystems and provide essential habitat for wildlife species, like Greater sage-grouse. The National Seed Strategy for Rehabilitation and Restoration provides a coordinated approach to improving the use of native seed, building federal and private capacity, and increasing the supply of genetically appropriate, native seed. Restoring the sagebrush biome poses significant logistical challenges for collecting, evaluating, increasing, procuring, and using genetically appropriate, native seed. Ecosystem resilience to disturbance and resistance to invasive annual grasses can be increased by considering both seed source and genetic diversity when selecting seeds and plant materials. Here, we present trade-offs to consider when selecting seed and plant materials for rehabilitation and restoration.

VISUALIZATION AND DECISION SUPPORT TOOLS

. Zachary Bowen*; USGS Fort Collins Science Center, Fort Collins, CO

ABSTRACT

The recently published *Science Framework for Conservation and Restoration of the Sagebrush Biome* (C&R Strategy) provides a strategic approach that supports management decisions across the sagebrush biome. U.S. Geological Survey scientists along with Federal and State partners are developing a core set of data, models, and a web-based geospatial tool for the C&R Strategy to support resource planning needs in the sagebrush biome. Initial efforts are focused on making data and derived products associated with the C&R Strategy available and useable by a wide audience, ranging from managers and decision makers to GIS professionals and resource specialists. Key functions associated with the web application include: 1) spatial data discovery and exploration; 2) desktop analysis of predefined or user-defined areas of interest; and 3) data summarization and generation of reports. This work is capitalizing on previous and ongoing research and development projects that are focused on large landscape conservation. The initial public release of the application is planned for December 2017.

MANAGING LIVESTOCK GRAZING. Jeffrey L. Beck*¹, Michael "Sherm" G. Karl², Jeanne C. Chambers³; ¹University of Wyoming, Laramie, WY, ²Bureau of Land Management, Denver, CO, ³USDA Forest Service, Reno, NV

ABSTRACT

Federal and state agencies are working together with private landowners to maintain or improve habitat for greater sage-grouse and other species at-risk in a manner appropriate for site conditions and landowner interests. Designing livestock grazing management practices to improve habitats requires a consistent approach that can be applied across jurisdictions. The Science Framework provides an approach for determining an area's suitability for management actions and the appropriate types of actions that can be applied to livestock grazing management. At the mid-scale (ecoregion or Management Zone) geospatial data and analyses are used to evaluate: 1) the predominant disturbances and stressors; 2) the likely response of an area to disturbance or stress and/or management actions (i.e., resilience to disturbance and resistance to invasion by annual grasses); and 3) the capacity of an area to support target species and/or resources. At the local scale (field office or district) ecological types/sites and state-and-transition models are useful for: 1) characterizing the area and its relative resilience and resistance; 2) evaluating the current ecological dynamics of the ecological types/sites and, where possible, their restoration pathways; and 3) selecting livestock grazing management practices with potential to increase ecosystem functioning and habitat conditions. Evaluating the habitat objectives for sage-grouse and other species at risk can help determine if the management area (e.g., grazing allotment) has potential to achieve the objectives and, if so, the specific livestock grazing management practices needed to achieve the objectives. Greater sage-grouse breeding and nesting seasonal habitat, and brood-rearing/summer seasonal habitat have the greatest potential to be affected by livestock grazing and vegetation objectives have been established for these habitats. Ecological type/site descriptions and state-and-transition models can be used to evaluate current habitat characteristics and determine appropriate livestock grazing management practices for meeting habitat objectives.

WILD HORSE AND BURRO CONSIDERATIONS. Paul Griffin*¹, Jared Bybee², Hope Woodward³, Gail H. Collins⁴, Jacob D. Hennig⁵, Jeanne C. Chambers⁶; ¹BLM, Fort Collins, CO, ²BLM, Ely, NV, ³USFS, Washington, DC, ⁴US Fish and Wildlife Refuge, Lakeview, OR, ⁵University of Wyoming, Laramie, WY, ⁶USDA Forest Service, Reno, NV

ABSTRACT

Wild horse and burro overpopulation on the range is not easily managed, and can influence the potential success of conservation and restoration projects. Wild horses can routinely move many miles per day for water and forage. At high densities, both horses and burros can have negative influences on vegetation, soils, and native wildlife. The BLM and USFS manage wild horses and burros on designated public lands in ten western States. Constraints on the agencies' abilities to manage wild horses and burros can limit habitat conservation and vegetation restoration. As of March 1, 2017, BLM estimated that there were nearly 73,000 wild horses and burros on BLM lands, while the appropriate management levels were approximately 27,000. Roughly 7,100 more wild horses and burros live on USFS lands. Approximately 45,000 to 47,000 unadopted animals are currently maintained off-range by BLM at an annual cost of \$49 million. Because of the high cost of holding animals off-range, the number of animals that can be removed from the range is limited, and the on-range population continues to grow exponentially, at rates up to 20% per year. We will present a spatial analysis, examining wild horse and burro densities with respect to three resistance and resilience categories, and with respect to Greater Sage-grouse breeding habitat probabilities. We will share insights from this analysis that can be useful for managers who are considering where and how to make rangeland conservation and restoration efforts.

INTEGRATING *TAMARIX* BIOCONTROL WITH CONVENTIONAL MANAGEMENT METHODS IN SOUTHWESTERN RESERVOIRS

. Leeland Murray*, Erik Lehnhoff, Brian Schutte, Carol Sutherland; New Mexico State University, Las Cruces, NM

ABSTRACT

Tamarix spp., invasive riparian shrubs, are ecological and economic threats in the southwest as they displace native vegetation and necessitate costly management. *Tamarix* control typically consists of chemical and mechanical removal, but these methods can prove to have negative ecological and economic impacts. Tamarisk beetles (*Diorhabda* spp.) released for biocontrol, are becoming increasingly established within Western river systems and are another form of control. While there is abundant research on each of these treatment methods, no research has been conducted on integrating these methods to improve management. Our work, conducted at Caballo Reservoir in southern New Mexico addressed the question, could *Diorhabda* herbivory be combined with mechanical and chemical treatment to achieve greater control with fewer non-target impacts. A field experiment was conducted by testing the impacts of integrating mowing and herbicide with herbivory at a standard and low rate (2.78 lb ae ha⁻¹ and 0.93 lb ae ha⁻¹ respectively), with treatments replicated five times, at two field locations — a seasonally flooded and dry site. Green foliage percent and gas exchange (via LI-COR 6400) were measured. Results showed herbicide treatments reduced transpiration rates and green foliage at both sites, and was influenced by adults and larva beetle numbers. At the end of two growing seasons, herbivory alone showed a high green foliage percent recovery, while mowing and herbicide treatments all displayed severely reduced percentages of green foliage. Data shows combining conventional management methods with biocontrol could result in additional stress through a combination of reduced green foliage recovery and a continued reduction in aboveground biomass within mowed treatments. Incorporating this new knowledge into land management objectives for *Tamarix* control can result in more effective overall management plans.

ACACIA FARNESIANA CONTROL IN BUFFELGRASS PASTURES IN THE MATORRAL AREA AT ALAMOS, SONORA, MEXICO. Fernando Jr. A. Ibarra-Martin*¹, Martha H. Martin Rivera¹, Fernando A. Ibarra-Flores¹, Rodolfo Garza Ortega², George A. Rasmussen³, Salomon Moreno Medina¹; ¹University of Sonora, Santa Ana, Mexico, ²Dow Agrosiences, Hermosillo, Mexico, ³Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

Vinorama or huizache (*A. farnesiana*) is an aggressive tall-shrub which invades buffelgrass (*Cenchrus ciliaris*) pastures and reduces productivity. Prado herbicide (621.3 g i.a./kg. Aminoipyralid + 94.5 g i.a./kg. Metsulfuron metil) is a new product from Dow Agrosiences in Mexico and no local data is available for its use. This study was conducted in summer of 2011 to evaluate the efficiency of Prado herbicide and manual control by machete to reduce vinorama populations. Treatments applied were: Prado herbicide one doses (75 grams) on 100 liters of water, manual control by machete and the untreated check. Plot 10 by 30 m were used in a randomized complete block design with three treatments and 20 replications. Data was analyzed by ANOVA. Evaluated variables were: brush mortality, grass density, plant height, basal cover and forage production. All variables were evaluated from 2011 to 2013. Prado herbicide controlled 100% of vinorama and caused no phytotoxicity problems to grasses present. Machete treatments controlled 5% of the vinorama plants but treated plants sprouted back and reach pretreatment levels after three summer growing seasons. Chemical brush control increased ($P < 0.05$) grass density, plant height, basal cover and the forage production of both buffelgrass and native grass species. Total forage production varied from 7.5 to 9.0 metric tons D.M./ha on chemically treated plots, from 6.5 to 6.8 metric tons D.M./ha on machete treated areas and from 4.3 to 4.9 metric tons D.M./ha on the untreated checks. Buffelgrass plots where vinorama was controlled produced additionally from 1.6 to 3.6 metric tons of D.M./ha/year. Manual control by machete is not recommended because of low plant control and forage production increases are short-lived and are economically not justified. Foliar applications of Prado herbicide are appropriated to reduce vinorama populations and increase productivity in buffelgrass pastures in the humid areas of southern Sonora, Mexico.

**AN ASSESSMENT OF SOCIAL, ECONOMIC, AND ENVIRONMENTAL ISSUES
RELATED TO PRESCRIBED BURNING**

. Omkar Joshi*, John R. Weir, Samuel D. Fuhlendorf; Oklahoma State University, Stillwater,
OK

ABSTRACT

Prescribed burn associations are the cooperatives that share knowledge, experience, and equipment among contributing members to increase the application and safety of fire as a management tool. However, soaring management costs, complex liability laws, and the uncontrolled fire risks in wildland-urban interface have negatively influenced their preference towards prescribed burning. We conducted an online survey of memberships to understand the social, economic, and environmental issues related to prescribed burning. The preliminary results suggest that more than half respondents had at least 10 years of experience in prescribed burning. The majority stakeholders, however, did not have an insurance coverage. Weather conditions, safety, firebreaks, and needed equipment to conduct the burn had the strongest influence in conducting or planning for a prescribed fire. Study results suggest some policy and outreach strategies that can help reduce burning costs and increase stakeholder participation in prescribed burning.

ABOVEGROUND CARBON ACCUMULATION IN TREATED AND UNTREATED WESTERN JUNIPER (*JUNIPERUS OCCIDENTALIS*) SYSTEMS IN CENTRAL OREGON . Mohamed A. Abdallah*, Ricardo Mata-Gonzalez, Carlos G. Ochoa, Jay S. Noller; Oregon State University, Corvallis, OR

ABSTRACT

Woody plant encroachment transforming rangelands influences the carbon pool worldwide. Encroachment of western juniper (*Juniperus occidentalis*) is a significant problem in Oregon rangelands and it is common to control this species to favor the regrowth of shrubs and grasses. However, the consequences of juniper control in terms of carbon pools are not known. We intended to fill this gap with this study. Our study site was a paired watershed in central Oregon in which juniper trees were controlled in one area (the treated watershed) in 2005 and were left intact in the other (the untreated watershed). Each watershed had an area of about 110 ha. We quantified aboveground carbon pools for trees, shrubs, grasses, and litter in both the treated and untreated watersheds. In each watershed 20 plots of 20 m X 20 m were systematically established for mass evaluations. Juniper tree mass was estimated by previously established allometric equations. Also, one plot of 10 m x 10 m for shrub mass evaluation and four plots of 2 m x 2 m for grass and litter mass evaluation were established within each 20 m x 20 m plot. We estimate the average total aboveground accumulation of carbon to be five times higher on the untreated than on the treated watershed. Trees of the untreated watershed stored approximately 21 times more carbon than regrowth trees in the treated watershed. Grasses of the untreated watershed stored 50% more carbon than grasses on the treated watershed. On the other hand, shrubs and litter of the treated watershed stored 8 and 6 times more carbon, respectively, than those of the untreated watershed. Our findings support the proposition that juniper control results in a decrease in total carbon pools, although the increase in the shrub carbon pool partially offsets those losses.

JUNIPER REMOVAL IN SAGEBRUSH COMMUNITIES: IMPLICATIONS FOR SPECIES INTERACTIONS

. Aaron C. Young*, Tracey N. Johnson; University of Idaho, Moscow, ID

ABSTRACT

Invasion by western juniper (*Juniperus occidentalis*) leads to fragmentation and alteration of sagebrush steppe and is a major consideration for managers concerned with the conservation of sagebrush-associated species. Recent efforts aimed at improving habitat for greater sage-grouse (*Centrocercus urophasianus*) have involved reduction of juniper cover. However, for other species associated with sagebrush, effects of these management actions remain either untested or only partially understood. Little is known about small mammal communities in juniper-encroached sage habitats, and the use of these landscapes by aerial predators that influence sage-grouse individual and nest survival has not been explicitly examined. For managers, balancing the requirements of a range of taxa necessitates an understanding of not only how management actions may influence population density and community structure, but also the mechanisms driving these changes. Altered habitat may affect species interactions at different spatial, temporal, and management thresholds through changes in predator-prey dynamics or habitat selection. Our objective is to examine how bird, small mammal, and predator communities respond to juniper removal and to identify how interactions among species may affect population demography.

The Bruneau-Owyhee Sage-Grouse Habitat Project (BOSH) is expected to remove juniper across 600,000 acres of sage-grouse habitat in southwest Idaho. To evaluate this management, we have initiated a four-year 'before-after control-impact' study to examine effects of juniper removal treatments on songbird and small mammal abundances and community structure. We will also evaluate site occupancy for corvid and raptor species to explore potential changes in landscape use for predators of both sage-grouse and songbirds. To address our objectives, we conducted songbird, small mammal, and raptor/corvid surveys within areas comprising three categories of juniper cover: 0-10%, 10-20%, and >20%. We present preliminary results from each of these surveys. One additional season of pre-removal surveys will be conducted, followed by two seasons of post-removal surveys.

JUNIPER ENCROACHMENT ON SAGEBRUSH-GRASSLAND IN NORTH EAST NEVADA. Glenn Shewmaker*; University of Idaho, Kimberly, ID

ABSTRACT

Juniperus osteosperma (Utah juniper; [syn.](#) *J. utahensis*) has increased in upland sagebrush (*Artemisia spp.*)—*Stipa spp.* and *Pseudoroegneria spicata* sites because of fire suppression since the 1970's. This has negative impacts on the soil and water resources, plant diversity, and several wildlife species, especially the greater sage-grouse (*Centrocercus urophasianus*). A photo-plot was established on the downward edge of juniper woodland in the 1970's. Yearly photos show obvious invasion down slope of juniper. Rehabilitation of stage I and II juniper woodlands would benefit greater sage-grouse, other wildlife, livestock distribution, and watershed values. The stage III juniper canopy is now in a stable state and will remain so until fire, flood, insects, or disease remove it. Photo-plots, weather data, and utilization records were used to interpret this shift in vegetation composition.

HABITAT MANAGEMENT THROUGH INVASIVE SPECIES CONTROL. Katie R. Brown*,
LynneDee Althouse, Daniel E. Meade; Althouse and Meade, Inc., Paso Robles, CA

ABSTRACT

Large scale renewable energy farms are being constructed throughout California to meet the States goal of deriving 50-percent of its electricity from renewable energy by 2050. Many of these renewable energy farms, including solar and wind turbine farms, are being constructed on sensitive wildlife habitat. Construction and associated ground disturbance allows establishment of invasive weed species, potentially introduces new species, and may increase weed dispersal rates. Invasive species identification, control, and management is critical in maintaining habitat integrity for wildlife. To manage and protect sensitive wildlife habitat on two large solar farms in San Luis Obispo and Monterey County, and one large wind turbine farm in Solano County weed populations and densities were mapped throughout project lands. Annual surveys are completed to determine success of control efforts and document changes in population and associated habitat. Long-term monitoring and management has resulted in invasive species population decline and improved wildlife habitat.

MECHANISMS THAT FACILITATE THE RESISTANCE TO CHEATGRASS INVASION IN PERENNIAL GRASS COMMUNITIES. Dan N. Harmon*¹, Charlie D. Clements²; ¹USDA-ARS, Reno, NV, ²USDA, Reno, NV

ABSTRACT

The competitive exclusion principle states that species competing for the same limiting resource cannot coexist. This contributes to the successful application of seeding and establishing an intact perennial grass community that resists invasion by cheatgrass (*Bromus tectorum*). Water and nitrogen are known limited resources in Great Basin ecosystems. Observations of variability of cheatgrass suppression or resistance to cheatgrass invasion during wet and dry years indicate soil moisture as a driving factor for resistance to invasion. We monitored perennial grass dominated communities where cheatgrass suppression was observed and the transition to cheatgrass dominance when the perennial grass was removed. We measured soil moisture and available nitrogen during this transition and the effect that seedbed litter had on cheatgrass invasion after perennial grass removal. Cheatgrass growth, density and seed banks were measured in healthy, robust and intact perennial grass communities and where the perennial grass was experimentally removed for comparison. We found a threefold increase in cheatgrass biomass when the competing perennial grass was removed (cheatgrass biomass lbs/acre = 108lb vs. 327lb). This increase has dramatic management implications for wildfire fuels management at the landscape level as cheatgrass biomass provides the fine fuels that increase the chance, rate and spread of wildfires in the Great Basin.

A DEGRADED SAGEBRUSH SITE OR AN ANNUAL GRASSLAND WITH SAGEBRUSH?
THE IMPORTANCE OF ACCURATE LANGUAGE. Brad Schultz*¹, Barry Perryman²; ¹UNR,
Winnemucca, NV, ²University of Nevada Reno, Reno, NV

ABSTRACT

During the past decade, and perhaps much longer, there has been substantial research and discussion about sagebrush plant communities and ecological sites. For sagebrush sites with a depleted perennial herbaceous understory, and an obvious component of annual grasses, the author virtually always describes the plant community as “a degraded sagebrush community.” We believe this occurs for at least two reasons: 1) sagebrush is still present, and often with desired amounts of canopy cover; and 2) there is a small population of perennial grasses that potentially may increase. We propose that such sites are not “degraded sagebrush sites”, but rather annual grasslands with a remnant population of sagebrush and perennial grasses: at best a mixed annual-perennial plant community. Virtually all, if not every ecological process is primarily influenced by the annual grass component. Annual grasses are the ecological driver of all plant community dynamics as far into the future as one can possibly see. Using accurate language is critical to accurately describing the ecological situation and determining appropriate management actions. Consistently placing the emphasis on the ‘remnant perennial’ component of the plant community, when the ecological driver is the abundance of the annual lifeforms regularly results in management for the perennial species. The result, especially in the most arid sagebrush systems, is more fires, fewer desired perennials, and an ever-larger portion of the landscape ecologically dominated by annual grasses. Acknowledging that landscapes with abundant annual grasses and remnant perennials, even when sagebrush cover is adequate, are actually annual grasslands with remnant perennials, changes the management focus from the “remnant perennials” toward to the ecologically dominant annual species. Management that does not address the ecologically dominant annual lifeform at least equal to the remnant desired perennial species, and yet, expects the perennials to increase, may be well-intended but borders on delusional.

PREDICTING SUCCESSFUL TREATMENT OF WYOMING BIG SAGEBRUSH WITH TEBUTHIURON. Stephen Cassady¹, Rokelle L. Reeve*², Clare Poulsen³, Andrew Brishke⁴, Elizabeth Delcamp²; ¹Arizona Game and Fish Department, Flagstaff, AZ, ²University of Arizona, St. George, UT, ³NCRS, Fredonia, AZ, ⁴University of Arizona, Kingman, AZ

ABSTRACT

The intent of this study is to determine our ability to predict successful treatment with the application of Tebuthiuron to reduce Wyoming big sagebrush and increase herbaceous perennial vegetation. The initial stage of this study was to determine if the information available through the Arizona Strip BLM's key area trend monitoring program could be utilized to predict the potential success of treating sagebrush dominated plant communities. From 1994 to 2010 approximately 108,000 acres were treated with Tebuthiuron on the Arizona Strip. BLM records were searched to identify potential sites for analysis. 77 sites were treated with Tebuthiuron and a multi-agency team visited these sites. At each location the team verified that a treatment had occurred, obtained soil information, verified the ecological site, took photographs, produced a species list in order of apparent dominance, and made an assessment of the success of the treatment. Information from the monitoring data included frequency of perennial plants and ground cover information. Components of this monitoring along with additional information collected by the team were then statistically analyzed for their reliability of predicting a threshold of success. This analysis did not provide a significant conclusion. The next stage of this project will be to analyze post treatment precipitation as a predictor of successful treatment. The Arizona Strip has many years of rainfall data that is collected quarterly. With the addition of precipitation data we hope to determine if post-treatment precipitation drives the success of Tebuthiuron treatments.

THE EFFECT OF HERBICIDE APPLICATION ON RANGELAND SOIL NUTRIENT AVAILABILITY. Robert Blank*¹, Charlie Clements¹, Tye Morgan¹, Dan N. Harmon²; ¹USDA-ARS, Reno, NV, ²USDA ARS, reno, NV

ABSTRACT

Very sparse literature exists on the effect of soil active herbicides on nutrient availability. As part of a larger rangeland rehabilitation project, on four sites in northern Nevada, we quantified the effect of the herbicides Landmark®, Perspective®, and Plateau® relative to controls on surface soil (0-10 cm) nutrient availability. Samples were collected multiple times over two years. The data set is complex and herbicide treatments interacted with site and time of sampling. Overall, relative to the controls, mineral N, soil-solution sulfate, and bicarbonate-extractable phosphorus quantities were often elevated on herbicide-treated plots. In addition, on some sites, herbicide treatments affected micronutrient availability. We believe these changes in nutrient availability are largely a function of vegetation loss (lack of nutrient uptake) due to the herbicides. We will continue to monitor plots for at least one more year.

GLYPHOSATE AS A TOOL TO INCREASE LIVESTOCK CONSUMPTION OF MEDUSAHEAD ON ANNUAL GRASS INVADDED RANGELANDS. Clint Stonecipher*¹, Casey Spackman², Kip Panter³, Juan Villalba⁴; ¹USDA-ARS-PWA-PPR, Logan, UT, ²Utah State University, 84333, UT, ³USDA, Logan, UT, ⁴Utah State University, Logan, UT

ABSTRACT

Invasive annual grasses are altering vegetation dynamics in the Western U.S., decreasing plant diversity and altering forage availability for livestock and wildlife. Preparation and reseeding annual grass invaded rangelands is necessary to change vegetation structure and a combination of input methods is typically required to achieve that goal. Herbicide application to control medusahead (*Taeniatherum caput-medusae*) is one tool recommended prior to revegetation. Herbicide application can be used prior to medusahead maturity to stop plant growth, preserve forage quality, and potentially increase palatability for livestock. In this study, we evaluated the application of glyphosate at three rates in the spring prior to medusahead maturity to determine if it would stop plant growth and increase palatability for livestock. Glyphosate treatment occurred in April at four rates: 1) 236 g ae ha⁻¹, 2) 394 g ae ha⁻¹, and 3) 788 g ae ha⁻¹, and 4) 0 g ae ha⁻¹, on plots measuring 3 m by 15 m. Plots were arranged in a randomized complete block design with four replications. Treatment plots were placed within a larger pasture of 89 ha that was treated with glyphosate at 788 g ae ha⁻¹. Cattle were allowed to graze the 89 ha pasture with free access to treatment plots from May through September. Vegetation measurements were taken prior to herbicide application, two weeks after herbicide application, and after grazing to determine biomass production and forage quality. Glyphosate applied at all three rates halted growth of medusahead and preserved water soluble carbohydrates. Livestock consumed medusahead biomass at all three application rates of glyphosate with the largest decrease occurring at the 788 g ae ha⁻¹ ($P < 0.05$). Glyphosate is a tool that can be applied to medusahead invaded rangelands to stop plant growth and preserve nutrients, thus increasing palatability of medusahead to livestock.

EVALUATION OF CATTLE GRAZING USE WHEN APPLYING RAFFINATE TO LEAFY SPURGE (*EUPHORBIA ESULA* L.) INVADED RANGELANDS. Tracy Ellig*¹, Kevin Sedivec¹, Dennis Whitted², Ryan Limb¹, Kent Belland³; ¹North Dakota State University, Fargo, ND, ²North Dakota State University, Walcott, ND, ³North Dakota Army National Guard, Bismarck, ND

ABSTRACT

Leafy spurge (*Euphorbia esula* L.) is a noxious weed that threatens grasslands throughout the northern Great Plains. Leafy spurge threatens prairie communities and not readily grazed by cattle. Currently, herbicides remain the most effective and commonly used practice to manage leafy spurge. However, if we can change the grazing behavior of cattle to consume leafy spurge, we would convert a weed into a valuable forage. In this study we tested the use of raffinate, a molasses extract, as a spray on feed attractant to increase forage and feed palatability of leafy spurge. Study objectives were to 1) determine if raffinate applied at two different ratios would attract cattle to consume leafy spurge and 2) determine if cattle grazing leafy spurge would alter the plant community over time. The study included three treatments 100% raffinate, 50% raffinate:50% water mixture, salt blocks and a control using a random block design with three replicates. The study was conducted on the Gilbert C. Grafton Military Training Base (South Unit) near McHenry, ND. Treatments were grazed with cow/calf pairs throughout the study duration. Treatments were applied in mid-June, mid-July and again in early September. We determined degree of disappearance by clipping 0.25 m² plots at eight meter intervals along transects at the end of the grazing season. We recorded graminoid species presence;absence using 0.1m² every 5 m, and density of leafy spurge and other broad leaf forbs using a 0.25m² plot every 5 m. Leafy spurge stem density declined on the salt and 50% raffinate:50% water treatments, indicating cattle grazing impacted the leafy spurge population. Furthermore, the salt and 100 percent raffinate treatments had a greater disappearance of leafy spurge standing crop after three applications of raffinate and continued presence of salt. Leafy spurge standing crop was reduced by 88 and 45 percent on the salt and 100 percent raffinate treatments, respectively. The application of raffinate to leafy spurge changed the grazing behavior of cattle, with cows consuming almost 50 percent of the leafy spurge biomass. Selective placement of salt also provided an effectively management strategy to achieve cattle consumption of leafy spurge on sands ecological sites.

USING A NEW NATURAL AREAS HERBICIDE TO CONTROL WINTER ANNUAL GRASSES AND ESTABLISH NATIVE SPECIES . Shannon L. Clark*¹, Derek J. Sebastian², Jim Sebastian³, Scott Nissen¹, Harry Quicke⁴; ¹Colorado State University, Fort Collins, CO, ²Bayer, Greeley, CO, ³Boulder County, Longmont, CO, ⁴Bayer, Windsor, CO

ABSTRACT

Downy brome (*Bromus tectorum* L.) and feral rye (*Secale cereale*) are competitive invasive winter annual grasses (IWAG). IWAG are considered one of the most problematic invasive species in rangeland and natural areas in the western United States. The currently recommended herbicides (imazapic and glyphosate) for site restoration have provided inconsistent control or cause injury to desirable perennial species. Indaziflam, a new herbicide alternative for weed management in natural areas and open spaces, provides long-term control of both downy brome and feral rye. Glyphosate can be mixed with a residual control product to control IWAG, while desirable perennials are dormant to achieve burndown of newly germinated seedlings. Field trials were conducted to evaluate glyphosate dose to provide adequate first-year IWAG burndown, downy brome and feral rye control with residual herbicides indaziflam and imazapic, and subsequent native species establishment through drill seeding. Applications were made in March 2014 and treatments included increasing levels of glyphosate tank mixed with indaziflam (44, 73, 102 g·ai·ha⁻¹) and imazapic (105 g·ai·ha⁻¹). Sites were then drill seeded with native species 9 MAT. Yearly visual control evaluations, IWAG biomass, and stand counts of the drilled species were collected. Glyphosate at 170 g·ae·ha⁻¹ provided the most consistent initial control of downy brome and feral rye. Plots treated with indaziflam at all 3 rates had significant native species establishment compared to the imazapic and control plots. Three YAT only treatments containing indaziflam at 44, 73 and 102 g·ai·ha⁻¹ had significant IWAG control (91.3% ± 7.2 - 99.5% ± 1) compared to the check. These results provide valuable information for land managers trying to restore rangeland and natural areas severely impacted by IWAG and establish native species.

USING TARGETED LIVESTOCK GRAZING TO STRATEGICALLY REDUCE FINE FUELS IN THE GREAT BASIN

. Mike Pellant*¹, Jeff Rose², Joe Tague³; ¹BLM (retired), Boise, ID, ²BLM, Bend, OR, ³BLM, Washington D.C., DC

ABSTRACT

Targeted grazing is broadly defined as using livestock time, intensity and duration of use to control vegetation to achieve a desired management goal. The Great Basin is experiencing unprecedented wildfires due in large part to invasive annual grasses (e.g., cheatgrass (*Bromus tectorum*)) which have increased fuel loads, created continuous fine fuel beds, and promoted longer fire seasons. The Bureau of Land Management is interested in working with partners and stakeholders to explore the feasibility of using livestock to strategically manage fuels across large areas dominated by invasive annual grasses as part of the Integrated Rangeland Fire Management Strategy. This strategy includes collaborative actions to implement targeted grazing programs and vegetation treatments to protect, conserve, and restore sagebrush steppe habitats across all ownerships and jurisdictions. An interagency team is pursuing the following activities to carry out this program: 1) Implementing well-monitored demonstration projects in conjunction with innovative livestock operators, 2) Developing a web-based “guidebook” to capture and continually update the science and user experiences of using targeted grazing to reduce fine fuels, 3) Distributing findings and facilitating information sharing through workshops, webinars and technical assistance. If successful, strategic targeted grazing will provide another option to reduce fine fuels and wildfire impacts on Great Basin rangelands.

TIMING OF GRAZING TO REDUCE CHEATGRASS FUELS.

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

ABSTRACT

The introduction and subsequent invasion of cheatgrass onto millions of acres of Great Basin rangelands has revolutionized secondary succession by providing a fine-textured early maturing fuel that has increased the chance, rate, spread and season of wildfires. With such vast acreages of landscapes being converted to cheatgrass dominance, resource managers and land owners are facing the daunting task of reducing wildfire risks caused by associated cheatgrass fuels. The grazing animal is the only real fuels management tool available on these vast landscape scales. We started a preliminary investigation of testing the ability of cattle to reduce fuel loads in northern Nevada. We hypothesized that spring grazing would reduce cheatgrass more than fall grazing, but that perennial grass species would experience a higher reduction rate than with fall grazing treatments. We tested a fall grazing treatment in 2014 and a spring grazing treatment in 2017 in which both grazing treatments significantly decreased cheatgrass fuel loads. Grazing from September 7 to 27-2014 reduced cheatgrass from 1,570 lbs/acre down to 138 lbs/acre, or 91.2% reduction. Grazing from May 6 to 26-2017 resulted in a cheatgrass fuels reduction of 95.8%, 1,674 lbs down to 71 lbs/acre. The 2014 fall grazing treatment resulted in a reduction of 8.6% in perennial grass density, 5.8 down to 5.3/m², whereas the 2017 spring grazing treatment recorded a reduction of 0.01%, 4.77 down to 4.7/m². The use of cattle to decrease cheatgrass fuel loads can be accomplished through this type of targeted grazing, if properly monitored, will not be detrimental to the existing perennial grass community.

MONITORING TARGETED GRAZING TO REDUCE INVASIVE PLANTS WITHIN RIPARIAN HABITAT

. Kristin E. Cooper*; Mendocino County Resource Conservation District, Ukiah, CA

ABSTRACT

North Coast Semaphore Grass (*Pleuropogon hooverianus*) is a threatened species in riparian areas embedded within California's north coast rangelands. *P. hooverianus* riparian habitat is commonly encroached upon by *Phalaris aquatica*, a highly competitive perennial forage grass. Targeted livestock grazing has been identified as a viable tool to enhance *P. hooverianus*. Efficacy depends upon matching the timing of grazing to the phenological development of the two species. Ideally, grazing should occur when *P. aquatica* is at optimal palatability. In 2016 and 2017 phenology of the two species was monitored throughout the spring growing season. In 2016 a pilot study was performed in a stand of *P. hooverianus* and *P. aquatica* to map timing of phenophases to inform targeted grazing decision-making, particularly the timing of *P. hooverianus* and *P. aquatica* reproductive phenophases relative to one another. The results of this research and the efficacy of resulting targeted grazing management on both species will be presented.

PLANT COMMUNITY RESPONSE FOLLOWING WILDFIRE AND HEAVY WINTER
GRAZING DISTURBANCE REGIMES. Lan Xu*¹, Jameson R. Brennan², Patricia S. Johnson²;
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ABSTRACT

Northern Great Plains (NGP) grasslands evolved under the influence of grazing and fire, resulting in a mosaic of habitats of low, mid, and high seral plant communities. Much of that heterogeneity has been lost due to fire suppression and contemporary grazing management for uniform use. Research demonstrates that patch-burn grazing (PBG) effectively increases heterogeneity on the landscape by creating a shifting mosaic of vegetation structure and plant communities. Many NGP landowners are averse to fire due to concerns of property and forage loss. Thus, winter patch grazing (WPG) is being studied as an alternative, non-pyric management strategy for creating heterogeneity, wherein patches within pastures are created with heavy grazing during the dormant season rather than burning. A wildfire in fall 2016 that burned several pastures at the SDSU Cottonwood Research Station, provided opportunity to compare the impacts of PBG and WPG on plant community composition and production. Three treatment areas were located within each of three pastures: a wildfire burned patch, WPG patch, and an untreated control area. Cattle grazed each pasture in summer 2017, with access to all areas of the pasture. Within each pasture and treatment, five exclosures were built to exclude cattle. Three 0.25m² plots were randomly placed in each exclosure for a total of 135 plots (45 per treatment). Cover by species, bare ground, and litter were ocularly estimated in mid June and late July 2017; biomass was estimated for each species during the July sampling period. Tiller density of western wheat grass and shortgrass species was also collected. Differences in plant community composition, cover, biomass production, and tiller density were analyzed to determine impacts of treatments. Results from this study will help inform land managers of potential outcomes following disturbance regimes, and provide valuable insights into plant community responses to management strategies alternative to fire.

GRAZING SYSTEMS AND NATIVE MIXTURES EFFECTS ON CATTLE AND FORAGE PRODUCTION IN SEMIARID WESTERN CANADA

. Alan D. Iwaasa*¹, Chen Gu², Ed Birkedal¹, Mengli Zhao²; ¹Agriculture and Agri-Food Canada, Swift Current, SK, ²Inner Mongolia Agricultural University, Hohhot, Peoples Republic

ABSTRACT

Production benefits for any grazing systems are affected by climatic conditions of the grasslands, forage species mixture and growth habits of the plants. Study objective was to evaluate the effects of native species mixtures [simple (six cool-season grasses and one legume) versus complex (eight cool-season, three warm-season grasses and one legume)] and grazing systems [continuous (CON) versus deferred rotational grazing (DRG)] on cattle performances [total live weight production (TLP), average daily gain (ADG) and pasture utilization (UTL)], pasture productions [available yield (AYD) and peak yield (CYD)] and qualities [NDF, ADF, CP and organic matter digestibility (OMD)]. A 12-yr (2005-2016) grazing experiment was carried out at Agriculture and Agri-Food Canada - Swift Current Research and Development Centre, Saskatchewan, Canada. Grazing systems by species mixtures interaction was not significant ($P > 0.05$). Higher TLP ($P = 0.02$) and ADG ($P = 0.04$) values were observed for complex versus simple and DRG versus CON, respectively. The TLP values were 55.5 ± 2.9 ha⁻¹ kg and 46.5 ± 2.6 kg ha⁻¹ for complex versus simple, respectively. The ADGs were 0.82 ± 0.04 kg d⁻¹ and 0.99 ± 0.04 kg d⁻¹ for DRG vs. CON, respectively. Deferred rotational grazing increased UTL ($P = 0.05$), all pasture productions ($P < 0.0001$) and ADF ($P < 0.0001$) versus CON but decreased ($P < 0.0001$) OMD due to higher ADF observed. Forage NDF was higher ($P < 0.05$) for complex versus simple and CP did not differ ($P > 0.05$) for both grazing systems and species mixtures. The DRG system allows forage species to set seeds, thus higher AYD, CYD and ADF compared to CON were expected. Warm season grasses present only in the complex seed mix would explain the higher NDF content level. No grazing system was the best and depending upon the animal and pasture productivity goals, either system could be considered.

HYDROLOGIC RESPONSE TO LIVESTOCK AND WILD HORSE GRAZING WITHIN LENTIC MEADOWS OF NORTHERN NEVADA

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ABSTRACT

Lentic systems scattered across Northern Nevada offer windows of opportunity for an ecosystem to make best use of its limiting resource: water. Compared to the surrounding landscape, these wet meadows have much higher plant productivity rates which capture sediment, reduce overland flow energy, and prevent excessive erosion. This productivity also attracts grazing animals. Large grazing species such as cattle and wild horses particularly prefer lentic and lotic riparian areas and will spend a disproportionate amount of their time within them. If over-used, a meadow loses the stabilizing plant community necessary to prevent erosion, causing a meadow to degrade. This study is working to quantify the hydrologic response to cattle versus wild horse use of 12 lentic meadow sites across Northern Nevada. Trail cameras set to 5-minute intervals give a clear picture of which species use a meadow and when. Camera data are combined with field surveys of vegetation species composition, stubble height measurements, and topographic survey data across meadow transects. We are using this data to detect how different grazing timing and duration between cattle and horses affects the community structure of stabilizing vegetation. We are then investigating the erosional response to stabilizing vegetation loss – particularly if lentic systems develop a thalweg, or channelized flow, that will increase shear stress and incision rates. This incision transports water quickly down-drainage, lowering water tables and shrinking meadow size. Meadow loss reduces important forage for grazing animals, threatens habitat for important conservation species such as the greater sage grouse, and reduces the hydrologic functionality of a drainage – making it more prone to destructive flows. It is therefore important to understand how these major grazing species affect Northern Nevada's lentic areas.

DOES GRAZING MANAGEMENT MATTER FOR SOIL CARBON SEQUESTRATION IN SHORTGRASS STEPPE?

. Justin D. Derner*¹, David Augustine², Douglas A. Frank³; ¹USDA-ARS, Cheyenne, WY, ²USDA-ARS, Fort Collins, CO, ³Syracuse University, Syracuse, NY

ABSTRACT

Considerable uncertainty remains regarding the potential of grazing management on semiarid rangelands to sequester soil carbon. Short-term (less than 1 decade) studies have determined that grazing management potentially influences fluxes of carbon, but such studies are strongly influenced by prevailing weather/climatic conditions, with carbon gains occurring during wet periods and losses during dry/drought conditions. A few decadal studies have evaluated influences of grazing management on changes in pools of soil carbon, but again these demonstrate interactions of grazing management and climate; in addition, these studies have limitations with quantifying the relatively small changes associated with grazing management relative to the inherently large soil carbon pool. To address this limitation, we sampled soils (0-20 cm) in 2011 from 26 long-term grazing exclosures and paired moderately grazed sites in the shortgrass steppe of northeastern Colorado. Exclosures were established in 1937 across a soil texture gradient. The use of ¹⁴C radiocarbon provided the opportunity to determine turnover of the stable C pool over a seven-decade period in the presence versus absence of grazing. The effects of long-term moderate grazing or removal from grazing did not interact with soil texture to influence total soil nitrogen, total soil carbon, soil organic carbon or turnover of the soil carbon. Soil texture did influence total soil nitrogen, total soil carbon and nitrogen, but not turnover of carbon. In contrast, grazing management did not influence any of the soil properties evaluated, even though grazing strongly influenced plant community composition and altered the relative abundance of C3 versus C4 grasses. These results provide evidence that long-term moderately grazed and ungrazed sites, though different in plant community characteristics, do not differ with respect to long-term soil carbon sequestration.

GRAZING MANAGEMENT IMPACTS ON WETLAND SOIL CARBON STORAGE ALONG THE NATIONAL HISTORIC TRAILS CORRIDOR IN WYOMING

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ABSTRACT

Wetlands are a valuable resource for water storage, sediment capture, biodiversity, habitat, and carbon (C) sequestration. Alterations to wetland functionality are often linked to land management decisions, such as grazing management. Potential changes in C storage and composition were quantified at study sites within the National Historic Trails Corridor in central Wyoming by measuring differences between historically grazed wet meadows and adjacent long-term grazing exclosures. Hummocks and interspaces were also compared to evaluate the micro-landscape. Initial results indicate that soil organic C (SOC) loss from interspaces has been significant at the center of each wetland. But, interspaces within exclosures appear to have recovered SOC. These results suggest that wetland functions and ecosystem services may be restored under reduced grazing pressure.

MANAGEMENT OF GRAZING IN BEAKED SEDGE (*CAREX UTRICULATA*)
COMMUNITIES IN NORTHEASTERN ARIZONA

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ABSTRACT

Beaked sedge (*Carex utriculata*) is a dominant species within montane riparian meadow communities in northern Arizona and is utilized by both livestock and wild ungulates throughout the growing season. Managing grazing in riparian areas containing beaked sedge as a component of critical habitat for the endangered New Mexico meadow jumping mouse is of increasing importance in the Southwestern Region. In order to determine potential best management grazing practices, we examined grazed and ungrazed stubble heights of beaked sedge from 2 riparian meadow pastures in northeastern Arizona between 2009 and 2017. Management practices employed to control intensity and timing of grazing included the use of portable electric fence and active herding of cattle. Adaptive management allowed flexible use periods based on growing season conditions and levels of use desired. Stubble height measurements were taken prior to, during, and following livestock grazing and throughout the growing season during years of complete rest. Average stubble heights ranged from 5 to 18 inches on grazed plants and 8 to 26 inches on ungrazed plants, depending upon season of use. The percent of plants grazed in all years was generally below 50%. Our data highlight 3 major findings: 1. It is important when, where and how sedge heights are measured in terms of meeting suggested guidelines for riparian vegetation; 2. Sedges grazed early to mid-growing season will significantly recover height by the end of the growing season; and 3. Wild ungulate use may impact meeting any stubble height guidelines in these riparian areas. If stubble heights are used to guide grazing management of riparian meadows, we recommend integrating adaptive management principles, such as flexible timing, into allotment management plans. Effective communication between the permittee and Forest Service range specialists is key to applying adaptive management practices to riparian grazing. We show that through successful working relationships established between the landowner and USFS, managed livestock grazing in riparian meadows can meet reasonable guidelines and maintain desired conditions for multiple resource objectives.

EFFECT OF SHEEP GRAZING ON *STIPA BREVIFLORA* REPRODUCTION IN THE DESERT STEPPE, CHINA. Chen Gu*¹, Mengli Zhao¹, Alan Iwaasa²; ¹Inner Mongolia Agricultural University, Hohhot, Peoples Republic, ²Swift Current Research and Development Centre, Swift Current, SK

ABSTRACT

Grazing by domestic livestock is the most common and economical use of grasslands. Plants adopt different reproduction tactics in response to herbivory disturbances under different grazing intensities. Grazing effects on reproduction of the dominant species (*Stipa breviflora*) in a desert steppe are still poorly understood. To evaluate effects of stocking rates on *S. breviflora* reproduction, a sheep grazing experiment was carried out in 2015 using a randomized complete block design, which was grazed from 2003 to 2017 under four stocking rates [0 (control, CK), 0.15 (light grazing, LG), 0.30 (moderate grazing, MG), and 0.45 (heavy grazing, HG) sheep unit hm⁻² month⁻¹] in the desert steppe of Inner Mongolia, China. Seed yield of *S. breviflora* was highest in LG (0.76 ± 0.09 g tussock⁻¹) (Mean \pm SE) while lowest in HG (0.20 ± 0.02 g tussock⁻¹) ($P < 0.0001$). A more pertinent explanation is the ratio of seed biomass ($28.85 \pm 1.80\%$ vs. $20.72 \pm 1.15\%$), reproductive branches ($28.55 \pm 1.87\%$ vs. 11.93 ± 0.94 count tussock⁻¹) and the ratio of reproductive branches ($89.98 \pm 2.07\%$ vs. $71.78 \pm 2.24\%$) were highest in LG and lowest in HG ($P < 0.0001$). Tillering was the primary asexual reproduction for *S. breviflora*, both tillers (57.97 ± 2.93 count tussock⁻¹) and clump diameter (5.19 ± 0.53 cm tussock⁻¹) of *S. breviflora* were increased by LG ($P < 0.05$). While the depth of tiller below the soil surface decreased as stocking rates increased ($P = 0.03$), this made tillers easier to come out from compacted soil trampled by sheep. Both sexual and asexual reproduction of *S. breviflora* were stimulated by LG while inhibited by increase stocking rates. Both MG and HG were detrimental to *S. breviflora* renovation and increased the risk of grassland degradation.

EFFECTS OF PATCH-BURN GRAZING ON AVIAN NEST SURVIVAL

. Cameron A. Duquette*, Torre J. Hovick, Ryan Limb, Devan A. McGranahan, Kevin Sedivec;
North Dakota State University, Fargo, ND

ABSTRACT

Traditional range management seeks to maintain even cattle distribution through constant grazing pressure and fire suppression. This homogenization of rangelands has caused concurrent declines in biodiversity and disturbance-dependent organisms. In contrast, patch-burn grazing relies on the interaction of fire and subsequent grazing selectivity to increase structural heterogeneity in grasslands. We are investigating the effects of patch-burn grazing on avian nest success at North Dakota State's Central Grasslands Research Extension Center in Kidder and Stutsman County, North Dakota. Experimental treatments consist of season long grazing, dormant season burns with a four-year fire return interval, and dormant season and growing season burns with a four-year fire return interval. We systematically surveyed sub-patches within treatment units for ground nesting birds using rope dragging. We monitored nests every 2-4 days until completion to assess success, clutch size, and parasitism rates. Following one season of data collection, we documented 380 nests consisting of 24 species, including 7 species of conservation priority. Results of this study will provide insight on the role of disturbance in maintaining biodiversity in grassland bird communities.

STUDYING GRAZING DISTRIBUTION OF BEEF CATTLE USING DNA TECHNOLOGY

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ABSTRACT

In beef cattle production systems, grazing distribution is an important aspect of rangeland management. Rangelands provide approximately 50 – 65% of the forage needed for domestic ruminants in the United States. As much as one third of the rangelands in the western United States are left ungrazed due to rugged terrain and long distances from water. By improving grazing uniformity, 30% more forage may be harvested from these rangelands. Although water developments, herding and other practices can be effective in improving grazing patterns, these approaches are laborious and often not cost effective. Previous research suggests that terrain-use indices used to quantify grazing distribution are genetically influenced at a level similar to weaning weight (20-35%); therefore, marker-assisted selection could improve grazing distribution. In an association study using GPS tracking data and Illumina HD genotypes, five candidate genes (*ACN9*, *FAM48A*, *GRM5*, *MAML3*, and *RUSC2*) have been associated with grazing distribution traits (slope, elevation, and distance to water) in cattle. The objective of this study was to further examine these genes and identify single nucleotide polymorphisms (SNP) that may be incorporated into a genotyping panel used for identifying genotype associations with terrain-use phenotypes measured by GPS tracking collars. A total of 124 tissue samples were collected from Brangus and Angus cattle from range research herds. Ribonucleic acid sequences were aligned to the annotated bovine reference genome. The analysis revealed 376 SNP located within the five candidate genes of which ten had three alleles segregating across breeds. These SNP will be incorporated into a DNA-based genotyping panel to examine associations with the terrain use phenotypic traits to derive information that is needed to develop genomic breeding values. This tool will allow producers to rank sires based on their likelihood to sire daughters that will use steep and rugged terrain and areas far from water.

Keywords: Cattle, grazing distribution, SNP, genetics

HEALING 140 MILES OF RIPARIAN AREA: THE SQUAW VALLEY SUCCESS STORY.
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ABSTRACT

The Squaw Valley Allotment, located in northeastern Elko County, Nevada, includes a mixture of both private and public lands administered by the Bureau of Land Management (BLM). Grazing management is controlled by the BLM even though most of the streams and riparian areas are located on private land. In general, the allotment's grazing terms and conditions have a March 15 to November 30 season of use and allow for up to 26,500 AUMs to be used. Over time, the allotment was converted from primarily a sheep to a cattle operation. The cattle have annually used more than 86% of the adjudicated AUMs for decades. Prior to 2004 the cattle grazed season long on the allotment. In 2004, a grazing goal was implemented to have more hot season rest than use on the riparian areas in a 10-year term. This grazing goal has not only been good for cattle but has enhanced Lahontan Cutthroat trout and beaver populations, as well as created late brood rearing habitat for sage grouse that is especially important during drought years.

COMPARING FUEL CHARACTERISTICS OF NATIVE AND INVASIVE GRASSES FOR RANGELAND FUEL BEDS

. Brittany N. Poling*, Devan A. McGranahan; North Dakota State University, Fargo, ND

ABSTRACT

Prescribed fire managers are encountering difficulties with the increase of cool-season non-native species in warm-season grasslands. Rothermel's fire spread equation treats all herbaceous fuels as a single fine fuel class, a valid assumption under extremely dry conditions for which the original fuel models were developed. Increased interest in growing season burns and altered plant community composition from invasive species introduces a novel degree of variability to the fine fuel component of grassland fuel beds, but differences in the flammability of various grass species is poorly understood. Flammability, a concept linked to how plant material burns, is measured inconsistently with multiple response variables reported (e.g. mass loss rate, % biomass consumed, rate of heat release, burning duration). Thus, there is no common framework for flammability in grasslands, which limits scalability to fire behavior at a landscape level. We ignited dried biomass of native and non-native grass species common to the Great Plains in the fume hood to produce two curves, (1) mass loss over time, recorded by a four-point balance and logged every 0.2 s, and (2) change in temperature over time, using a thermocouple datalogger with multiple sensors placed at various positions in and above the plant material. These curves and their slopes will assist in identifying differences in fuel in terms of components of flammability. Characterizing differences in fuel properties, such as flammability, provides insight into species-specific influences. These species-specific data can be scaled up to a landscape level by anticipating differences in fire behavior based on a relative abundance of species in the fuel bed.

IMPACT OF FIRE AND HEAVY WINTER GRAZING ON LIVESTOCK USE PATTERNS
. Jameson R. Brennan*¹, Jennifer L. Lutze², Patricia S. Johnson¹, Kenneth C. Olson¹; ¹South Dakota State University, Rapid City, SD, ²South Dakota State University, Brookings, SD

ABSTRACT

Northern Great Plains (NGP) grasslands evolved under the influence of grazing and fire, resulting in mosaics of habitats of low to high seral plant communities. Much of that heterogeneity has been lost due to fire suppression and contemporary grazing management for uniform use. Research demonstrates that patch-burn grazing (PBG) effectively increases heterogeneity on the landscape by creating a shifting mosaic of vegetation structure and plant communities. Many NGP landowners are averse to fire due to concerns of property and forage loss. Thus, winter patch grazing (WPG) is being studied as an alternative, non-pyric management strategy for creating heterogeneity. In WPG, intensive winter grazing by cows in patches reduces standing dead forage and vegetation structure, to mimicking the effects of fire. In October 2016, wildfire burned parts of 3 pastures in the WPG study at the Cottonwood Research Station. Thus, a study was conducted to compare effects of a wildfire burned patch (PBG), a WPG patch, and an untreated patch (Control) in each of the 3 pastures on livestock use patterns. Height of standing live and dead vegetation in spring 2017 was measured to assess the impact of each treatment on vegetation structure. NDVI values from satellite imagery were used to compare greenness of vegetation for each treatment. To assess livestock use patterns, a subset of steers within each pasture were outfitted with GPS collars that recorded a fix at one minute intervals during the summer 2017 grazing season. GPS data were used to calculate cattle preferences for each plant community in each pasture. Results show livestock have higher preference for PBG areas of each pasture followed by WPG, and then Control. Results from this study can help provide a framework for fire adverse land managers to use WPG as a surrogate for fire to create heterogeneity on the landscape.

THE PURPLE PLAGUE: EFFECTS OF GRAZING POST FIRE ON PURPLE THREEAWN COVER AND REPRODUCTIVE EFFORT

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

ABSTRACT

Purple threeawn (*Aristida purpurea* Nutt.) is a native warm season bunch grass that is quickly gaining attention in western Kansas on The Nature Conservancy's Smoky Valley Ranch. We see a decrease in grazing/clipping pressure on this bunch grass, upon maturity, 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 that cause negative impacts to the prairie ecosystem. Prairie dogs, a keystone species for this ecosystem, are being "choked" out by these near monocultures and searching for better quality habitat. The issue is, purple threeawn readily takes over prairie dog colonies due to the heavy disturbance. This directly affects many species on the ranch that rely on the prairie dogs for habitat and/or food including the Black-footed ferret (*Mustela nigripes*), North America's most endangered mammal. This study will aim to determine a large-scale management strategy using natural processes such as fire and grazing to decrease purple threeawn. Late summer burns have shown to be the most effective at reducing purple threeawn cover. This study will look at the effects of high intensity grazing by cattle, at season long and short duration as well as the effects of clipping by prairie dogs, post burn. Live crown density, number of reproductive stems of purple threeawn and species composition will be measured to detect any change. With an appropriate management plan, action can be taken against purple threeawn to increase forage quality and maximize cattle gains while creating better quality habitat for prairie dogs and all the organisms that rely on them.

DOES BURNING AND CLIPPING AFFECT SEED PRODUCTION OR SEED SIZE OF BLUEBUNCH WHEATGRASS OR SQUIRRELTAIL? Elsie Denton*, Roger L. Sheley; ARS, Burns, OR

ABSTRACT

Restoring rangelands damaged by invasive species and other degradation remains a major challenge for land managers. One means by which success could possibly be improved is by increasing the quality of seed used in restoration efforts. Burning of adult plants has been postulated to improve seed quality through maternal effects. To test this we selected 32 adult perennial grasses, half bluebunch wheatgrass (*Pseudoroegneria spicata*) and half squirreltail (*Elymus elymoides*). These were randomly assigned to four treatments: control, burned, clipped, and clipped and burned, with 4 replicates (n=32). The clipping treatment was included to determine if any effects from burning were specific to that treatment or part of a more general release from light limitation. We hypothesized that burning would increase seed production and quality; however that was not the case. Burning reduced seed production in both species by more than 50%. However, squirreltail increased seed production when clipped (716 seeds vs 240 seeds), while bluebunch wheatgrass decreased seed production when clipped vs not (5 seeds vs 47 seeds). This indicates that mowing could potentially be an effective strategy to boost seed production in commercial production of squirreltail seed but is not recommended in the case of bluebunch wheatgrass. Burning is not recommended in either case. Best strategies to enhance seed production in other species might vary and should be tested.

IMPACTS OF STRATEGIC GRAZING AND FIRE ON SOIL SEED BANK HETEROGENEITY IN MIXED-GRASS PRAIRIE

. Kassidy Weathers*¹, Lan Xu¹, Patricia S. Johnson²; ¹South Dakota State University, Brookings, SD, ²South Dakota State University, Rapid City, SD

ABSTRACT

Native plant communities in the Northern Great Plains evolved under periodic fire and substantial grazing pressure from native herbivores. Fire and grazing are two important drivers for maintaining structural and compositional heterogeneity of North American grassland ecosystems. Contemporary grassland management practices have focused on maximizing livestock production through fire suppression and uniform use of plant communities, resulting in decreased vegetation heterogeneity with corresponding reductions in species richness, wildlife habitat, and biodiversity. The objectives of this study are to evaluate and compare impacts of patch-burn grazing (PBG) and winter-patch grazing (WPG) management on soil seed bank compositional heterogeneity in terms of species richness, abundance, and diversity. A wildfire occurred at the SDSU Cottonwood Research Station at 16 October 2016. Following the wildfire, five grazing exclosures were erected on each treatment (PBG, WPG, and CG (untreated area)) within each of three pastures on clayey ecological sites. Two soil cores (10-cm dia x 10-cm depth) were extracted at random locations within each exclosure one-year post-fire and pooled into one composite sample, resulting in 45 total soil samples (3 pastures X 3 treatments X 5 exclosures). Each composite soil sample was spread onto a plastic tray (25-cm by 25-cm by 6-cm) and placed in a greenhouse (23±3°C) with 16hr/8hr light/dark photoperiod. Trays were misted daily. The direct germination method was used to determine the germinable seed composition in the soil. Emergence of seedlings was recorded and identified every other day for 28 days, then weekly for 2 months. Species richness, density, and diversity of seed bank under different treatments were determined. The information generated from this study will increase our understanding of soil seed banks in response to disturbance regimes and potential vegetation restoration. It will also inform science-based alternative management strategies for heterogeneity in northern Great Plains.

IMPACTS SEASON OF PRESCRIBED FIRE AND FIRE FREQUENCY HAS ON A KENTUCKY BLUEGRASS INVADDED PLANT COMMUNITY IN THE NORTHERN TALLGRASS PRAIRIE REGION.

. Haley M. Johnson*, Ryan Limb; North Dakota State University, Fargo, ND

ABSTRACT

Non-native invasive plant species have led to changes in plant community composition by displacing native species, ultimately decreasing species richness and diversity. Kentucky bluegrass (*Poa Pratensis*), a non-native grass, has invaded a majority of rangelands within the Northern Great Plains. Prescribed fire can potentially reduce Kentucky bluegrass and increase native grass and forb richness and diversity in the tallgrass prairie. Our objectives were to investigate the effects of burn season and frequency on Kentucky bluegrass and native plant community composition. We conducted this study in a non-grazed pasture within the tallgrass prairie of the Sheyenne National Grasslands in southeastern North Dakota, USA. To assess effects of burn season on plant community composition and Kentucky bluegrass suppression, we burned 3 ha plots at mid-growing season and dormant season, and a non-burned control with six replicates. To assess the effect of burning frequency on plant community composition and Kentucky bluegrass suppression, three mid-growing season plots were burned a second time the following year. Prior to the initial burn, species composition, abundance, litter and bare ground were recorded within 30 random 1 m² frames within each replicate using a modified Daubenmire cover-class method. Post-fire composition and abundance were recorded at mid-summer for three growing seasons. Standing biomass was collected within each replicate using 12 randomly distributed quarter meter frames clipped to ground level and oven dried to constant weight. We used nonmetric multidimensional scaling to compare plant community composition of treatments. Kentucky bluegrass was strongly correlated with fall and non-burned treatments, while native grasses were correlated to summer burns. Restoring fire to native prairie appears to be a viable option to reduce exotic species while promoting natives.

COMPARISON OF PINE AND OAK TRANSPIRATION ACROSS BURN SEVERITIES IN THE LOST PINES REGION OF TEXAS

. Caitlyn E. Cooper*¹, Luiza M. Aparecido², James P. Muir³, Cristine L. Morgan², James L. Heilman², Georgianne W. Moore²; ¹Texas A&M AgriLife Research - Vernon, Vernon, TX, ²Texas A&M University, College Station, TX, ³Texas A&M AgriLife Research - Stephenville, Stephenville, TX

ABSTRACT

Changes to species diversity, spatial distribution, and shifts to younger, actively growing vegetation following wildfires may modify stand transpiration and the amount of water available to other parts of the hydrologic cycle. Therefore, the objective of this study was to determine how burn severity affected transpiration through alterations in stand structure and age in mixed pine/oak stands following a wildfire in the Lost Pines eco-region (Bastrop, TX, USA). Transpiration was monitored in loblolly pine (*Pinus taeda*)/ oak (*Quercus stellata*, *Q. marilandica*) stands across three burn severities: an unburned, mature stand; a moderately burned mature site; and a severely burned stand (pine saplings and oak resprouts). From May – October 2016, pines had 31% and 39% greater sap flux rates (*J*s) than oaks at the unburned and moderately burned stands, respectively. Pines at the severely burned site started the period with greater *J*s than the resprouts, but *J*s decreased as shallow soil moisture was depleted. As a result, young pines had ~9% less *J*s than the resprouting oaks across the measurement period. Pine transpiration made up 75% and 86% of unburned and moderate stand daily transpiration, respectively. Alternatively, resprouting oaks dominated the severely burned stand, contributing over 95% of daily transpiration. Transpiration was greatest at the moderately burned stand (2.08 mm day⁻¹), followed by the unburned stand (1.48 mm day⁻¹), and the severely burned stand (0.46 mm day⁻¹). Although resprouts and saplings exhibited greater *J*s than mature trees, reductions in total sapwood area after the severe fire resulted in lower daily transpiration at the stand level. Results suggest light to moderate burns may enhance transpiration through reductions in competition and increased irradiance, while severe fires reduce stand transpiration through reductions in vegetation density. Oaks will likely dominate some severely burned stands post-fire and consequently affect the hydrological cycle through changes in transpiration.

EFFECTS OF MOB GRAZING ON BERMUDAGRASS REMOVAL AND NATIVE GRASSLAND RESTORATION

. Julia R. Shipman*¹, James P. Muir²; ¹Tarleton State University, Stephenville, TX, ²Texas A&M AgriLife Research - Stephenville, Stephenville, TX

ABSTRACT

Converting bermudagrass pastures into native species prairies with high diversity is a multi-stage process, more complicated than it appears. Limiting factors include cost, timing, seed and equipment availability, climate, soils and management. Some common management practices for species suppression include prescribed burning and herbicides, but these generally are ineffective in facilitating native plant establishment. Bermudagrass has many adaptations that resist suppression: fast growing, dense and resilient, which are desirable to landowners and ranchers when purposely planted for grazing, but create problems when converting pastures to diverse native grasslands. Because bermudagrass is so aggressive it easily out-competes native species, especially during the first few years when native seedlings are most vulnerable.

Our project in northcentral Texas compares bermudagrass suppression methods, seedbed preparation, native seed mixes, and mowing vs. mob grazing to determine which are most effective combinations to convert bermudagrass fields into diverse native grasslands, mimicking prairies once widely present in Texas. Our trial is in two locations to represent two different ecoregions: Stephenville, TX, Cross Timbers ecoregion and McGregor, TX, Blackland prairie. We measured seedling emergence and ground cover at 80 and 160 days following planting. In mob grazing post-seeding to facilitate native seedling establishment vis-à-vis weeds, we recorded canopy cover and plant height pre- and post-grazing. Our main objective is to suppress invasive bermudagrass and other weeds while increasing biodiversity through native grasses, and forbs which will provide habitat and food sources to native wildlife, specifically ground-dwelling birds such as bobwhite quail.

LESSONS LEARNED LOOKING BACK AT 25 YEAR OLD RECLAMATION PROJECTS
IN THE INTERMOUNTAIN WEST. Ed S. Kleiner*; Comstock Seed, Gardnerville, NV

ABSTRACT

Lessons learned from restoration projects that we observe over time are numerous. A few that rank at the top include:

- 1) Promises made about the future success of new restoration projects can be short sighted and lead to false expectations.
 - 2) We can only set up conditions that improve the chances of long term success acknowledging that external influences will affect our projects both positive and negative. Success is a moving target with many definitions to different people at different times.
- This poster shows several projects that provide teaching moments.

IMPROVING SEEDING SUCCESS IN THE SAGEBRUSH STEPPE WITH SEED PRIMING AND DEEP FURROW PLANTINGS

. Rhett M. Anderson*, Benjamin Hoose, Janae Radke, Matthew D. Madsen; Brigham Young University, Provo, UT

ABSTRACT

In the western United States, direct seeding is a common practice that attempts to restore native plant communities and ecological function back into the ecosystem. However, many invasive annual weed species such as *Bromus tectorum* have a faster germination time than commonly seeded native species, which appears to give them an advantage in dealing with harsh temperature and soil moisture environments. We evaluated the ability of seed priming and microsite manipulation through deep furrowing to improve seedling establishment in a Wyoming big sagebrush ecological site near Vernon Utah. Within a randomized block split-plot design, *Pseudoroegneria spicata* and *Linum lewisii* seed was either left untreated, pelleted, or primed and pelleted. Seeds were planted in the spring (March), at either a 5 mm depth below the soil surface or at the same depth in the bottom of a 120 mm deep furrow. Both priming and deep furrowing increased seedling density for both species with the combination of the two treatments producing the highest treatment response. For example, in the first month after planting, primed seed of *L. lewisii* and *P. spicata* in deep furrows had 303-128% more seedlings, respectively, than untreated seed not planted in deep furrows. By the end of the growing season differences between these two treatments declined to 151-94% more seedlings, respectively. These results indicate that rapid germination of primed seeds and the use of deep furrows to improve plant microsite conditions may assist seedlings in establishing earlier in the growing season and better compete with invasive species.

USE OF FLASH FLAMING TECHNOLOGY TO IMPROVE SEED HANDLING AND DELIVERY OF WINTERFAT SEEDS

. Mitch Thacker*¹, Todd E. Erickson², David Tryon¹, Soren Larson¹, Matthew D. Madsen¹;
¹Brigham Young University, Provo, UT, ²Project Manager, Restoration Seedbank Initiative, Perth, Australia

ABSTRACT

Ecological restoration of rangelands using wild-collected seeds can be challenging for land managers in many parts of the world. Difficulties due to low seed quality, inconvenient seed anatomy, and poor seed establishment are some of the major factors contributing to restoration failure. In rangelands of North America, the half-shrub winterfat (*Krascheninnikovia lanata* (Pursh) A. Meeuse & Smit) is a valuable protein-rich forage for wildlife and livestock, particularly during the fall and winter period. Seeds are contained in one-seeded fruits enclosed in four silky bracts. While the seeds can be removed from the bracts through cleaning it is not recommended; the bracts are thought to help protect the radicle region of the seed and aid in seed germination and early seedling growth. However, fluffy bracts of winterfat make it difficult to incorporate the seed at any significant level within a seed mix because it can prevent the seed from flowing from mechanized seeders. Additionally, fluffy bracts limit the ability of seed pretreatments to be applied, such as a seed coating. Our goal was to evaluate a recently developed seed cleaning technique on winterfat that uses “flash flaming” to remove seed appendages. We demonstrate how flash flaming can be used to improve the geometry of the seed without impacting seed germination. Cleaning winterfat seeds through “flash flaming” allows the seeds to be distributed through a broadcast seeder and improves the quality and integrity of a polymer seed coating. Future work is now merited for evaluating how flash flaming winterfat seeds influence seed germination and plant survival in field conditions. If shown to be successful, flash flaming could prove to be a new technology that allows the planting of winterfat seeds on degraded rangelands.

USE OF PHOSPHORUS FERTILIZER AS A SEED COATING TO ENHANCE SEEDLING GROWTH OF BLUEBUNCH WHEATGRASS

. Morgan E. Parkinson*, Matthew Madsen, Bryan G. Hopkins, Neil C. Hansen; Brigham Young University, Provo, UT

ABSTRACT

Applying fertilizers at the time of planting may improve native plant establishment by increasing the ability of the seedlings to cope with environmental stresses. However, traditional fertilizer applications are often economically infeasible and may be counterproductive by encouraging weed invasion. Seed coating technology allows for the efficient application of fertilizers within the microsite of the seeded species. The objective of this study was to evaluate the efficacy of fertilizer as a seed coating treatment to improve seedling emergence and plant growth, and to determine the optimal rate of fertilizer to apply to the seed. We chose to use a phosphorus rich and nitrogen poor fertilizer (9-30-1) to promote root growth over shoot growth. Fertilizer was applied to bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) Á. Löve) seeds in a rotary coater at rates of 0, 0.5, 1, 2, 4, 8, 16, and 32 g of fertilizer 100 g⁻¹ of seed. Seeds were planted in 13 x 13 cm acrylic boxes filled with fine sand. Seedling emergence was counted every couple days. At the conclusion of the study (90 days from sowing) seedlings were harvested and biomass of the roots and shoots were recorded. Results show an increase in biomass produced from seeds coated with 0.5, 1, 2, and 4 g of fertilizer 100 g⁻¹ of seed and a decrease in biomass as rates exceeded 16 g of fertilizer 100 g⁻¹ of seed. These preliminary results indicate that a fertilizer seed coating can be effective in improving seedling growth of bluebunch wheatgrass, which may improve seeding success in nutrient poor rangeland soils. Future work is merited for evaluating fertilizer seed coatings in the field.

EFFICACY OF ABSCISIC ACID IN REDUCING SEEDING FAILURE BY DELAYING GERMINATION OF *PSEUDOROGENIA SPICATA*. Travis G. Sowards*, Matthew D. Madsen, Bruce A. Roundy, Sam St Clair; Brigham Young University, Provo, UT

ABSTRACT

The Great Basin covers approximately 49.2 million hectares and spans from the Columbia Plateau to the Mohave Desert and from Wasatch Mountains to the Sierra Nevadas. Within this region the invasive annual grass *Bromus tectorum* has caused a shift in the fire-regime, resulting in reduced burn intervals. Post-fire restoration efforts have focused on establishing native perennial grasses, forbs, and shrubs to increase competition and reduce *B. tectorum* population. *Pseudorogenia spicata* (bluebunch wheatgrass) is a drought tolerant steppe system bunch-grass frequently used in restoration projects; however, fall seeding events have a reported germination occurrence of 80% within sub-optimal winter conditions. Winter germination timing leads to greater pathogen susceptibility, premature exhaustion of seed resources (carbohydrates), drought stress and predation, thereby increasing seeding failure. The plant hormone abscisic acid is reported to prolong seed dormancy and has the potential to mitigate seeding failure due to sub-optimal germination timing.

I propose a study to determine the efficacy of seeds enhanced with ABA across the Great Basin. Five study sites will be selected from the eastern (Rush Valley & Santaquin, UT), central (two in Great Basin National Park), and northern (Steen Mountain, OR) districts of the Great Basin. Cultivars of *P. spicata* will be coated with varying levels of ABA and planted in randomized blocks at each site. Germination bags will be randomized across the blocks and retrieved monthly for non-structural carbon, ABA levels, and germination and viability assessments. I hypothesize that cultivars of *P. spicata*, augmented with ABA, will exhibit prolonged dormancy traits similar to the natural after-ripening and dormancy of local seed, enhancing seedling establishment and survival.

LABORATORY EVALUATION OF ABSCISIC ACID AND GIBBERELIC ACID SEED COATINGS TO IMPROVE GERMINATION TIMING OF WYOMING BIG SAGEBRUSH

. Chelsea E. Keefer*¹, Ryan Call¹, Sam St Clair¹, Bruce A. Roundy¹, Tamzen Stringham², Matthew Madsen¹; ¹Brigham Young University, Provo, UT, ²University of Nevada Reno, Reno, NV

ABSTRACT

Impacts to sagebrush habitat are threatening the survival of hundreds of sagebrush obligate and associated species and decreasing rangeland ecosystem goods and services. Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis*) is a dominant shrub on the more arid portions of the sagebrush biome. Efforts to reestablish this species through seeding has been met with limited success. In general, germination timing can have a strong influence on the ability of a plant to establish. Altering the timing of germination for Wyoming big sagebrush may improve the establishment of this species. Seed germination timing can be adjusted by altering the planting date. Seed enhancement technologies also offer a novel approach to controlling germination timing. The plant hormone abscisic acid (ABA) can be applied to seeds to delay germination. Conversely, the plant hormone gibberellic acid (GA) can be used to accelerate germination. The objective of our research was to understand how planting date and application of ABA and GA treatments influence germination timing of Wyoming big sagebrush. Seed was either left untreated, treated separately with 5 concentrations of ABA and treated with 5 concentrations of GA. Hydrothermal germination models were developed for each seed treatment and applied to field soil moisture and temperature data to predict germination timing. Simulated planting dates were tested at monthly intervals from October – April on 8 different years at 6 different Wyoming big sagebrush sites. Results indicate that planting date, ABA, and GA concentrations can have a strong influence on seed germination timing. Depending on the planting date, and coating application rate, simulations show that ABA or GA could alter germination timing to occur in windows that appear to have more favorable temperature and moisture conditions for plant establishment.

INFLUENCE OF SMOKE ON SEED GERMINATION IN THE SOUTHERN HIGH PLAINS
. Yvonne Jimison*, Robert D. Cox; Texas Tech University, Lubbock, TX

ABSTRACT

Although smoke has been known to influence germination of species from many Mediterranean-climate ecosystems, little is known about how species in the Southern High Plains of Texas respond to smoke. We tested four native plant species (sideoats grama, *Bouteloua curtipendula* “El Reno”; blue grama, *Bouteloua gracilis* “Hachita”; plains coreopsis, *Coreopsis tinctoria* “Plains”; and Illinois bundleflower, *Desmanthus illinoensis*) using aerial smoke and heat from in-situ prescribed fire as an application method for in-situ germination responses. We also tested the same species, and honey mesquite (*Prosopis glandulosa*), using varying concentrations of liquid smoke for ex-situ germination responses in a lab setting. Aerial smoke neither inhibited nor increased germination of some species, but liquid smoke had inhibitory effects at specific concentrations on all species. Using this knowledge of the inhibitory effects may allow for targeted use as a pre-treatment application of some species in rangeland management methods. Additional testing of even more species may increase our knowledge of germination responses of smoke applications, providing greater flexibility for managing rangelands in this region.

IMMATURE SEEDLING FATE AND GROWTH DYNAMICS OF THE NATIVE GRASS,
ELYMUS ELYMOIDES

. Jesse R. Morris*, Steven L. Petersen, Matthew Madsen, Brock R. McMillan; Brigham Young University, Provo, UT

ABSTRACT

Elymus elymoides and other native perennial grasses are commonly used species for rangeland revegetation in the Great Basin. In areas with low precipitation the establishment of native species has been marginal, and the germination and seedling stages have been identified as “bottlenecks” to plant establishment. Though the effects of failure to germinate or emerge from the soil are well documented, the fate of seedlings in the first few months of life is not well documented. In this paired plot study, we use time-lapse photography combined with motion-triggered photography to track seedlings from time of emergence from the soil to death. We document growth rates, and timing and cause of death for seedlings. To determine the relative effects of herbivory and seed predation we exclude small mammals and larger herbivores in half the plots, and compare total survival between plots. Results will be presented at the meetings.

SEASONALITY OF PRECIPITATION AFFECTS BUNCHGRASS SEEDLING
SENESCENCE IN POST-FIRE SAGEBRUSH RANGELANDS. Quinn R. Campbell*¹, Jeffrey
M. Gicklhorn¹, Beth A. Newingham²; ¹University of Nevada, Reno, Reno, NV, ²USDA-ARS,
Reno, NV

ABSTRACT

Soil water availability is a major limiting factor for plant growth in arid ecosystems, which presents challenges for arid ecosystem restoration. Native perennial bunchgrasses are often seeded after wildfire in the Great Basin to prevent the spread of invasive species and minimize soil erosion; however, seeding failure is often attributed to lack of suitable winter precipitation. Seedling emergence and establishment depend on adequate winter precipitation; survival through the growing-season may depend on infrequent, growing-season events that delay soil water deficit and subsequent plant senescence. We investigated how growing-season rainfall events affected soil moisture and possible effects on bunchgrass seedling senescence. We used soil moisture probes to record hourly soil moisture data at two sites (northwestern Nevada and southeastern Oregon) during the second and third year after wildfire. We used soil moisture data to quantify the magnitude of increase in soil moisture and duration of delay in soil-water deficit. Seedling senescence and growing-season precipitation events were measured using regular field surveys and high-precision rain gauges, respectively. The Nevada site experienced average spring precipitation but above-average summer precipitation both years; the Oregon site experienced average rainfall in year two but above-average spring and below average summer precipitation in year three. Across both sites and both years, soil moisture increased at a greater magnitude in response to later growing-season events as compared to earlier season events with similar amounts of precipitation. Summer precipitation events in Nevada had a strong effect on soil moisture and delayed soil moisture deficit until later in the season than in Oregon. The delay in soil moisture deficit corresponded with a delay in seedling tiller senescence, where bunchgrass tillers at Nevada senesced later than those in Oregon in both years. Our results suggest that variation in growing-season precipitation may play an important role in determining seeding treatment effectiveness.

NO TIME FOR SUCCESSION: MAKING DESERT OUT OF ABANDONED AGRICULTURE.
Ron A. Tucker*; Los Angeles Department of Water and Power, Bishop, CA

ABSTRACT

Large-scale dryland reclamation is arguably one of the most difficult undertakings in restoration ecology. This assertion compounds when restoration goals are established using socio-political deadlines with little to no consideration of edaphic development or biotic successional requirements. Soil development and natural establishment of plant communities in undisturbed deserts is increasingly slow with late seral communities evolving over centuries. Restoration goals in highly disturbed sites are often unrealistically set in the decadal time scale. In 2003, restoration goals for 253 acres of abandoned agricultural lands in Laws California were developed including species, foliar cover, composition, and uniform distribution requirements. All goals were to be completed by 2013. Even after considerable capital investments and labor during the first five years progress was insufficient to attain goals within the specified time period. The challenges associated with dryland restoration had proven to be extreme and numerous including high temperatures, limited moisture, low fertility and highly disturbed soils. From 2003 to present inexpensive broadcast and dryland drill seeding methods transitioned to more costly above ground driplines and direct seeding methods, to ultimately a more involved and expensive method utilizing hundreds of miles of below ground drip lines and thousands of containerized plants. Also during this time soil stability and microbial studies were conducted, various methods to control wind erosion and rodent herbivory were developed and duration and timing of irrigation water was refined. Synergy of these improvements occurred in 2009 with the addition of two fully automated climate controlled greenhouses allowing for an aggressive twice annual outplanting of up to 36,000 containerized plants. Although great strides were made during those last four years, goals were ultimately not met in 2013. To date 233 of 253 acres have been fully planted with healthy maturing plants. New restoration goals are currently being developed.

ROLE OF SOILSCAPES IN RESTORING PASTURE AND CROPLAND IN GUANACASTE PROVINCE, COSTA RICA. Kevin Hesson*¹, Ron Reuter²; ¹Oregon State University, Corvallis, OR, ²Oregon State University, Bend, OR

ABSTRACT

Conversion of native forests to cattle pasture and coffee plantations in the Guanacaste Province of Costa Rica has resulted in reduced habitat and fragmentation of vital avian and mammalian migration corridors. Efforts to restore forest corridors have seen mixed success. Soils have largely been absent from the conversation of restoration in the region. The purpose of this study is to determine the influence of soilscales on forest re-establishment. Three land use types were examined: pasture/cropland with low seedling survivorship, high seedling survivorship, and intact forest. After preliminary soil exploration, representative soil pits were excavated and sampled for basic soil characterization parameters: horizons, texture, pH, NPK, % C, color, roots, resistivity, and structure. For each site, a set of sample points were probed, designed to encompass soilscale variability. At each sample point, depth to Bt or clay-restrictive horizon and thickness and color of the A horizon were recorded. Correlations between sample pits and probe data were constructed. Probe data were geospatially analyzed to determine expected conditions in intact forests and soilscale variables most associated with seedling success or failure. Depth to clay and organic carbon content best indicate seedling success. Geospatial analysis also revealed a relationship between slope and thickness of the A horizon, which impacts the organic carbon content present at each site. Improving local knowledge of terrain-soil relationships can help local communities and conservation groups prioritize areas for restoration efforts, improving success and effectiveness.

SMALL MAMMALIAN HERBIVORES INHIBIT GRASS ESTABLISHMENT IN AN ARID SHRUBLAND. Samuel Abercrombie¹, Jeffrey S. Fehmi*¹, John L. Koprowski¹, Mary H. Nichols²; ¹University of Arizona, Tucson, AZ, ²USDA-ARS, Tucson, AZ

ABSTRACT

Shrub encroachment in southwestern grasslands has negatively impacted ranching, soil conservation, and grassland dependent species. Past research suggested that a complex interaction between grazing, altered fire regimes, and changing climates maintained shrublands once they established. Understanding the ecological interactions that maintain shrub dominance is critical for grassland restoration efforts to be successful. To assess the impact of native herbivores on grass reestablishment in an arid shrubland, we established an herbivore enclosure experiment on a 10.92 ha parcel on the USDA-ARS Walnut Gulch Experimental Watershed near Tombstone, Arizona. Cattle were removed from the site over 50 years ago, yet the intershrub areas remain devoid of an herbaceous layer. We hypothesized that at this site, herbivory pressure of native mammals is significant enough to suppress the reestablishment of an herbaceous strata, which provides a positive feedback for the continued displacement of grasslands by native shrubs. We constructed herbivore exclosures with 5 treatment levels which corresponded to herbivory pressure among size classes of mammalian herbivores. The levels were: small (e.g. kangaroo rats [*Dipodomys merriami*]), medium (e.g. desert cottontails [*Sylvilagus audubonii*]), and large (e.g. mule deer [*Odocoileus hemionus*]). Two control levels (total access and total enclosure) were included as well. We used a two-way repeated measures ANOVA with trial date and enclosure type as our factors, and found a significant difference in grass utilization among enclosure types ($F(4,45)=14.38$, $p<0.001$). A Tukey's post-hoc analysis indicated that utilization was significantly higher in exclosures that allowed access to small and medium sized mammals, relative to our control ($p<0.001$). This pattern disappeared following the monsoon rains ($p=0.96$), suggesting that forage demand shifts significantly depending on season. Our results suggest that herbivory pressure from small and medium sized herbivores may impede the reestablishment of grasslands in an arid shrubland.

THE GREAT BASIN CHAPTER OF THE SOCIETY FOR ECOLOGICAL RESTORATION.
Great Basin Society for Ecological Restoration*; Society for Ecological Restoration, Reno, NV

ABSTRACT

Founded in 2011, The SER Great Basin Chapter is dedicated to fostering collaboration and knowledge exchange among practitioners, researchers, students, policy makers and the general public to promote the science and application of restoration ecology. The Chapter promotes the importance of ecological restoration in the community to improve stewardship of Great Basin ecosystems. Chapter activities include The Right Seed in the Right Place at the Right Time webinar series and collaborative field tours, workshops and meetings. New programs of the Society for Ecological Restoration include a biennial North American conference for restoration ecologists and a program for professional certification for qualified practitioners.

RESTORATION AND SUPPRESSION AS TOOLS FOR THWARTING ACCELERATED WILDFIRE IN THE GREAT BASIN. Mark A. Ricca*¹, Peter S. Coates², David S. Pilliod³, Cali L. Roth¹, Brian G. Prochazka¹, Michael Chenaille¹; ¹USGS-Western Ecological Research Center, Dixon, CA, ²USGS Western Ecological Research Center, Dixon, CA, ³US Geological Survey, Boise, ID

ABSTRACT

Larger and more frequent wildfires are a primary threat to sagebrush ecosystems and populations of Greater sage-grouse in the Great Basin. The threat is exacerbated by the invasion of annual grasses that drive an accelerated grass-fire cycle, which hinder recovery of fire-intolerant and slow-growing sagebrush. Moreover, recent research has quantified how increasing rates of cumulative (rather than instantaneous) area burned have long-term negative impacts on sage-grouse annual rates of population change. If these rates of cumulative area burned continue unabated, projections indicate that populations of sage-grouse in the Great Basin will be reduced to 43% of their current numbers over the next 3 decades.

Managers have two broad sets of tools available for slowing the loss of sagebrush and reduced persistence probability of sage-grouse in face of wildfire threats: post-wildfire restoration and wildfire suppression. To help identify how much effort from each tool is required to slow or nullify the cumulative effects of fire, we describe preliminary results of retrospective and prospective simulation analyses that model effects of: 1) increased suppression while accounting for current rates and restoration (i.e., seeding and seedling application); and 2) increasing restoration while accounting for current rates of suppression. These simulations account for factors influencing ecosystem resilience to disturbance and resistance to invasion (R&R), sagebrush return rates influenced by R&R, biophysical setting, and restoration type, and (eventually) juxtaposition of fuel breaks and assumed future annual grass control. Model output highlight that restoration and suppression activities are not mutually exclusive of one another, but also point out that the current rate of cumulative area burned in the Great Basin may outpace the rate at the which sage-grouse populations can respond positively as sagebrush recovers. This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science.

RANCHING, RECREATION & RESILIENCE: A CROSS-SCALE AND MIXED METHODS VULNERABILITY ASSESSMENT. Corrie N. Knapp*¹, Shannon McNeeley², Trevor Even², Julia Nave¹, John Gioia¹, Tyler Beeton², Bruce Rittenhouse³; ¹Western State Colorado University, Gunnison, CO, ²Colorado State University, Fort Collins, CO, ³Bureau of Land Management, Denver, CO

ABSTRACT

The Bureau of Land Management (BLM) is tasked to manage their landscapes for multiple use. In the Western United States, where many counties are predominately comprised of public lands, the use of these lands is critical to local economies. Changes in land management in response to climate change could have sizable impacts on rural economies across the West, however vulnerability assessments typically focus only on ecological systems. This project uses a cross-scale and mixed-methods approach to understand social vulnerability of land-based livelihoods, predominately ranching and recreation businesses that depend on BLM lands, through a spatial indicators approach, two local case studies, and a grey literature review. A review of BLM planning documents showed relatively minor incorporation of climate change into current planning documents, and even less consideration of how BLM responses to climate change could impact permittees. Our spatial indicators approach provided a statewide view of baseline vulnerabilities, relative dependence on BLM lands, and different types of dependencies across the state. Two case studies, comprised of interviews and document review, assisted to deepen this broad assessment and contextualize it. The resulting information suggests common permittee desires including greater flexibility, timelier range improvements, and better access to scientific information. By layering these analyses, we are able to get a more complete picture of how the BLM is currently integrating climate change into planning, which areas of Colorado are most dependent on BLM lands (and for which activities) and how decision-making in the context of climate change might impact BLM permittees.

COORDINATING A NATIONAL RANGELAND MONITORING TRAINING PROGRAM: SUCCESSES AND LESSONS LEARNED. Baili M. Foster*¹, Sarah McCord², Emily Kachergis³; ¹Bureau of Land Management, Lakewood, CO, ²USDA-ARS Jornada Experimental Range, Las Cruces, NM, ³BLM, Denver, CO

ABSTRACT

One of the best ways to ensure quality of information gathered in a rangeland monitoring program is through a strong and uniform set of trainings. Curriculum development and delivery of monitoring trainings poses unique challenges that are not seen in academic settings. Participants come from a range of educational and experience backgrounds. Additionally, participants may only have the period of the training to receive the necessary instruction before fully implementing the protocol as part of their job duties. Consequently, careful consideration for content delivery and hands on learning activities is critical for active learning. We present the lessons learned from the Bureau of Land Management's Assessment Inventory and Monitoring (AIM) training program with the partnership of USDA-ARS Jornada Experimental Range. The successes and lessons were developed from web-based and in-person trainings targeting BLM staff, seasonal staff, non-profit organizations, and academic partners for topics relating to data collection, analysis, database use and more. Consideration was given to the identification and education of both the target audience and the potential non-target audiences while taking into account the unique needs of adult learners. The AIM program has formatted training curriculum that addresses the needs of spatial, auditory, linguistic and kinesthetic learners. Challenges that impact training quality such as inconsistency in staff availability, a seasonal workforce, timing of data needs, phenology, and funding were also factored into the development of the training program. The importance of forming a training cadre and what factors should be assessed in this process has been an additional consideration. The final portion of the process was to review the most effective methods for assessing success. The training program of AIM is continually evolving, building on the success and lessons learned of the past to provide high quality information for rangeland management

SITUATION ASSESSMENTS: BRIDGING THEORY AND PRACTICE IN CONFLICT RESOLUTION AND COLLABORATIVE PROBLEM SOLVING. Laura Van Riper*; Bureau of Land Management - National Riparian Service Team, Prineville, OR

ABSTRACT

Some of the most controversial and politicized debates in the United States today concern the appropriate management of natural resources. Many of these issues are characterized by high levels of scientific and regulatory complexity, limited information for understanding the issues, and diverse and often competing values. Furthermore, they are interdependent problems that cannot be solved in relative isolation from one another; and they have a range of alternative solutions, each with different implications for people and resources. Some scholars refer to these issues as ‘wicked problems,’ and stress the need for ongoing dialogue and deliberation between scientific/regulatory experts and stakeholders in successful resolution.

Over time, the use of conflict resolution and consensus-based facilitation to foster collaborative problem-solving has become more common place in the natural resource arena. These types of approaches are grounded in the belief that if you bring the right people together, in constructive ways and with good information, they will develop reciprocal understanding, shared knowledge and mutual trust/accord and ultimately produce better decisions (more informed, effective, sustainable and accepted).

Organizing and launching a collaborative process can be a daunting task, especially when there are many parties involved. The person convening the process must first determine what possibilities exist to handle the issue in a collaborative manner. This requires conveners know who the parties are, understand their perspectives, gauge whether they are willing to ‘come to the table,’ and design a process that best meets the situation at hand. The likelihood of implementing a successful collaborative process largely depends on these early decisions.

EXPLAINING DIFFERENT LAND USE TRAJECTORIES IN THE CHIHUAHUA-NEW MEXICO BORDERLANDS. Tracy Hruska*; University of California, Berkeley, Berkeley, CA

ABSTRACT

Conversion of rangeland to housing and irrigated crops continues to be a concern in the Southwest. This study was devoted to understanding dramatic differences in land use/land cover in the US-Mexico border region along northwestern Chihuahua and the Bootheel of New Mexico. While southwestern New Mexico has remained overwhelmingly devoted to raising cattle on native range, northwestern Chihuahua has undergone steady conversion of range to irrigated crops over the last several decades. Given that the two sides of the border share the same ecology – that of mixed Chihuahuan Desert grasslands and shrublands, why has land use varied so dramatically in recent decades? This question was answered primarily through extensive interviews with residents of Janos municipality, Chihuahua, and Hidalgo County, New Mexico. Land conversion in Janos has been driven by the conjuncture of three quite separate factors: a national land reform that fractured large ranches into smaller ones intermixed with newly-created agrarian communities; an influx of ethnolinguistically distinct farmers – Mennonites – with a strong cultural value for farming; and a system of groundwater regulation that does little to regulate groundwater. With none of these factors present in Hidalgo County, the region also retains relatively low land values and a strong cultural value for ranching. The future of Janos now depends on the (largely unknown) profundity of its isolated aquifer, while the Bootheel will be shaped by other factors.

ARAB SPRING EFFECT ON LAND USE/COVER CHANGE OF JORDANIAN LANDS
. Mohammed N. Sawalhah*, Salman D. Al-Kofahi; Assistant Professor, Zarqa, Jordan

ABSTRACT

The influence of population growth and refugees settlements on land use change in Jordan has been assessed by using Geographic Information System and ENVI-supervised classification technique. Eleven Landsat 8 OLI Images (cloud free) were used to classify the whole Jordanian area. Maximum likelihood classification was applied to estimate rangeland, vegetation, urban, water and forest percentages for the period (2013-2015). After that, Landsat images were used also to classify the two major Municipalities lands in Jordan (Amman and Irbid) into urban, agricultural and undeveloped lands to investigate the spatial and temporal urban expansion on the agricultural lands for the period 2003-2015. During the first study, change detection technique was performed on both 2013 and 2015 images. Change detection analysis using remotely-sensed data revealed a marked expansion of urban area and a reduction in rangeland percentage especially, in north-western Jordan. Across the study period (2013-2015), Jordanian rangelands percentage decreased by 10.4%, forests by 0.4% and water by 0.5%. Meanwhile, urban area increased by 10.8% and agricultural lands by 0.5%. During the second study; across the study period (2003-2015), agricultural lands decreased by 13% and 10% and urban area increased by 16% and 12% in Amman and Irbid respectively. We attributed this change mainly to refugees settlement rather than to normal population growth rate. This settlement process increased the demand for food and water and accelerated the desertification process in Jordanian rangelands, especially those in the north-western part. Overall, We suggest initiating rigorous urban settlement and land conservation control programs to mitigate land degradation in Jordanian rangelands and agricultural lands.

HUMAN DIMENSIONS OF THE SPOTTED HYENA IN ETHIOPIA . D. Layne Coppock*¹, Julie K. Young¹, Gidey Yirga², Marcus Baynes-Rock³; ¹Utah State University, Logan, UT, ²Mekelle University, Mekelle, Ethiopia, ³University of Notre Dame, South Bend, IN

ABSTRACT

The spotted hyena (*Crocuta crocuta*) is the second-largest mammalian carnivore in sub-Saharan Africa. This species has historically played an important role as scavenger and predator in wildland ecosystems, but as native habitats and prey have disappeared alongside steady encroachment of humanity, hyenas have adapted to a variety of human-dominated settings to find suitable den sites and food resources. This includes shifts to preying on livestock and livestock carrion in pastoral areas and rummaging in refuse of growing cities and towns. Ethiopia is an excellent example of this dynamic. And in some extreme cases where hyenas and people have shared resources for long periods of time, there is evidence from the literature that the hyena-human interaction can develop into a form of mutualism. As part of a pilot assessment of hyena-human interactions in Ethiopia, we wanted to gain insights into hyena-human linkages concerning household economics, culture, and health. We held focus groups and key informant interviews that incorporated feedback from 170 citizens residing in three distinct parts of the country: Mekelle, Harar, and Arba Minch. Participants represented a wide array of religious, economic, and educational backgrounds and lived as urbanites or rural dwellers. Results suggest that the hyena-human dynamic is highly variable across these locations. While all participants recognized the importance of hyenas as scavengers to maintain a clean environment, there was pronounced variation in cultural perspectives—for example, while the people of Harar revere hyenas in spiritual terms, in Arba Minch they are regarded as nuisance animals. While hyenas are universally respected as a formidable predator, reports of livestock depredation and attacks on humans were few. This is despite that in Harar and Mekelle hyenas and humans co-occur at high densities and frequently encounter each other. We conclude by exploring the implications of these findings for hyena management in Ethiopia.

SOCIAL AND LEGAL OBSTACLES TO PRESCRIBED FIRE USE ON PRIVATE LAND IN SOUTHERN GREAT PLAINS. J. Kelly Hoffman*¹, Thomas McDaniel¹, Lars Coleman¹, R. Patrick Bixler², Morgan Russell³, Urs P. Kreuter¹; ¹Texas A&M University, College Station, TX, ²University of Texas, Austin, TX, ³Texas A&M Agrilife Extension, San Angelo, TX

ABSTRACT

Grasslands and savannas in tropical and subtropical regions around the world are most commonly fire driven ecosystems. Prescribed fire is a powerful management tool for maintaining the integrity of rangelands and, depending on its intensity, is capable of shifting rangeland plant communities. Despite the extensive history of prescribed fire use in the southern Great Plains of Texas and Oklahoma, this practice continues to face numerous social and legal obstacles to more widespread implementation on private land.

Past research into social obstacles points to a general reluctance by nonpractitioners to begin using fire due to the perception that deliberately igniting fire is inherently unsafe. Others cite limited expertise and capacity as obstacles, specifically a lack of resources and personnel. Some also point to a perceived lack of 'ideal' burn days throughout the year to execute multi-fire management plans. Legal obstacles identified by past research frequently cite perceived excessive liability associated with the use of fire on private land in the event of an escaped fire.

Our research seeks to understand the extent to which these barriers as well as of other obstacles not yet noted in the literature inhibit more widespread use of prescribed fire in the southern Great Plains. Preliminary findings indicate the influence of legal issues such as perceived liability vary greatly between geographic areas, while social issues such as capacity, expertise, and perceived ideal burn days are cited by a broad cross-section of practitioners and nonpractitioners alike. Additionally, there seems to exist a lack of consensus as to what constitutes a legal burn during periods of high wildfire threat and county- or state-wide burn bans.

LITIGATION BETWEEN WESTERN WATERSHEDS PROJECT AND FEDERAL LAND MANAGEMENT AGENCIES

. Beth Burritt*; Utah State University, Logan, UT

ABSTRACT

Lawsuits initiated by environmental groups that oppose grazing on public lands can be problematic for federal agencies. Information on lawsuits between federal land management agencies (Bureau of Land Management (BLM), Forest Service and Fish and Wildlife Service) and environmental groups is usually found only in law review, court documents and popular articles. This study summarized 15 years of litigation between the environmental group, Western Watersheds Project (WWP) and federal land management agencies. The results show that the number of appeals brought by WWP against federal agencies has not increased in recent years. In general, the BLM prevailed over WWP in most disputes heard in administrative court. Most of the court cases brought by WWP in Federal District Court concerned either management of specific grazing allotments or the Endangered Species Act (ESA). In 44% of district court cases, the agency prevailed or the case was dismissed, 30% were settled, in 10% of cases the decision was mixed, and in 16% WWP prevailed. WWP collected about 5.7 million dollars in attorney's fees and court costs. Fees were paid by the ESA's citizen suit provision or by the Equal Access to Justice Act (EAJA). EAJA fees are paid from the agencies' budget. Usually, permittees did not lose their grazing rights nor were their grazing rights directly affected as a result of litigation unless their livestock operation was located in Idaho.

LONG-TERM VEGETATION, HYDROLOGY, AND EROSION RESPONSES TO TREE REMOVAL BY PRESCRIBED FIRE, CUTTING, AND MASTICATION IN SAGEBRUSH STEPPE.

. Christopher J. Williams*¹, Frederick B. Pierson², Sayjro K. Nouwakpo³, Osama Al-Hamdan⁴, Patrick R. Kormos⁵, Mark A. Weltz⁶, Samantha Vega⁷; ¹USDA - Agricultural Research Service, Tucson, AZ, ²USDA - Agricultural Research Service, Boise, ID, ³University of Nevada - Reno, Reno, NV, ⁴Texas A&M University, College Station, TX, ⁵USDA-Agricultural Research Service, Boise, ID, ⁶USDA ARS, Reno, NV, ⁷University of Idaho, Moscow, ID

ABSTRACT

Land managers across the western US are faced with selecting and applying effective tree-removal treatments on sagebrush rangelands, but current understanding regarding long-term ecohydrologic responses to tree removal remains inadequate. This study used vegetation measures, rainfall simulations, and overland flow experiments to evaluate the impact of prescribed fire, tree cutting, and shredding tree-removal treatments on vegetation and hydrology and erosion processes at two sites 9 yr after tree removal. All treatments were effective at recruiting sagebrush steppe vegetation, but burning also increased cheatgrass cover in isolated patches around burned trees. High rates of runoff and erosion were reduced by tree removal treatments at one site, but were minimally altered at a second more degraded site. Collectively, the study demonstrates that prescribed fire and mechanical tree-removal treatments can effectively re-establish sagebrush steppe vegetation attributes and improve hydrologic function, but also show that hydrologic recovery can require more than 9 yr on more degraded sites as vegetation increases over time.

ECOYDROLOGIC CONNECTIONS IN WESTERN JUNIPER SYSTEMS. Carlos G. Ochoa*¹, Phil Caruso¹, Tim Deboodt², Grace Ray³; ¹Oregon State University, Corvallis, OR, ²Oregon State University, Prineville, OR, ³Turner Enterprises, Inc., Bozeman, MT

ABSTRACT

Objectives of this study conducted in a western juniper (*Juniperus occidentalis*) dominated system of central Oregon were to: (1) evaluate tree canopy cover effects on effective precipitation and soil moisture recharge; and (2) assess surface water and groundwater connections in treated (juniper removed) and untreated watersheds. Detailed measurements of precipitation, tree canopy cover, and soil moisture were used to evaluate juniper interception and seasonal soil moisture fluctuations. Ephemeral stream runoff, springflow, and groundwater level data were used to characterize transient hydrologic connections within and out of the two watersheds. Results show that tree canopy cover was 29% at a watershed bottom location and 26% at an upstream hillslope location. On average, canopy interception was 44% at the bottom location and 36% at the hillslope location. In general, lower soil moisture values were obtained in the under-canopy locations when compared to the inter-canopy.

Study findings indicate there are seasonal upland-valley hydrologic connections driven by a combination of winter precipitation and local geology that favors transient groundwater storage in the shallow aquifer. For the four-year period evaluated (2014-2017), greater groundwater level values were observed in all monitoring locations during the last two years where greater snowpack levels were measured. Snowpack and runoff relationships that were evaluated for years 2016 and 2017 show there were greater springflow levels in the treated watershed when compared to the untreated. An upward positive trend in springflow rates has been observed in the treated watershed following juniper removal in 2005. The untreated watershed has shown a flat trend response over the last 12 years.

Results from this study contribute to improved natural resources management through a better understanding of the hydrologic connections occurring in rangeland ecosystems and the role that Western juniper encroachment may have on altering the hydrology of the site.

THE FATE OF SALT AFFECTED RANGELAND SOILS AND SURFACE WATER QUALITY USING RAINFALL SIMULATION. Awadis Arslan*¹, Sayjro K. Nouwakpo², Mark A. Weltz³, Colleen Green⁴, Kenneth McGwire⁵; ¹University of Nevada, Reno, Reno, NV, ²University of Nevada - Reno, Reno, NV, ³USDA ARS, Reno, NV, ⁴Bureau of Land Management, Denver, CO, ⁵Desert Research Institute, Reno, NV

ABSTRACT

Runoff on saline range soils is associated with transport of salts dissolved from the soil to the lowlands and surface waters causing water quality deterioration. In an attempt to quantify the amounts of salts leaving the soil profile, rainfall simulation experiments were conducted on saline sodic soils in the Upper Colorado River Basin. Four rainfall intensities on plots 2 m wide by 6 m long under dry soil moisture conditions was applied over a range of canopy cover and slopes in order to determine the effect of canopy cover and slope on the amount of salts transported with runoff. Three replications of each rainfall intensity was applied for a total of 12 plots. A plot was only evaluated under a specific rainfall intensity to avoid confounding effects of associated with multiple rainfall events and trying to associate salt movement into and through the soil profile from applied rainfall events. In this study, total salt balance was partitioned between that on the soil exchange sites and the soluble fraction in the saturated extract of surface soils. Salts were also quantified in the dissolved fraction in the runoff to calculate a total salt balance for the site. Canopy cover, slope and other experimental conditions influenced the salt partitioning processes via hydrology, erosion and soil property interactions. Results from this study will improve existing model such as Rangeland Hydrology and Erosion Model (RHEM) and others for predicting the possible deterioration of surface water quality as a result of rainfall on saline soils and suggest management practices of such soils in order to reduce their negative effect on surface water.

PROCESS-BASED MODELING OF UPLAND EROSION AND SALT LOAD IN THE UPPER COLORADO RIVER BASIN. Sayjro K. Nouwakpo*¹, Mark A. Weltz², Colleen Green³, Kenneth McGwire⁴, Awadis Arslan⁵; ¹University of Nevada - Reno, Reno, NV, ²USDA ARS, Reno, NV, ³Bureau of Land Management, Denver, CO, ⁴Desert Research Institute, Reno, NV, ⁵University of Nevada, Reno, Reno, NV

ABSTRACT

The Colorado River is a vital resource in the United States and Mexico but is susceptible to detrimental salinity levels with salinity-related damages estimated at \$385 million per year. Over 55% of sediment and salts entering the Colorado River is of natural origin with a significant contribution from accelerated soil erosion on federal rangelands. This suggests a significant potential to reduce dissolved-solids loading to the Colorado River through land and water-management activities on rangelands. In this study, we aim to develop parameter estimation equations that are valid on saline rangeland sites for use in the Rangeland Hydrology and Erosion Model (RHEM). Data from rainfall simulation experiments were used to develop these predictive equations. Along with traditional soil erosion measurement data, information on soil salinity and sodicity represented by Electrical Conductivity EC and Sodium Adsorption Ratio (SAR) were included in the parameter estimation equations to improve runoff and erosion modeling in salt-affected conditions. Runoff and soil loss prediction performances were assessed with the Nash-Sutcliffe Efficiency (NSE), the coefficient of determination (R²) and the percent bias (PBIAS). These new developments will provide a physically-based modeling scheme to land managers for predicting rainfall-driven soil and salt load to surface waters of the Upper Colorado River Basin.

SPATIAL ASSESSMENT OF SALINE SOIL EROSION CONTRIBUTION TO UPPER COLORADO RIVER WATERSHED SALT LOAD. Travis W. Nauman*, Christopher Ely, Michael C. Duniway; US Geological Survey, Moab, UT

ABSTRACT

The Colorado River (COR) watershed includes a variety of areas with saline geologic and soil materials. International concerns over the salt load of the river began when salinity levels in COR water flowing into Mexico peaked in the 1960s. This sparked ongoing debate and various efforts at salinity abatement ensued by a variety of stakeholders. We looked at potential salinity sources due to eroding soils in the COR watershed above Lake Mead. New predictive soil mapping techniques along with remotely sensed landcover metrics were used to estimate erosion in areas with saline soils at a field scale (30m grid). Initial results show salinity hotspots near Vernal and Price, UT, Delta, CO and areas near Lake Mead, NV. The Unit Stream Power Erosion and Deposition model (USPED) was employed to estimate modern soil erosion rates to overlay onto salinity maps. Erosion models suggest the more rugged areas on the margins of these saline areas could be significant sources of salinity into COR. Surprisingly, initial results also suggest some higher mountain basins as a potentially significant salinity source. These mapping results will be validated with field assessments and by spatio-temporal comparison to different electrical conductivity measurements made on river locations in the basin. Project goals include a potential salt contribution map prioritized by a hydrological distance from surface waters within the basin. These maps and analysis are being made to aid land managers in targeting restoration and determining sound policies for land use while helping deliver high quality water down to lower COR water users.

MANAGEMENT AND VEGETATION COMMUNITY IMPACTS ON RAINFALL
EFFECTIVENESS ON THE 77 RANCH, BLOOMING GROVE, TEXAS

. William E. Fox*; Texas A&M AgriLife Research, Temple, TX

ABSTRACT

Land management and vegetation community have significant impacts on the effectiveness of precipitation. We have monitored rainfall/runoff on three small watersheds in the Blackland Prairie region of Texas for the past 5 years. Each watershed represents a different vegetation community: 1) blackland soils with tall grass species community, 2) blackland soils with mid-grass species community and 3) blackland soils with mesquite/grass species community. In addition to measuring rainfall/runoff, each site also has been monitored over the last two years for soil moisture and soil temperatures. The main objectives of the program are to 1) assess the impacts of vegetation community on water resources, 2) assess the impacts of variable precipitation events on infiltration and runoff and 3) assess the impacts of variable precipitation events on soil moisture and soil temperature. We have found that over the 5 years of the program, vegetation communities have had some minor shifts, but have remained relatively stable. Rainfall events from 2015-1016 have changed somewhat compared to previous years. Soil moisture tracks relatively well between depths over the long-term; however, there are some "event" dynamics that show different responses based on vegetation community. Our goal is to further develop an understanding of the relationship of vegetation community to "rainfall effectiveness" under a working lands management program.

KENTUCKY BLUEGRASS EFFECTS ON WATER INFILTRATION AND RUNOFF ON A LOAMY NORTHERN GREAT PLAINS RANGELAND. David Toledo*¹, Sayjro K. Nouwakpo², Mark A. Weltz³; ¹USDA-ARS, Bismarck, ND, ²University of Nevada - Reno, Reno, NV, ³USDA ARS, Reno, NV

ABSTRACT

According to National Resources Inventory data, Kentucky bluegrass is now present in over 85% of the areas sampled in the northern Great Plains of the USA. This non-native, perennial, cool season grass has the potential to develop a dense thatch layer and root mat near the soil surface affecting how water infiltrates and runs off of a site. We used rainfall simulators and the water droplet infiltration time test to determine whether the presence of a Kentucky bluegrass root mat, thatch, and litter layers affected water infiltration and therefore hydrologic function of these Kentucky bluegrass dominated ecosystems. Rainfall simulation results show time to runoff is primarily controlled by rainfall intensity. As intensity increased from 63.5 mm/hr to 127 mm/hr, time to runoff was shortened. Hydrophobicity test results show that when dry, Kentucky bluegrass litter is very hydrophobic and is significantly more hydrophobic than thatch, root mat or mineral soils. However, hydrophobicity of bluegrass litter is significantly reduced after it has been wetted. Results also show how strata with the highest percent of organic matter (dead Kentucky bluegrass blades) were also the most hydrophobic. Results highlight the need for further research on Kentucky bluegrass effects on infiltration and runoff and the importance of management strategies that minimize excessive accumulation of Kentucky bluegrass litter.

PRELIMINARY ASSESSMENT OF GRAZING MANAGEMENT INTERVENTIONS ON VEGETATION AND SOIL SURFACE FEATURES IN NORTHERN NAMIBIA

. D. Layne Coppock*¹, Luke Crowley², Susan Durham¹, Dylan Groves², Julian Jamison², Dean Karlan³, Brien Norton¹, Doug Ramsey¹, Andrew Tredennick¹; ¹Utah State University, Logan, UT, ²Innovations for Poverty Action, New Haven, CT, ³Northwestern University, Chicago, IL

ABSTRACT

Grazing management interventions that improve rangeland condition and trend are often elusive in lands governed by common-property regimes. In 2010-14, GOPA—a consulting firm—was contracted by the Millennium Challenge Account (Namibia) to implement cattle grazing-management interventions based on holistic management principles under the auspices of the Community Based Rangeland and Livestock Management (CBRLM) project. Project beneficiaries are agro-pastoral and pastoral people residing in 123 Grazing Areas (GAs) occurring along an 800-km, east-to-west transect near the Angolan border. Producers here have traditionally relied upon “low input” grazing and herding practices that have reportedly contributed to rangeland degradation. The interventions implemented by GOPA were intended to slow or reverse rangeland degradation and improve dry-season fodder reserves via adoption of short-duration, “higher-input” grazing and herding practices. GOPA targeted fifty-two GAs for inputs in support of new grazing systems, while 71 GAs have served as controls. Some of the 52 GAs, however, did not fully accept the program. From 2015 to the present, effects of the intervention package on management behaviors, cattle productivity, and household wealth and resilience have been assessed by researchers affiliated with a US-based NGO called Innovations for Poverty Action (IPA), and will not be addressed here. IPA recruited ecologists in 2016 to assess the effects of grazing intervention on the rangeland environment, with a focus on vegetation and soil surface features. Our field data collection has occurred within 972 1-hectare plots, using 1 to 10 plots per GA. Data collection has included cover and line-intercept measurements in wet and dry seasons. Analysis of precipitation records and remotely sensed images provide context for the field studies by identifying possible long-term drought cycles and regional trends for woody encroachment and water-point development. Here we provide a preliminary analysis concerning the ecological effects of the grazing management interventions across a diverse landscape.

EVOLUTIONARY HISTORY OF HERBIVORY IN PATAGONIAN STEPPE: ALIGNING PRESENT GRAZING WITH PALEOHERBIVORY. Fidel Hernandez*¹, Carlos Ríos², Humberto P. Baldivieso³; ¹Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ²University of Magallanes, Punta Arenas, Chile, ³Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

Herbivory exerts a profound influence on ecosystem function and physiognomy. How a plant community responds to grazing by domestic herbivores is to a large degree dependent on its evolutionary history of herbivory. Plants evolving in communities with a long evolutionary history generally possess adaptations that make them resilient to grazing, whereas plants evolving in communities without such history often do not. The evolutionary history of herbivory therefore can serve as an indicator of a system's resiliency to grazing. However, determining a system's evolutionary history of herbivory is problematic because quantitative measures are needed of native herbivores over an evolutionary time period, as is knowledge of plant origin and evolution. Paleoecology provides a useful framework for assessing the co-evolution of plants and herbivores. The Patagonian steppe of South America is a biotic province with an evolutionary history of herbivory whose resilience to grazing is uncertain. Herbivory on the steppe transitioned from a diverse assemblage of megaherbivores during much of the Tertiary to an impoverished community consisting of a single, large herbivore—the guanaco (*Lama guanicoe*)—from the late Pleistocene extinction onward. Here we present a paleoecological approach to reconstruct the evolutionary history of herbivory in Patagonian steppe and examine the role of megaherbivores and guanaco in shaping its vegetation. We discuss how present management is misaligned with the steppe's evolutionary history of herbivory and offer suggestions for steppe conservation under contemporary land use.

UPLAND AND RIPARAIN COVER UNDER STRATEGIC GRAZING, CONTINUOUS STOCKING AND MULTI-YEAR REST. Rick Danvir*¹, Gregg E. Simonds², Eric D. Sant³, Eric T. Thacker⁴, Randy Larsen⁵, Anthony J. Svejcar⁶, Doug Ramsey⁴, Fred Provenza⁴, Chad Boyd⁷; ¹Western Landowners Alliance, Casper, WY, ²Open Range Consulting, Park City, UT, ³Open Range Consulting, Preston, ID, ⁴Utah State University, Logan, UT, ⁵Brigham Young University, Provo, UT, ⁶Oregon State University, Burns, OR, ⁷USDA - ARS, Burns, OR

ABSTRACT

Despite the complex nature of biophysical systems, ranchers need ways to assess ecological progress, and grazing management practices must be science-based to be broadly accepted. We used innovative remote sensing technology in this case study to quantitatively assess whether four New Mexico mid-grass prairie ranches using Strategic Grazing Management (SGM) and rotational grazing, had less upland bare ground and more riparian vegetation than neighboring lands which did not use SGM. Neighboring lands were managed with continuous stocking (CS) or multi-year rest. A combination of Ground-Based Vertical Photographs, Pleiades 0.5m2 and Landsat satellite imagery were used to develop continuous cover maps of each ranch and compare upland and riparian cover on paired polygons of ecologically similar sites along ranch boundaries. Bare ground averaged significantly less (13% less; $p < 0.001$) on SGM ranches than on adjacent paired sites (using pooled data from all four ranches). On Ranch 3 alone, bare ground was significantly lower than adjacent CS pastures (27% lower, $p < 0.001$) and lower than adjacent pastures rested > 3 years (20% lower; $p = 0.072$). Riparian vegetation averaged 19% greater on SGM stream reaches than on paired CS reaches ($p < 0.002$) since ranches began using SGM (1984-2015). However, precipitation-driven changes in percent riparian vegetation on both SGM and CS pastures in the thirty-year time-series caused cover values to fluctuate significantly, and to converge at high and low precipitation extremes.

PLANT COMMUNITY DYNAMICS IN THE SHORTGRASS STEPPE 24 YEARS AFTER REVERSAL OF A GRAZING EXCLOSURE EXPERIMENT

. Hailey Wilmer*¹, David Augustine², Daniel G. Milchunas³; ¹USDA-Northern Plains Climate Hub, Fort Collins, CO, ²USDA-ARS, Fort Collins, CO, ³Colorado State University, Fort Collins, CO

ABSTRACT

State-and-Transition Models are important decision-support tools for rangeland managers that suggest directional effects of both long-term grazing imposition and relaxation on plant community composition. However, most studies of the effects of grazing on semiarid rangelands evaluate only one direction of management: response to rest or relaxation of grazing pressure. Here, we study the long-term effects of the imposition and relaxation of cattle grazing on the composition of vegetative community composition on shortgrass steppe. In 1993 we reversed a long-term grazing exclosure study. We opened half of grazing exclosures established in 1939 to moderately stocked, continuous season-long grazing. We built new exclosures in pastures that had been similarly grazed since 1939. In late July of each year we sampled percent cover of all plant species over three dry-wet cycles through 2017. Introduction of grazing into previously ungrazed communities caused them to converge with long-term grazed communities within a decade. Conversely, the abundance of cool-season mid-grasses, and specifically western wheat grass (*P. smithii*) increased in new exclosures, and converged with long-term exclosures within a decade. Differences between grazed and ungrazed communities increased with successive wet periods through 2016 and declined during dry periods. These findings have direct implications for the revision of State-and-Transition Models using empirical data.

RUBRIC FOR DISENTANGLING ADAPTIVE MANAGEMENT THEORY AND PRACTICE
IN RANGELAND MANAGEMENT. Natalya C. Robbins Sherman*, Aaron M. Lien, Laura
López-Hoffman, George Ruyle; University of Arizona, Tucson, AZ

ABSTRACT

Adaptive management (AM) theory is a popular management and conservation tool favored by many land managers and scientists. Its influence is widely observed in the policies and goals of many federal land management agencies. Rangeland management in the west is no exception. AM has been proposed for use in grazing management because it recognizes that rangelands are not static. AM allows land managers to respond to unexpected environmental stressors, such as drought, by adjusting the intensity, season, or duration of grazing. Despite its widespread adoption in policy, implementing AM on the ground has proven to be a difficult task. We hypothesize that some of this difficulty stems from a misunderstanding of what practices are consistent with AM and because of an under-emphasis on the different approaches to AM, ranging from **passive** (informed by best practices; includes monitoring, reflection and incorporating learning into management) to **active** (focused on learning and hypothesis testing; emphasizes formulation and testing of hypotheses, and incorporates knowledge and experiences from a wide range of stakeholders; embraces interdisciplinarity and complexity). This research presents a thorough review of AM implementation on rangelands in theory and practice. Through this review, we have compiled all available literature on AM practices used in rangeland management, evaluated the characteristics of typical AM approaches, and proposed an *adaptive management rubric* for use in assessing the presence or absence and qualities of AM in management documents. This review and AM rubric can be used in determining the degree to which AM is being implemented in rangeland management and other natural resources management settings and contributes to efforts to evaluate the efficiency and efficacy of institutionally mandated AM policies.

THE EFFECTS OF SUPPLEMENTATION STRATEGY AND DORMANT SEASON GRAZING ON CATTLE USE OF MIXED-GRASS PRAIRIE HABITATS. Samuel A. Wyffels*¹, Lance B. McNew¹, Janice G. Bowman¹, Mark K. Petersen²; ¹Montana State University, Bozeman, MT, ²USDA-ARS Fort Keogh, Miles City, MT

ABSTRACT

In Montana, economic efficiency of cattle production is threatened by high feed and input costs. Dormant season livestock grazing reduces reliance on harvested feeds, but typically requires protein supplementation to be successful during periods of low forage quality. Providing supplements to grazing beef cattle during times of low forage quality may improve animal performance and vegetation utilization across the landscape. However, information relating supplementation strategies to individual grazing behavior and resource utilization on dormant forage is lacking. Thus, the intent of this research is to examine cattle resource utilization and residual cover and biomass removal of vegetation on rangelands grazed during the dormant season under two supplementation management strategies. Approximately 100 weaned composite heifer calves were randomly selected and placed into one of two supplementation treatments in each of 2 years (50 heifers/treatment/year); one receiving a free access 62% crude protein self-fed mineral/protein concentrate, and the other receiving a daily hand-fed 20% crude protein cake fed in bulk. Grazing for both treatments occurred simultaneously beginning in December (2015 & 2016) and continued through March (2016 & 2017). Thirty transects were randomly located within each pasture for measuring vegetation composition, production and quality, canopy cover and visual obstruction pre- and post-grazing. Grazing locations were recorded for twenty-one randomly selected individuals within each treatment with Lotek GPS collars containing head position sensors that record daily space use as well as timing and location of grazing activities at 5 minute intervals. Data sets were used to quantify space use as a continuous, probabilistic variable and related to the habitat covariates using generalized linear models to assess cattle resource utilization. Our research addresses comprehensive agro-ecosystem responses of dormant season cattle grazing and protein supplementation while providing multidimensional insight to stakeholders concerning grazing behavior and the ecological impacts of late season use on Montana rangelands.

FORAGE QUALITY AND INTAKE RATES OF LIVESTOCK GRAZING PASTURES OCCUPIED BY PRAIRIE DOGS

. Jameson R. Brennan*¹, Kenneth C. Olson¹, Janna J. Kincheloe², Patricia S. Johnson¹; ¹South Dakota State University, Rapid City, SD, ²North Dakota State University, Hettinger, ND

ABSTRACT

Prairie dogs have long been seen as being in competition with cattle. Prairie dogs can reduce the carrying capacity on rangelands by up to 50% through direct consumption of vegetation and by clipping plants to improve predator detection. Studies have shown that forage quality and digestibility are greater on prairie dog towns than off-town, however research is lacking that quantifies rates of forage and nutrition intake by cattle. In 2012-2016, we conducted a study in northcentral South Dakota to evaluate livestock grazing behavior, forage quality, and rate of intake on three plant communities in pastures occupied by prairie dogs. Plant communities studied were grass-dominated on-town sites, forb-dominated on-town sites, and grass dominated off-town sites. Three pastures with varying levels of prairie dog occupation (0%, 19%, and 40%) were studied. Remote sensing was used to identify plant communities in each pasture. Each pasture was grazed by a separate herd of yearling steers, a random subset of which were fitted with GPS collars equipped with motion sensors to determine graze locations. Daily time spent grazing was estimated for each plant community and averaged by month for each pasture. Intake was estimated using ruminally fistulated steers that were allowed to graze in 30 minute increments in temporary exclosures within each plant community and pasture for June, July, and August of each year. Rumen forage samples were weighed and analyzed for OM, CP, NDF, and ADF. Intake was calculated as the rate of OM per minute and multiplied by average monthly grazing time based on GPS collar data. Overall quality of the diet was calculated. Results from this study will further our understanding of diet selection and diet composition of free ranging cattle in pastures occupied by prairie dogs, and inform land managers of potential forage contributions of on-town and off-town plant communities.

HOW DOES PULSE GRAZING INFLUENCE WITHIN-AND BETWEEN-GRAZING SEASON DIETARY QUALITY OF CATTLE IN SHORTGRASS STEPPE? Tamarah R. Plechaty*¹, Justin D. Derner², John D. Scasta¹, David Augustine³; ¹University of Wyoming, Laramie, WY, ²USDA-ARS, Cheyenne, WY, ³USDA-ARS, Fort Collins, CO

ABSTRACT

Pulse grazing, high stock density with short grazing periods (weeks) followed by long rest periods (months to > 1 year), is a management strategy posited to decrease selectivity and increase utilization of forage by cattle, but influences on dietary quality of grazing animals in shortgrass steppe are unknown. We used the experimental framework of the participatory, stakeholder-led Collaborative Adaptive Rangeland Management (CARM) project at the USDA Central Plains Experimental Range to compare effects of pulse grazing to traditional rangeland management (TRM) on weekly dietary quality (based on fecal NIRS) of yearling steers for a 20-week grazing season (mid-May to early October) for two years (2015 and 2016). Pulse grazing employed the same moderate stocking rate as TRM, but stocking density was ten-fold higher (1.85 vs. 0.185 steers per ha), and livestock were adaptively rotated among 10, 130 ha pastures within the grazing season. Across the grazing season, crude protein in cattle diets was 26-31% greater for TRM than pulse grazing in 2015 (TRM $9.7 \pm 0.6\%$, pulse grazing $7.4 \pm 0.5\%$, mean ± 1 SE) and 2016 (TRM $8.6 \pm 0.5\%$, pulse grazing $6.8 \pm 0.2\%$). Dietary digestible organic matter was also greater for TRM than pulse-grazing in 2015 (TRM $62.4 \pm 0.3\%$, pulse-grazing $61.0 \pm 0.4\%$) and 2016 (TRM $64.0 \pm 0.8\%$, pulse grazing $62.4 \pm 0.8\%$). Within grazing season diet quality differences were greater between pulse grazing and TRM early in the season (mid-May through June), with these differences declining as the growing season progressed. Adaptive management decision-making to enhance dietary quality with pulse grazing should address use of prescribed burning to increase early grazing season forage quality, matching mid-and late-season use of pastures with local precipitation patterns and amounts, and likely quicker rotations through pastures during rapid vegetation growth periods.

CAN INTENSIVE EARLY STOCKING BE UTILIZED WITH REPRODUCTIVE CATTLE?
. Keith Harmony*, John Jaeger; Kansas State University, Hays, KS

ABSTRACT

Intensive early stocking was introduced nearly a half century ago in eastern Kansas, and has since been adopted as a major management tool to increase animal production, efficiency of production, and economic return almost exclusively by using young stocker animals. Meanwhile, perennial grassland acres available for cattle production are declining in many western and mid-western states. Using management practices that mimic a modified intensive early stocking strategy to increase beef cattle stocking density for breeding herds may allow producers to maintain or increase cow numbers for beef production on fewer perennial grassland resources. The objective of this project was to compare beef cattle reproductive herd performance and rangeland characteristics of traditional continuous season-long stocking and modified intensive early stocking systems. On native mixed-grass rangelands, cow/calf pairs at two locations were stocked at either 1.45X the typical stocking density May through July or at a 1X density. Calves from the more densely spring stocked 1.45X cows were weaned mid-growing season and were backgrounded, reducing stocking rate and density for the last portion of the growing season. Calves from 1X cows were weaned in October. At a third location, breeding heifers were also stocked at a 1.6X rate early in the season and were compared to heifers stocked at a 1X rate. At midseason, heifers that conceived to artificial insemination (AI) in the 1.6X pastures remained on pasture, while heifers not pregnant to AI were removed from pasture. Body weights, body condition and pregnancy rates were measured, and all pastures were monitored for plant composition, ground cover, and biomass at key ecological sites to compare rangeland health between modified intensive early stocking and continuous stocking systems.

POST-FLEDGING HABITAT USE AND SEASONAL PRODUCTIVITY OF
HENSLOW'S SPARROW (*AMMODRAMUS HENSLOWII*)

. Aaron C. Young^{*1}, L. LaReesa Wolfenbarger², John P. McCarty², W. Andrew Cox³;

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ABSTRACT

Management of tallgrass prairies using fire is an important tool for preventing invasive woody vegetation. The effects of management on grassland songbirds have often been measured using one aspect of overall breeding season productivity, nest success, as a metric for habitat quality. However, ignoring other life-stages and demographic parameters during the breeding season may lead to inaccurate assumptions for the effects of habitat, and associated management, on populations. The post-fledging period may be a time of high mortality, and vegetative associations of fledglings may not match those of nesting adults. In this case, management aimed at providing nesting habitat may not meet the needs of fledglings. For a complete estimate of seasonal productivity at a site, rates of re-nesting must be estimated. Together, the effects of habitat on each of these parameters can be estimated in order to more accurately estimate seasonal productivity.

We provide the first estimate of seasonal productivity for Henslow's Sparrow, a species of conservation concern, at a tallgrass prairie in Missouri. We estimated survival during the post-fledging period as a function of vegetative characteristics and compared habitat used by fledglings during the dependent and independent periods. Seasonal fecundity was estimated using radio transmitters attached to females. Finally, we built models that combined our complete set of breeding season parameters to predict population change for the site. Results show strong effects of lowered survival during both the nesting and post-fledging stages as areas of invasive sumac (*Rhus copallinum*) coverage increase. Survival of dependent fledglings increased with years since burn. Independent fledglings used habitat with lower cover of litter and increased forb cover compared to habitat used during the nesting and dependent periods. Our findings suggest that removal of woody vegetation and implementation of small-scale burn mosaics will improve productivity while providing habitat for independent fledglings.

INFLUENCE OF ENVIRONMENTAL CHANGE AND HUMAN ACTIVITIES ON GREATER SAGE-GROUSE LEK COUNTS. Jonathan B. Dinkins*¹, Jeffrey L. Beck², Kirstie J. Lawson²; ¹Oregon State University, Corvallis, OR, ²University of Wyoming, Laramie, WY

ABSTRACT

Hunter harvest of greater sage-grouse (*Centrocercus urophasianus*; hereafter “sage-grouse”) has been regulated by wildlife agencies during most of the past century. Range-wide population declines of sage-grouse have prompted wildlife agencies to restrict harvest with increasingly more conservative hunting season regulations since the mid-1990’s. Sage-grouse populations are known to oscillate over time, and population growth can be influenced by seasonal weather and habitat disturbance. We compared sage-grouse lek trends from 21 distinct populations in 9 western U.S. states and 2 Canadian provinces from 1995–2013. We stratified 8 harvest histories characterizing these populations into 3 categories (non-hunted, continuously hunted, and hunting season discontinued between 1996–2003) to evaluate the potential impact of harvest on sage-grouse populations. Concomitantly, we assessed the effects of proportion burned, forested and agricultural habitat; winter, spring, and summer precipitation; and human population, road, and oil and gas well densities on lek counts. Density dependent models (Gompertz or Ricker) fit lek trend data best for 7 of the 8 harvest histories. Higher proportions of burnt, forested, and cropland; and greater human population and oil and gas well densities were generally associated with decreasing equilibrium abundance. We found mixed results regarding the effect of hunting regulations on instantaneous growth rate (r). The cessation of harvest from 1996–2001 in approximately half of the largest sage-grouse population was associated with higher r . Continuously harvested sage-grouse populations with permit hunting seasons had higher r during years with higher proportion of area exposed to permitted tag hunting rather than general upland game seasons. However, more liberal hunting regulations were positively associated with higher r in populations continuously harvested under general upland game hunts. Most state and provincial wildlife agencies were adept at monitoring changes in lek trends and subsequently limiting hunting opportunities to prevent hunting sage-grouse facing drastic declines in lek trends.

TARGETED CATTLE GRAZING TO ENHANCE SAGE-GROUSE BROOD-REARING HABITAT. Jarrett M. Payne*¹, Jeffrey C. Mosley¹, Andrea R. Litt¹, Brent L. Roeder², Tracy K. Mosley³, Lance B. McNew¹, Hayes B. Goosey¹; ¹Montana State University, Bozeman, MT, ²Teton County Extension, Montana State University, Choteau, MT, ³Park County Extension, Montana State University, Livingston, MT

ABSTRACT

Suboptimal brood-rearing habitat often limits sage-grouse (*Centrocercus urophasianus*) populations in western North America. In many mountain big sagebrush (*Artemisia tridentata* subsp. *vaseyana*) brood-rearing habitats, sagebrush canopy cover is too dense (> 25%) and limits the understory forbs that sage-grouse prefer to eat during summer. We investigated whether protein supplementation could concentrate cattle grazing or trampling during late fall to reduce mountain big sagebrush canopy cover and increase the diversity and abundance of forbs. We applied targeted cattle grazing within two large, contiguous pastures (approximately 615 ha each) in the Beaverhead Mountains of southwestern Montana. Pastures were grazed simultaneously at a light stocking rate (6.25 ha/AUM) for approximately two weeks in mid-October of 2015 and 2016. Within each pasture, we selected one 4-ha macroplot of dense sagebrush, and within each macroplot we treated and evaluated vegetation response at a spatial scale of 0.008 ha to match the spatial scale at which sage-grouse broods select habitat characteristics. We identified 16, 0.008-ha microsites where mountain big sagebrush canopy cover exceeded 30%. Each year we placed a low-moisture block protein supplement in the center of four microsites per macroplot, while another four microsites per macroplot comprised the untreated control. Vegetation response was quantified in early summer 2016 and 2017. One year after treatment, supplemented sites had 78% less sagebrush canopy cover (8% vs 36%), 31% more forb canopy cover (15% vs 12%), 19% greater forb diversity, and 13% greater forb richness than untreated sites ($P \leq 0.10$). Bite count observations and fecal microhistology indicated that sagebrush cover was reduced by cattle trampling rather than browsing, as sagebrush comprised < 1% of cattle diets. Our results indicate that protein supplementation during late fall can concentrate cattle trampling sufficiently to enhance sage-grouse brood-rearing habitat.

THE ABCS OF SAGE-GROUSE HABIT: MAPPING STMS IN EASTERN OREGON

. Eric D. Sant*¹, Gregg E. Simonds²; ¹Open Range Consulting, Preston, ID, ²Open Range Consulting, Park City, UT

ABSTRACT

ARS/OSU Extension. It places Sage-Grouse habitat into broad easily defined and communicated categories based on the threats of annual grass and juniper invasion into traditional Sage-Grouse habitat. Ten million acres of Sage-Grouse priority habitat was mapped in Eastern Oregon using ABC mapping. The methodology, validation, and utility of this unique product in Sage-Grouse habitat mapping make it a quick, cost effective, and accurate way to assess basic Sage-Grouse habitat over large areas.

POPULATION RESPONSE OF GREATER SAGE-GROUSE TO LANDSCAPE-SCALE REMOVAL OF CONIFERS

. Andrew Olsen*¹, John Severson², Jeremy Maestas³, Todd Forbes⁴, Dave Naugle⁵, Christian Hagen⁶; ¹Oregon State University, Philomath, OR, ²University of Idaho, Moscow, ID, ³Natural Resources Conservation Service, Portland, OR, ⁴Bureau of Land Management, Lakeview, OR, ⁵University of Montana, Missoula, MT, ⁶Oregon State University, Bend, OR

ABSTRACT

Conifers such as western juniper (*Juniperus occidentalis*) have encroached sagebrush (*Artemisia* spp.) ecosystems and impacted greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) habitat. This encroachment began just after European settlement of the Intermountain West resulting from anthropogenic changes in fire regimes. Sage-grouse avoid conifers at canopy cover levels <2% and landscape-scale removal of conifers has been documented to improve nest and adult survival rates. However, little empirical data on the impact of conifer removal on sage-grouse population abundance or growth exists. Using a “before-after-control-impact” study design, sage-grouse marked with VHF and GPS transmitters were monitored at a treatment site with conifer removal and a control site without conifer removal in Lake County, Oregon from 2010–2017. Conifer removal began in the treatment area in 2012 and approximately 13,134 ha were removed on public and private lands by 2017. Over the course of the study, 417 marked females, 378 nests, and 223 broods were monitored. Hierarchical integrated population models were used to incorporate demographic data from telemetry and count data from annual lek surveys for more informative characterization of population growth rates in the treatment and control areas. The results of these analyses will provide insights into the potential impact of conifer removal on sage-grouse populations as well as useful information for wildlife and land managers. A robust understanding of the impacts of management actions such as conifer removal on native wildlife including sage-grouse is critical for sustainable management of rangelands and sagebrush systems.

THE GRADIENT CONCEPT OF LANDSCAPE STRUCTURE FOR WILDLIFE HABITAT IN RANGELANDS. Humberto L. Perotto*¹, Jose M. Mata², Janel L. Ortiz³, John T. Edwards³, April A. Torres Conkey², Fidel Hernandez⁴, Leonard A. Brennan², Sandra Rideot-Hanzak⁵, David B. Wester²; ¹Texas A&M University - Kingsville, Kingsville, TX, ²Texas A&M university-Kingsville, Kingsville, TX, ³Texas A&M University-Kingsville, Kingsville, TX, ⁴Caesar Kleberg Wildlife Research Institute, Kingsville, TX, ⁵Texas A&M University-Kingsville, Kingsville, TX

ABSTRACT

The gradient concept of landscape structure is a relatively new conceptual paradigm in landscape ecology that provides an additional framework to pattern-process relationships occurring in the landscape. This model, takes into consideration the inherent environmental variability that exists in a landscape. This variability results in a gradient influencing organisms and ecological processes and their corresponding responses to changes along this gradient. This inherent continuous nature of ecological attributes was not previously well represented with the patch mosaic model, which has been used by landscape ecologists to describe landscape spatial heterogeneity. The goal of our research was to assess the value of the gradient concept of landscape structure based on remote sensing data to quantify suitable areas of northern bobwhite habitat (example 1) and hotspots of guild richness (example 2) in ground foraging avian species in South Texas. The first example uses existing data from northern bobwhite to assess suitability in habitats affected by tanglehead. The second example uses surface metrics to quantify potential hotspots for ground foraging birds. We applied the gradient concept of landscape structure by quantifying landscape metrics to develop surface metrics. We used moving window analyses to develop surface layers that describe landscape structure for northern bobwhites and ground foraging birds in South Texas. The selected metrics for these analyses included percent woody cover, mean patch area, edge density, aggregation index, interspersion and juxtaposition index, and cohesion index for woody cover and herbaceous cover (including tanglehead for northern bobwhites). These surface metrics were then used to develop spatial models that can quantify habitat suitability for avian populations in rangelands. Our results show that these models can be very useful to identify suitable areas for northern bobwhite habitat as well as predicting guild richness for ground foraging avian species.

EXAMINING ECOLOGICAL INTERACTIONS OF FERAL HORSES ON MONTANE RIPARIAN SYSTEMS

. Brett C. Blum*¹, George Ruyle¹, Mary H. Nichols²; ¹University of Arizona, Tucson, AZ, ²USDA-ARS, Tucson, AZ

ABSTRACT

Understanding the ecological interactions of feral horse populations is of increasing importance on Western rangelands where management options are often case specific and complex. In the White Mountains, Arizona, USA, feral horse habitat overlaps heavily with cattle and other species of native ungulates including elk, mule deer and pronghorn. The addition of a novel large bodied grazing mammal within an ecosystem may have implications for both interspecies competition as well as for the soils and vegetative communities on which they graze. As is often the case, meadows and riparian areas are the focus of these interactions. To better understand grazing use and behavior we established a network of time lapse cameras and grazing exclosures to examine interspecies interactions as well as the intensity of grazing on two adjacent riparian study areas from May-October 2017. Photographic time series were used to examine both the fine scale spatial and behavioral relationship between grazers when they co-occurred as well as to explore the potential for more coarse scale temporal distributional strategies between species. We also used time lapse imagery to conduct a chromatic pixel analysis through R to establish a metric of seasonal forage availability as it relates to precipitation and ratio of greenness by image. Grazing frequency and species detection rates were compared with available forage using a simple linear model. To estimate forage utilization we established six 1m² grazing exclosures at each site ($N=12$). We compared stubble height, species composition and dry yield to six randomly selected grazed plots within both study areas. Our study establishes base line information that can be used to inform feral horse management and design future hypothesis driven research to better understand the impacts of feral horses on rangelands. Preliminary results of this research are pending and will be presented at the time of the conference.

EFFECTS OF MANAGEMENT AND HUMAN ACTIVITY ON SPACE USE AND MOVEMENT OF WILD TURKEY

. Allison Rakowski*, Robert D. Elmore, Craig A. Davis, Samuel D. Fuhlendorf; Oklahoma State University, Stillwater, OK

ABSTRACT

Management practices and landscape impacts of energy development can cause changes in animal behavior, distribution, and space use. Understanding how anthropogenic structures and disturbance affects wildlife is pertinent to management. Although disturbance has been recognized as an important factor affecting wild turkey populations, little research has been conducted to quantify the effects of energy development (oil and gas) and management practices (prescribed fire) on wild turkey space use and movement. Effects of energy development may include the direct loss of habitat by the instillation of well pads (and removal of roost trees) and indirect loss of habitat due to changes in space use because of sound or vehicle traffic. To better understand how of Rio Grande Wild Turkeys (*Meleagris gallopavo intermedia*; hereafter turkey) respond to management practices and energy development, we placed backpack-style GPS transmitters on 30 female turkeys and deployed 15 traffic counters throughout Packsaddle Wildlife Management Area in western Oklahoma. Each of the transmitters recorded 7 daytime locations (every 2 hours from 0800-2000) and one nighttime location (0200) daily. These GPS locations along with a spatial map of the study area were used to create home ranges and selection functions to determine if turkey locations are related to distance to oil and gas wells, distance to roads, and level of vehicle traffic. In addition, we mapped and combined prescribed fire into three time since fire categories (<1 year, 1-2 years, >2 years) to determine if turkey locations are related to time since fire.

DIRECT/INDIRECT IMPACTS TO RANCHERS FROM WOLVES AND OTHER PREDATORS: BUILDING A BASELINE IN CALIFORNIA. Roger Baldwin¹, David Lile², Daniel K. Macon*³, Robert D. Stager⁴, Jeff Stackhouse⁵, Carissa Rivers⁶, Tina Saitone⁷, Tracy Schohr⁸, Laura K. Snell⁹, John Harper¹⁰, Roger Ingram¹¹, Kim Rodrigues¹², Luke Macaulay¹³, Leslie Roche¹; ¹University of California, Davis, CA, ²UCCE, Susanville, CA, ³UCCE - Placer/Nevada/Sutter/Yuba, Auburn, CA, ⁴Retired & Consultant, Overgaard, AZ, ⁵UCCE, Eureka, CA, ⁶UCCE, Yreka, CA, ⁷UC Davis, Davis, CA, ⁸UCCE, Oroville, CA, ⁹University of California, Alturas, CA, ¹⁰UCCE, Ukiah, CA, ¹¹UCCE, Auburn, CA, ¹²UC Hopland Research and Extension Center, Hopland, CA, ¹³UC Berkeley, Berkeley, CA

ABSTRACT

While the direct impacts of gray wolves (*Canis lupis*) and other predators on rangeland livestock production are more easily measured and well-documented, research in other Western states suggests that indirect impacts (e.g., reduced livestock productivity and increased expense) may be more economically significant. We initiated a long-term (10 year), longitudinal survey of rangeland cattle, sheep and goat producers in northern California to quantify the direct and indirect impacts from gray wolves, which are increasing in numbers in the state, and other large carnivores on rangeland livestock production. During winter/spring 2017, we hosted 7 producer-researcher workshops across northern California, which featured livestock-predator conflict experts. At these workshops, we collected the first round of survey data from 91 operations representing 41,034 head of beef cattle and 12,955 head of sheep and goats, and more than 1.13 million acres of grazing land. We will present our initial survey results, which have established a baseline for livestock production practices and economics in northern California. In addition, we will present preliminary findings regarding the adoption rate, efficacy and cost of a variety of commonly used livestock protection tools on rangeland livestock operations at a variety of scales.

LOVE'EM OR HATE 'EM: MEETING BEAVER CHALLENGES WITH ON-THE-GROUND SOLUTIONS. Jennifer Caudron*¹, Norine Ambrose²; ¹Alberta Riparian Habitat Management Society "Cows and Fish", Edmonton, AB, ²Alberta Riparian Habitat Management Society "Cows and Fish", Lethbridge, AB

ABSTRACT

Presentation Title: Love' em Or Hate 'em: Meeting Beaver Challenges With On-The-Ground Solutions

Presenter: Jennifer Caudron - Alberta Riparian Habitat Management Society (Cows and Fish)

Presentation abstract: Beavers are an integral part of the rangelands of North America, and are called nature's engineers for good reason. Their industrious nature means they do a lot and their work also means they frequently create challenges which result in conflict with humans and our infrastructure. If we want to understand them, recognize their key role in riparian areas and watersheds, including water storage, flood attenuation, fish and wildlife habitat provision, we need to figure out how to live with them. To do so, a good starting point is to educate ourselves on the ecology and life history, as well as the science behind their behaviour. Subsequently, we can then better grasp the issues, challenges, options and alternatives for future possibilities of living with beaver. Beavers cheerfully ignore our property lines and often issues that arise are ones involving several landowners. Getting together, learning about beaver together and involving people with expertise provides more long lasting solutions, allowing us to solve collectively what we can't individually. Our approach speaks to engendering a community response and a watershed approach. This presentation will highlight some of the beaver's natural history and role they play in watershed resiliency while also showcasing some ways land managers and practitioners are working together to help increase tolerance of beavers with practical on-the-ground tools . Love 'em or hate 'em, we need to figure out how to live with them.

FACTORS LIMITING USE OF DROUGHT-MANAGEMENT TACTICS AMONG UTAH CATTLE RANCHERS

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

ABSTRACT

Recurrent drought is a defining feature of rangelands. How ranchers cope with drought is an important issue. In 2010 a mail and telephone survey was conducted across Utah that involved 509 randomly selected cattle ranchers. One goal of this work was to assess the use of 14 drought-management tactics during the last multi-year drought of 1999-2004. Tactics included an array of technical and policy-related options covering the management of water, land, livestock, and forage as well as household income diversification, enrollment in government programs, purchase of feed insurance, use of drought-forecasting tools, and seeking information from Extension services. Overall, the 14 tactics were used by 41% of the cattle-ranching population, on average. The most commonly used tactic was water development, as reported by 76% of survey respondents. The least-used tactic was hay forward-contracting (8% of respondents). Marked variation in the use of these tactics was thus evident, but why? To answer this question a follow-up survey was personally tailored to each of the 509 ranchers contacted in the 2010 effort. If a rancher had indicated that he or she had not used certain tactics, they had an opportunity to explain why. In this follow-up effort the framework of Everett Rogers (2003) concerning the diffusion of innovations was employed to help sort prominent barriers that limit innovation adoption. Four hundred and twenty-nine usable surveys were obtained from the second round, summarizing 3,133 non-adoption decisions. Overall, the majority (44%) of non-adoption decisions occurred due to the tactic not being relevant to the priorities of the producer. Lack of need was followed by a lack of key resources necessary for implementation (15%), high complexity or low utility (12%), lack of awareness (10%), or high cost (6%). Implications of these findings for development of drought-related technologies, policies, and programs are reviewed.

LAND MANAGER PERCEPTIONS OF THE OPPORTUNITIES AND CONSTRAINTS TO USING LIVESTOCK TO MANAGE INVASIVE PLANTS. Matthew W. Shapero*¹, Jeremy J. James², Lynn Huntsinger³, Theresa Beccehiti⁴, Fadzayi Mashiri⁵; ¹UC ANR, Ventura/Santa Barbara, CA, ²Center Director, Browns Valley, CA, ³University of California, Berkeley, Berkeley, CA, ⁴UCCE, Stockton, CA, ⁵UCCE, Mariposa, CA

ABSTRACT

The ecological impacts of invasive plants on rangelands have been widely documented, and yet the implementation of successful, long-term invasive plant management programs has remained limited. A growing body of research has identified domestic livestock grazing as the most practical and economical tool available to control invasive rangeland plants. While these studies have addressed potential limitations, to date we do not have a systematic assessment of the challenges and opportunities that producers and other land managers see as most important when considering the use of livestock to manage invasive plants. As a first step toward addressing this need, we conducted in-depth, semi-structured interviews with ranchers, public agency personnel, and NGO land managers who work on rangelands across California. While interviewees broadly agreed that grazing could be an effective management tool, differences emerged between the three groups in the priority they gave to invasive species control, the resources they devoted to control, and the grazing strategies employed. Interviewees identified common challenges that hinder broad-scale adoption of control efforts, such as the potential incompatibility of invasive plant management and livestock production; a lack of secure, long-term access to land for many ranchers; incomplete or insufficient information, such as the location or extent of infestations or the economic impacts to operations of invasive plants; and the temporal and spatial variability of the ecosystem. The results from this study should help guide future research and extension on using grazing animals to manage invasive plants that accounts for and addresses the practicality of large-scale management on working landscapes.

IDENTIFYING DIFFERENT PERSPECTIVES ON BEEF PRODUCER GRAZING
MANAGEMENT SYSTEMS. Kristine M. Dahl*; University of Alberta, Edmonton, AB

ABSTRACT

Livestock management systems are becoming an increasing focus of attention in scientific study. An area of study that has not been heavily investigated is the social dimension of grazing management. Why do some livestock producers choose one form of grazing management over another? Why is there such a divide between adherents of different management systems? This study is aimed at understanding the differences in motivations and decision making regarding grazing management options across Alberta. Ranches involved in this study represent the Boreal, Montane, Parkland and Grassland Natural Regions of Alberta, and fall in to one of four distinct groups of grazing management systems: Holistic Management, Fast Rotational, Slow Rotational and Continuous/Seasonal. We will investigate the differences in landscape and grazing management by approaching graziers on a personal level, through a series of interviews. Each interview becomes more in-depth, with a focus on understanding perspectives on grazing and what motivates graziers. A biophysical range health assessment on approximately 30 ranches complements these interviews and provides physical evidence of the range health of the land. This assessment will be followed by a second in-person interview with the grazier focused on range health results. This second interview will address the extent to which the range health assessment is in line with expected results. We are currently beginning work on the in-depth interviews and range health assessments, with preliminary results expected for January 2018. With a focus on both the social aspect of grazing through candid interviews and range health assessments, along with grazier discussions, this approach to studying grazing management may result in a new understanding of grazier motivations and mindsets, and improve ways of fostering sustainable grazing management in Alberta and beyond, especially in areas where grazing management is largely a private and self-directed enterprise.

CAN ADAPTIVE MANAGEMENT HELP OVERCOME PERMITTEE-US FOREST SERVICE CONFLICTS? Aaron M. Lien*, George Ruyle, Laura López-Hoffman; University of Arizona, Tucson, AZ

ABSTRACT

In 2007, Region 3 of the US Forest Service (encompassing all national forests in Arizona and New Mexico) implemented a new policy to require the use of adaptive management in the administration and management of grazing allotments. This policy change was intended to increase flexibility and responsiveness to unpredictable environmental changes such as short- and long-term drought and wildfires thereby improving environmental, economic, and social outcomes. Resource users and on-the-ground managers have a significant impact on the success or failure of resource management policy. To evaluate how the US Forest Service adaptive management policy has been implemented and its success in improving social outcomes on-the-ground, we interviewed ranchers and forest district staff in Arizona and New Mexico. Interviews explored the management approach used on allotments, the relationship between the US Forest Service and permittees, and the impact of implementation of adaptive management policies on relationships between US Forest Service personnel and permittees. We hypothesized that implementation of adaptive management would have a positive impact on relationships between US Forest Service personnel and permittees because adaptive management provides for greater management flexibility and a context for improved communication about resource challenges and solutions. Our results show the policy has had positive social impacts in some parts of the region, but that these outcomes are variable and dependent on staff turnover in forest district offices, trust between US Forest Service personnel and permittees, and pre-existing conflicts unrelated to adaptive management policy.

CALIFORNIA-PACIFIC SECTION'S RANGE CAMP &NDASH; IMPACTS OF OVER 30 YEARS OF RANGE EDUCATION. Julie A. Finzel¹, Theresa Becchetti^{*2}; ¹UC Coop Exten, Bakersfield, CA, ²UCCE, Stockton, CA

ABSTRACT

The California-Pacific Section (CalPac) started Range Camp in 1984, over 30 years ago, pulling high school kids from across the state and more recently also from Hawaii. It has always been held in Half Moon Bay, California at UC Elkus Ranch Environmental Education Center. Many things about camp have changed since that first week, however, the core concept and organization remain the same. Looking ahead to another outstanding 30 years, camp organizers wanted to gain some feedback from past campers. A survey was distributed to former campers dating from 2001 to 2016 camp years. 284 surveys were mailed, with 248 of those also receiving an email link to the survey for ease of completing. Our response rate was 14%, with the most recent years having a higher return rate of roughly 30% each for 2015 and 2016. Survey participants were asked to share their background and knowledge prior to camp and then their perceptions of range management after completing the one week camp. The survey not only captured information on lecture topics and camp activities, but also asked participants to indicate if camp had any influence on their academic or career choices. 73% of the respondents said Range Camp did influence their academic or career choices. Range Ecology and Range Management appear to be the most influential topics for students. Of the campers already in the workforce, 64% have a position in a range related field. 95% of campers indicated that Range Camp did increase their understanding of land and natural resource management as well as their perception of how their personal actions might affect the environment. Complete survey results will be presented along with next steps.

ALONE ON THE RANGE: EXPLORING FIRST-GENERATION RANCHERS' ADAPTATIONS TO SOCIO-ECONOMIC CHALLENGES IN CALIFORNIA

. Kate Munden-Dixon*¹, Leslie Roche², Tracy Schohr³, Justin D. Derner⁴, Bethany B. Cutts⁵, Kenneth W. Tate¹; ¹University of California, Davis, Davis, CA, ²University of California, Davis, CA, ³UCCE, Oroville, CA, ⁴USDA-ARS, Cheyenne, WY, ⁵North Carolina State, Raleigh, NC

ABSTRACT

California's ranching landscape is shifting as new ranchers enter, often with differing socio-economic backgrounds and goals. In contrast to multi-generational ranchers (MGRs), research suggests that first-generation farmers and ranchers (FGRs) are more likely to be younger, highly educated, non-White, non-Hispanic and female (Ahearn and Newton 2009). This talk will first discuss findings from a survey of California Cattlemen Association members to identify how FGRs' operations, values, concerns and information sources differ from MGRs within California. Identifying these differences, as well as the nexus of similarities is critical, as previous research has indicated that understanding variations in FGRs' operations and decision-making is key to crafting policies and initiatives to support these beginning ranchers and the health of rangelands (Huntsinger & Oviedo, 2014; Roche et al., 2015). The latter half of the presentation will present preliminary findings from an ongoing state-wide study in California that aims to identify the alternative goals of first-generation ranchers and strategies to access rangelands, markets, and information. Through the use of semi-structured interviews and surveys, this project offers an in-depth look into the diversity of first-generation ranchers involved in cattle, sheep and goats. This presentation will conclude with implications for the future of California ranchers and offer potential lessons for other rangelands undergoing demographic transitions.

POINT BLUE'S RANGELAND WATERSHED INITIATIVE: CULTIVATING LEOPOLDIAN LAND STEWARDS. Kate Howard*¹, Carrie Richards²; ¹Point Blue Conservation Science, Yuba City, CA, ²Richards Grassfed Beef, Oregon House, CA

ABSTRACT

Point Blue Conservation Science in partnership with the Natural Resources Conservation Service (NRCS) has implemented a Rangeland Watershed Initiative in 22 counties in California and Nevada. Partner Biologists work in NRCS offices to assist land owners and managers increase soil health, water-holding capacity, and biodiversity as well as production on California rangelands. This Partner Biologist model relies heavily on building trusting relationships with private landowners. One of our goals is to cultivate and promote Leopoldian Land Stewards, based on a suite of characteristics that demonstrate an individual's desire and ability to treat the land as a member of the community and maintain healthy functioning ecosystems for future generations to come. By tapping into ranchers' inherent husbandry skills and family legacies, partner biologists encourage land owners extend these principles to the landscapes they work and rely upon. Ranchers face many challenges in today's world. Partner Biologists work with them to help address an array of these challenges. By working together toward common goals of healthy landscapes and thriving communities, we are helping to promote and conserve the unique and diverse rangelands and the families and communities that live and work on them.

HOW CAPACITY-BUILDING PARTNERSHIPS CAN IMPROVE RANGELAND STEWARDSHIP: EXAMPLES FROM THE NRCS AND POINT BLUE.

. Tiffany Russell*; Point Blue Conservation Science, Susanville, CA

ABSTRACT

Partner biologists work with landowners, agencies, and non-governmental organizations to help improve wildlife habitat and the sustainability of working lands. They increase the capacity of existing agencies, such as the Natural Resources Conservation Service (NRCS), as well bring in new partners and investors in private land conservation. In California, partner biologists are adding value by identifying wildlife habitat opportunities within the regular NRCS Conservation Planning process, writing plans specifically for funds designated for wildlife benefits, providing additional capacity to monitor projects, helping with collaborative planning efforts in the local community, and connecting innovative producers and conservation partners.

HABITAT FOR THE HOGWALLOW STARFISH (*HESPEREVAX CAULESCENS*) AND
OTHER SPECIAL STATUS SPECIES ON CALIFORNIA'S RANGELANDS:
ENCLOSURE AND ACCUMULATION ON A CATTLE RANCH

. Sheila Barry*; UCCE, San Jose, CA

ABSTRACT

Past critiques of conservation easements have focused on the nature of perpetuity, enforcement limitations, and lack of easement flexibility and conservation effectiveness (Korngold 2009; Owley 2011). I argue that easements especially an exacted easement, one that is fulfilling a mitigation requirement fundamentally change the landowner's relationship to the land and its associated conservation values. Through review of three exacted conservation easement agreements, their management plans and endowment budgets, I provide evidence that re-territorialization, dispossession, and enclosure leading to accumulation perpetuate conflict between ranch landowners and conservation interests over protected versus working lands. First, re-territorializing of the ranch as a preserve changes how ranchers can use the rangeland resources. It fails to value livestock production or rancher ecological knowledge, which contribute to ecosystem sustainability. Second, prohibitions on some rangeland management practices like pest control, water development, and range seeding may render parts of the land of little value for livestock production resulting in dispossession. Third, enclosure for conservation requires compliance and for exacted easements typically requires resource enhancements leading to accumulation. A service industry emerges to uphold environmental regulations required for "special status" species that previously had no economic value. On the surface, all conservation easements give sustainable management "a foot in the door" and support the rancher's place on the landscape, but taking a closer look reveals new enclosures of rangeland resources from exacted conservation easements and dispossession of livestock ranchers combined with accumulation by third party, non-state agents.

THE RANCHER AS THE STEWARD: BUILDING A LANDSCAPE OF COLLABORATION IN THE AMERICAN WEST

. Jared L. Talley*; Michigan State University, Lansing, MI

ABSTRACT

The armed occupation of the Malheur National Wildlife Refuge in early 2016 is the latest encounter in a long history of conflict surrounding the federally managed lands in the Intermountain west region of the United States. The standoff appeals to a narrative of the American West that pits the renegade against the lawman and the rancher against the management agency, celebrating the rugged individualism characteristic of the Western machismo. This project offers a counter-narrative of communities in the Intermountain west that wish to retain their unique cultural histories while evolving with the needs and commitments of contemporary environmental governance. In this paper, I aim to both offer a perspective of western communities that centers on their relationship to the land, including their willingness and desire to care for the environment as stewards, while highlighting some of the conceptual issues that impede this stewardship.

This project stems from my own publicly engaged philosophical research in the deserts of Nevada surrounding collaborative efforts to better manage public lands. Standing in stark contrast to the strategies of those that forcefully occupied the Malheur National Wildlife Refuge are those community members that seek to engage with local management agencies in collaborations that center trust, humility, and authentic dialogue in working through the environmental conflicts that impact the ecosystems, economies, and cultures of the west. This project builds a counter-narrative from these collaborations that considers new strategies of environmental governance on public lands, including discussion of the different types of expert knowledge brought to bear in public land management, the obstacles of deciding who to include and exclude in collaborative efforts, and the institutional obstacles that prevent legitimate collaboration and problem-solving at the local level.

ECONOMICS OF SAGE-GROUSE CONSERVATION PRACTICES AT THE RANCH LEVEL. Anna T. Maher*¹, Nicolas E. Quintana Ashwell¹, John Tanaka²; ¹UNIVERSITY OF WYOMING, LARAMIE, WY, ²University of Wyoming, Laramie, WY

ABSTRACT

The conservation practices championed by the Natural Resource Conservation Service (NRCS) have reduced threats to the greater sage-grouse (*Centrocercus urophasianus*) in 90% of the species' breeding habitat. How livestock are grazed has changed on millions of acres of land across the western United States. Although these practices have resulted in positive conservation outcomes, this study is the first widespread effort to quantify their economic impact on ranch operations.

We model cow-calf ranch operations of varying sizes from enterprise budget data collected from ranchers in the Major Land Resource Areas (MLRAs) where sage-grouse conservation practices are being implemented. The target MLRAs cover parts of Colorado, Oregon, Nevada, Idaho, Wyoming, and Montana. Results are obtained through recursive linear programming models that are solved using the General Algebraic Modeling System. These models use a profit-maximizing objective function and are evaluated over a 40-year planning horizon. Economic outcomes of sage-grouse conservation practices are reported according to changes in grazing and livestock management, net present value of profits, and likelihood of annual operation losses.

Studies have shown that the recovery of the greater sage-grouse is correlated with healthier rangelands. Conservation efforts that lead to rangeland restoration could equate to increased forage production over time, which suggests the common motto "what is good for the bird is good for the herd". However, the benefits and costs of grazing management to improve sage-grouse habitat at the ranch-level have not been analyzed. This study explicitly incorporates both the grazing limitations and the forage production benefits of conservation practices as a means to quantify net impacts. The results from this study will help guide decision-making among land managers and ranchers in the planning for sage-grouse conservation impacts at both the individual ranch and community level.

VALIDATION OF A MULTI-SPECIES NEAR INFRARED SPECTROSCOPY
CALIBRATION FOR FECAL NITROGEN IN FREE-RANGING RUMINANTS.

. Douglas R. Tolleson*¹, Jay Angerer²; ¹Texas A&M Agrilife Research, Sonora, TX, ²Texas A&M Agrilife Research, Temple, TX

ABSTRACT

Nitrogen is one of the constituents found in mammalian feces. Fecal nitrogen can be monitored to indicate forage diet quality or potential re-deposition of nitrogen into an ecosystem. Near infrared spectroscopy (NIRS) is a non-invasive, non-destructive analytical method used to determine fecal nitrogen. Multi-species NIRS calibrations have been developed for forage quality and composition but it is not known how well fecal NIRS calibrations might apply across herbivore species. We applied NIRS to determine fecal nitrogen in a temporo-spatially diverse calibration derived from multiple ruminant herbivore species (i.e. cattle, bison, deer, elk, goats, and sheep). Fecal samples collected fresh from the ground representing a herd or flock composite were shipped frozen or chilled to our laboratory via 2-d priority mail. Upon arrival, samples were processed for NIRS (400 to 2498 nm). Predictive calibrations and validations were developed using partial least squares regression for: 1) all samples, 2) cattle only, 3) all except bison, 4) all except deer, 5) all except elk, 6) all except goats, and 7) all except sheep. All multiple coefficient of determination values for fecal nitrogen calibrations were ≥ 0.97 . Corresponding standard error of cross validation values were ≤ 0.13 . Validation results include simple coefficient of determination and standard error of prediction for each alternate species (3-7 above) using the cattle derived calibration ranged from 0.76 to 0.84, and 0.28 to 0.5 respectively. Similar values for the sequential species leave-one-out validation for fecal nitrogen were 0.67 to 0.89, and 0.17 to 0.47 respectively. Multi-species fecal NIRS calibrations for fecal nitrogen will facilitate real-time monitoring for pollution mitigation, precision application of soil amendments, livestock supplemental feeding, or wildlife habitat evaluation within appropriate guidelines. Our multi-species calibration results should be considered a preliminary evaluation of the technique.

INFLUENCE OF FIRE ON THE THERMAL ENVIRONMENTS OF SAGEBRUSH (*ARTEMISIA SPP.*) COMMUNITIES

. Christopher R. Anthony*¹, Christian Hagen², Robert D. Elmore³, Katie M. Dugger⁴; ¹Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, OR, ²Oregon State University, Bend, OR, ³Oklahoma State University, Stillwater, OK, ⁴U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit, Corvallis, OR

ABSTRACT

All organisms have some range of temperature that constrains their ability to function properly (i.e., thermal sensitivity) and can even influence individual fitness. Thus, understanding the relationship between organisms and their thermal environments is fundamental to their conservation and management. Little is known about the thermal environments of sagebrush (*Artemisia spp.*) communities and the effects of fire on the thermal landscape. Our objective was to provide a baseline of spatial and temporal thermal heterogeneity by measuring operative temperature within a sagebrush landscape affected by fire. Operative temperature characterizes the temperature of organisms in their environment independently of thermoregulation by integrating ambient temperature, solar radiation and conductive and convective heat transfer between organisms and their environments. Sagebrush communities affected by fire provided many thermal options for organisms. We observed a wide thermal gradient with a range of operative temperature from -8° to 61° C. Furthermore, when ambient temperature was 10° C, operative temperature varied 37° C (range: -3° to 34° C). Fire increased thermal heterogeneity across the landscape. Unburned sagebrush areas were cooler and had a lower rate of increase than burned sagebrush areas indicating that this relationship was magnified as ambient temperature increased. Additionally, the magnitude at which thermal environments were modified differed among unburned and burned, big (*A. tridentata* spp.) and low sagebrush (*A. arbuscula*) areas. Unburned big sagebrush areas buffered operative temperature relative to ambient temperature slightly more than burned big sagebrush, unburned low sagebrush, and burned low sagebrush areas. These results show high thermal variation among sagebrush communities and that fire alters thermal patterns across the landscape, which will likely influence the behavior of sagebrush obligate organisms, including Greater Sage-grouse (*Centrocercus urophasianus*).

COMPARING BIRD COMMUNITIES IN WINTER PATCH AND PATCH BURN GRAZING SYSTEMS IN WESTERN SOUTH DAKOTA. Jennifer Lutze*¹, Patricia S. Johnson², Kent Jensen¹, Jameson R. Brennan², Ashleigh Rhea¹; ¹South Dakota State University, Brookings, SD, ²South Dakota State University, Rapid City, SD

ABSTRACT

The suite of grassland bird species native to the Northern Great Plains (NGP) requires a mosaic of diverse habitats ranging from excessive to lightly disturbed plant communities. Many of these species have been on a considerable decline since 1966, more so than any other group of birds in North America. A major cause of this decline has been loss of habitat, more specifically loss of heterogeneity in the NGP. Contemporary grazing strategies manage for uniform use of plant communities and have resulted in reduced structural heterogeneity at both the pasture and landscape scales. Patch-burn grazing (PBG) has been a very effective management strategy in the tallgrass prairies to increase structural heterogeneity, and bird responses have been very positive. However, burning is extremely unpopular in much of the NGP. Therefore, we conducted research to evaluate winter-patch grazing (WPG) as a non-pyric strategy to increase the structural heterogeneity on mixed grass prairie pastures and increase avian diversity. WPG was implemented at the SDSU Cottonwood Research Station and on two cooperator ranches in 2016. In October 2016, a large wildfire burned a considerable amount of the station research pastures. This provided a unique opportunity to compare the effects of WPG and PBG on structural heterogeneity and avian diversity on NGP grasslands. Differences in bird parameters (e.g. species diversity, composition, densities, and nest success) and habitat parameters (e.g. plant community height, composition, VOR), were analyzed to determine treatment differences. Results from this study will help inform land managers of the potential for WPG to serve as a substitute for PBG for improving grassland heterogeneity, and as a management strategy for improving grassland bird habitat.

EFFECTS OF RANGELAND MANAGEMENT ON SHARP-TAILED GROUSE HABITAT SELECTION IN MIXED GRASS PRAIRIES. Megan C. Milligan*¹, Lance B. McNew¹, Lorelle I. Berkeley²; ¹Montana State University, Bozeman, MT, ²Montana Department of Fish, Wildlife, and Parks, Helena, MT

ABSTRACT

Temperate grasslands, including mixed grass prairies, suffer from the greatest levels of habitat loss and degradation of any ecosystem. This can have cascading negative effects including changes in ecosystem function, wildlife population declines, and the deterioration of ecosystem services. Grazing is the predominant land use on grasslands across western North America and directly affects the structure, composition, and productivity of these ecosystems. While certain grazing regimes can negatively affect wildlife habitat, properly managed grazing can be compatible with wildlife conservation and is preferable to other land uses that destroy or fragment native grasslands. Rest-rotation grazing is implemented on conservation easements in Montana to improve wildlife habitat, but this grazing system was developed in arid bunchgrass rangelands and its effectiveness has not been studied in more mesic mixed grass prairie. Sharp-tailed grouse (*Tympanuchus phasianellus*) have large home ranges and differing requirements for nesting and winter habitat, making them an ideal indicator species for grassland habitats. Rest-rotation grazing systems could influence grouse habitat selection at multiple spatial scales by providing patches of habitat that are periodically rested from disturbance. We hypothesized that management regimes that provide these heterogeneous mosaics of grassland habitats would result in smaller home ranges and shorter individual movements due to increased heterogeneity resulting in greater availability or proximity of important resources. We used compositional analysis and resource utilization functions to investigate home range selection in relation to the larger study area and selection of habitat features within the home range, respectively. We monitored 82 female sharp-tailed grouse during the breeding seasons of 2016-17. Average home range size was 503 ± 56 ha and grazing system was not a good predictor of home range size. By evaluating sharp-tailed grouse habitat selection, this research provides insight into the effectiveness of different rangeland management practices for improving wildlife habitat.

EFFECTS OF LIVESTOCK GRAZING MANAGEMENT ON GRASSLAND BIRD ECOLOGY IN THE NORTHERN MIXED-GRASS PRAIRIE. Skyler T. Vold*¹, Lorelle I. Berkeley², Lance B. McNew¹; ¹Montana State University, Bozeman, MT, ²Montana Department of Fish, Wildlife, and Parks, Helena, MT

ABSTRACT

Grassland bird populations have declined more than any other guild of birds during the past 50 years as a result of habitat loss. The majority of remaining native grassland habitat in North America is managed for livestock production, so livestock grazing management can have significant impacts on the conservation of grassland birds. We evaluated the effects of three livestock grazing systems on grassland bird abundance in the northern mixed-grass prairie ecosystem of eastern Montana. Our objectives were to: 1) evaluate effects of grazing system on species-specific abundance of grassland birds, 2) evaluate the importance of local vegetation characteristics for grassland birds within grazing systems, and 3) provide management recommendations to agencies and private landowners for improving habitat quality for grassland birds in the northern mixed-grass prairie. During 2016–17, we conducted replicated point-count surveys at 150 locations on a 3,008-ha ranch managed with rest-rotation cattle grazing, and 155 locations on adjacent reference properties (4,020-ha) employing season-long or intensive summer-rotational grazing systems. We evaluated a suite of habitat conditions within 100-m from each survey point. We built and analyzed support for a set of N-mixture models to identify grazing system influences on grassland bird abundances while controlling for local habitat conditions at each site. Relative to season-long and summer-rotational grazing systems, we observed a lower abundance of a dense-grass obligate species, the grasshopper sparrow (*Ammodramus savannarum*; $\hat{\beta} = -0.30 \pm 0.05$), on pastures within rest-rotation grazing systems. Additionally, we found evidence of an interaction between grazing system and rangeland productivity, where areas of high productivity had higher abundance estimates of grasshopper sparrow on pastures employing intensive summer-rotation grazing ($\hat{\beta} = 0.55 \pm 0.06$), and lower abundance estimates of grasshopper sparrow on pastures employing rest-rotation grazing ($\hat{\beta} = 0.34 \pm 0.04$), or season-long grazing ($\hat{\beta} = 0.31 \pm 0.06$).

GRAZING-INDUCED TROPHIC RELATIONSHIPS AND IMPLICATIONS FOR GRASSLAND SONGBIRDS. Tracey N. Johnson*¹, Sandra J. DeBano², Patricia L. Kennedy³; ¹University of Idaho, Moscow, ID, ²Oregon State University, Hermiston, OR, ³Oregon State University, Union, OR

ABSTRACT

Grazing by cattle affects plant morphology, phenology, and species composition, which can result in changes within invertebrate communities at broad scales. For grassland songbirds, altered invertebrate communities may influence prey availability or foraging preferences, and ultimately affect habitat use or demography. Although grazing represents a complex disturbance, in managed systems stocking rate and associated vegetation utilization levels can determine vegetation responses to grazing, and potentially, habitat quality for other trophic levels. To better understand the relationship between utilization and grassland bird food habits, we examined diet composition of nestlings for four songbird species breeding in paddocks with experimentally-manipulated stocking rates in a Pacific Northwest bunchgrass prairie in northeastern Oregon. We compared nestling diet composition with invertebrate abundance in paddocks to examine the effect of utilization rates on dietary preferences of breeding birds. Moths and butterflies comprised the largest proportion of prey in nestling diets (31%) followed by short-horned grasshoppers (28%) and spiders (20%). We observed variable preferences across invertebrate taxa, with strongest preference for moths and butterflies. Preference for only two invertebrate taxa varied as a function of utilization rate, and only in the first year of our study: moths and butterflies were preferred at low utilization rates and avoided at high utilization rates, and spiders were more strongly avoided at moderate versus high utilization. When compared to patterns of invertebrate abundance at the paddock-level, the lack of strong patterns of preference with increasing utilization suggest that adult birds may be able to compensate for altered food abundance by adjusting foraging strategies. However, this compensation may still come at a cost to nestlings if more time is devoted to foraging for specific prey by adults, thereby allowing less time for nest defense, or negatively affecting total volume of prey delivered to nestlings. Implications for grazing management will be discussed.

HOW RESPONSIVE ARE SANDHILLS SONGBIRDS TO GRAZING STRATEGIES? Walt Schacht*¹, Maggi Sliwinski², Larkin Powell²; ¹University of Nebraska - Lincoln, Lincoln, NE, ²UNL, Lincoln, NE

ABSTRACT

Diversity in the structure and botanical composition of grazing lands is commonly reported to provide the variety of habitat types needed for a diversity of birds. It follows that the use of a variety of grazing strategies on a management unit or across a rangeland landscape leads to vegetation heterogeneity and diverse bird communities. We selected management units in a rangeland landscape in the Nebraska Sandhills that were managed with a variety of commonly-used grazing strategies, including continuous stocking, deferred and rest rotation grazing, and short duration grazing. We hypothesized that habitat characteristics and abundance of songbird species would vary among units within this landscape. The Sandhills region is mixed prairie dominated by warm-season tallgrasses within a rich mixture of cool-season grasses, sedges, forbs, and shrubs. Visual obstruction readings (VOR), plant cover, and songbird composition and abundance data were collected in 2003/2004 and 2014/2015 on rangelands managed with a variety of grazing strategies. VOR and measures of plant/ground cover generally did not differ among grazing strategies, although these measures were affected by timing of grazing and stocking rate, and differed among pastures within a grazing strategy. Grassland birds (e.g., grasshopper sparrow and lark sparrow) responded to habitat variables, such as standing dead cover and VOR, but bird abundance and composition generally did not vary by grazing strategy. Overall, structural heterogeneity of vegetation did not consistently differ among ranches managed with different grazing strategies and was not sufficient to affect songbird abundance and composition. Vegetation composition and structure of upland range in the Sandhills is largely homogeneous because rangeland managers have been effective in managing for the dominant native tall and mid-grasses and for optimizing ground cover, regardless of the grazing strategy used. Range managers use different grazing strategies based on cattle enterprise objectives, tradition, and management style but they mostly have comparable vegetation cover goals. To provide habitats for more diverse avian communities, conservation planners should consider management tools that create depth of disturbance beyond that provided by typical grazing strategies.

EFFECTS OF TIME-CONTROLLED LIVESTOCK GRAZING ON HABITAT OF SOUTHWESTERN WILLOW FLYCATCHERS IN WEST-CENTRAL ARIZONA. Zachary Smalls*¹, Larry Howery¹, Stuart Tuttle², George Ruyle¹, Robert Steidl¹; ¹University of Arizona, Tucson, AZ, ²NRCS, Flagstaff, AZ

ABSTRACT

The southwestern willow flycatcher (*Empidonax traillii extimus*) is an endangered subspecies of willow flycatcher that occupies dense riparian habitats of the southwestern United States. Many factors, including improper livestock grazing practices, are thought to explain declines in this species, although no long-term studies have sought to quantify the effects of grazing on willow flycatcher habitat. The main goal of our study was to determine how time-controlled grazing by domestic livestock affects willow flycatcher habitat in west-central Arizona by: 1) measuring key vegetation attributes before and after livestock grazing, and at the end of the growing season; 2) providing quantitative baseline data on riparian woody vegetation that are considered vital habitat characteristics; and 3) assessing the effects of episodic rainfall events throughout the year. We monitored vegetation on two ranches along the same watershed in west-central Arizona throughout 2015 and 2016, and focused on changes in vegetation in response to routine livestock grazing practices. Specifically, we monitored mean utilization (%) of woody and herbaceous plant species; biomass (%), cover (%), and height (m) of the dominant plant species (woody and herbaceous); and density (#/m²) of woody plant species (seedlings). Time-controlled livestock grazing (< 62 days) resulted in low relative and total utilizations (< 14%) for both herbaceous and woody plants during all sampling periods. Consequently, species composition, canopy cover, and woody height of non-seedling woody plants remained relatively stable across most sampling periods. Density of woody seedlings changed most in response to episodic flooding.

EFFECTS OF PRAIRIE DOG AND CATTLE DEFOLIATION ON WESTERN WHEATGRASS RHIZOME LENGTH AND TILLER DENSITY

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ABSTRACT

Western wheatgrass is an important cool-season species in the Northern Great Plains mixed-grass prairie for ecological function, wildlife habitat, and livestock forage. Western wheatgrass relies primarily on vegetative reproduction for recruitment. Daughter tillers are produced either from buds at the crown or buds along rhizomes. Crown daughters are relatively easy to study. Patterns of tiller recruitment from rhizomes are less understood because these are much more difficult to study without extensive excavation. They are, however, critical to understanding western wheatgrass persistence and responses to disturbances such as grazing and drought. We initiated a study to examine the impact of cattle and prairie dog grazing on rhizome tiller development on a ranch near Mahto, SD. In summer 2014, PVC collars (10cm diam. X 15 cm depth) were driven into the soil around western wheatgrass tillers (≥ 1 tiller/collar) in exclosures preventing cattle grazing located both on- and off prairie dog towns. PVC collars restrict new rhizomes to the soil core within the collar, allowing relatively easy examination of rhizome and tiller development. Approximately 200 tillers were included on-town and 200 off-town; half of each were located on thin claypan and half on loamy ecological sites (ES). Half of on-town tillers on each ES were open to prairie dog grazing; the remaining tillers were protected. Half of off-town tillers in each ES received simulated cattle grazing in summer 2015; remaining tillers were ungrazed. PVC-collared soil cores were excavated in fall 2016. Crowns and rhizomes were carefully extracted from each core and plant components (crowns, rhizomes, and tillers) were mapped, rhizome lengths measured, and crown and rhizome tillers counted. Data were analyzed to evaluate the impact of grazer (prairie dog, cattle) and ES (thin claypan and loamy) on the vegetative reproductive strategies of western wheatgrass.

MANAGING SPECIES AT RISK - POLICIES AND TOOLS

. Peg L. Strankman*; Barbwire Consulting, Airdrie, AB

ABSTRACT

Abstract:

The *Managing Species at Risk - Policies and Tools* workshop was sponsored by Environment and Climate Change Canada to discuss current knowledge and management of species at risk (SAR) on the Canadian Prairies.

The workshop focused on two broad areas. One addressed the opportunities in developing sustainable approaches to managing species at risk (SAR) and their needs. This included presentations on the use of tools such as modifying range health assessments, developing beneficial management practices and taking an ecosystem/multi-species approach. The use of citizen science was also explored.

The second area focused on the use of policies to lower the risk for ranchers protecting SAR habitat through conservation/management agreements, incentives such as payment for ecological services and providing additional management information through existing agricultural programs such as the provincial environmental farm plans (EFP).

The following is a summary of themes found in the presentations and discussions following the workshop. This presentation will elaborate on the project approaches and themes.

Primary themes

One size does not fit all. Respect the individuality of each agricultural operation.

Take a multiple species approach.

Getting more information into hands of producers is a good thing

Make the programs voluntary

Management changes are sometimes minimal cost

Economic viability of the operation must be considered.

Consistent long-term funding is necessary to make the programs operational

Strong participation from agricultural organizations is important

The first seven presentations featured projects currently underway under the Species at Risk Partnerships on Agricultural Lands (SARPAL) fund of Environment and Climate Change Canada. The SARPAL initiative is intended to promote voluntary (i.e. non-regulatory) protection of individuals, residences, and/or critical habitat located on commercial agricultural lands, through a partnership approach.

BEST MANAGEMENT PRACTICES FOR MONARCHS AND POLLINATORS ON WESTERN RANGELANDS

. Emma Pelton*; The Xerces Society, Portland, OR

ABSTRACT

Many wild pollinator species, including monarch butterflies and some bumble bee species, are in decline. Rangelands are essential to the conservation of pollinators, but land managers need science-based, actionable guidance. The Xerces Society for Invertebrate Conservation is working with multiple public land management agencies to develop meaningful Best Management Practices (BMPs) for monarchs and pollinators on western rangelands. The BMPs will address the needs of native bees and butterflies, including monarchs—a species which has declined by over 90% in the past few decades. The BMPs are based on 1) a thorough literature review of peer-reviewed and technical materials related to rangelands and pollinators and 2) surveys and interviews with practitioners and researchers who understand the science, practice, and economic issues related to pollinator conservation and habitat management in rangelands.

Management practices addressed in the BMPs include grazing, mowing, fire, pesticide use, restoration practices, and invasive species management. Guidance is region-specific and include optimal methods and timing of management activities for relevant species. The management practices are summarized in clear, concise guidance which can be used by practitioners in the field. The BMPs provide both a roadmap and technical guidance for incorporating pollinator conservation into rangeland management in the West.

ELEVATED CO₂ INDUCES SUBSTANTIAL AND PERSISTENT DECLINES IN FORAGE DIGESTIBILITY AND PROTEIN CONTENT IRRESPECTIVE OF WARMING IN MIXED-GRASS PRAIRIE. David Augustine*¹, Dana M. Blumenthal¹, Tim Springer², Dan LeCain¹, Stacey A. Gunter², Justin D. Derner³; ¹USDA-ARS, Fort Collins, CO, ²USDA-ARS, Woodward, OK, ³USDA-ARS, Cheyenne, WY

ABSTRACT

Increasing atmospheric [CO₂] and temperature are expected to affect the productivity, species composition, biogeochemistry, and therefore the quantity and quality of forage available to herbivores in rangeland ecosystems. Both elevated CO₂ (eCO₂) and warming affect plant tissue chemistry through multiple direct and indirect pathways, such that the cumulative outcomes of these effects are difficult to predict. Here, we report on a 7-year study examining effects of CO₂ enrichment (to 600 ppm) and infrared warming (+1.5°C day/3°C night) under realistic field conditions on forage quality and quantity in a semiarid, mixed-grass prairie. For the 3 dominant forage grasses, warming effects on *in vitro* dry matter digestibility (IVDMD) and tissue [N] were detected only in certain years, varied from negative to positive, and were relatively minor. In contrast, eCO₂ substantially reduced IVDMD (2 most abundant grasses) and [N] (all 3 grass species) in most years, except the two wettest years. Furthermore, eCO₂ reduced IVDMD and [N] independent of warming effects. Reduced IVDMD with eCO₂ was related both to reduced [N] and increased acid detergent fiber content of grass tissues. For the 6 most abundant forage species (representing 96% of total forage production), combined warming+eCO₂ increased forage production by 38% and reduced forage [N] by 13% relative to ambient climate. While the absolute magnitude of the decline in IVDMD and [N] due to combined warming+eCO₂ may seem small (e.g. from 63.3 to 61.1% IVDMD and 1.25 to 1.04% [N] for *P. smithii*), such shifts could have substantial consequences for the rate at which ruminants gain weight during the primary growing season in the largest remaining rangeland ecosystem in North America. With forage production increases, declining forage quality could potentially be mitigated by increasing stocking rates, and through management such as prescribed burning, fertilization at low rates, and legume interseeding to enhance forage quality.

WEIGHT GAIN AND BEHAVIOR OF RARAMURI CRIOLLO VERSUS CORRIENTE STEERS DEVELOPED ON CHIHUAHUAN DESERT RANGELAND

. Matthew M. McIntosh*¹, Andres F. Cibils¹, Rick E. Estell², Sergio A. Soto-Navarro¹, Alfredo Gonzalez², Shelemia Nyamuryekunge³, Sheri Spiegel⁴; ¹New Mexico State University, Las Cruces, NM, ²USDA - Agricultural Research Service, Las Cruces, NM, ³Range Science PhD, Las Cruces, NM, ⁴USDA - ARS Jornada Experimental Range, Las Cruces, NM

ABSTRACT

Raramuri Criollo (RC) steers are commonly raised for beef and finished on rangelands, while Corriente (CR) are often raised for rodeo sports. However, no data exist on weight gains and grazing behavior of rangeland-raised Criollo steers. An experiment was conducted in the Chihuahuan Desert using two cohorts of RC and CR to investigate the effects of biotype on growth performance and landscape utilization. Twenty-two 17-month (cohort 1) steers [10 RC (RC1) and 12 CR (CR1)] were weighed every 60 d between December 2015 and January 2017 and eighteen 8-month (cohort 2) steers [11 RC (RC2) and 7 CR (CR2)] were weighed every 60 d between December 2015 and August 2017 to determine individual body weight (WT), average daily gain (ADG), and body condition score (BCS). Nine steers from each cohort were monitored with Lotek 3300LR GPS collars at 5-min intervals during December 2015 and December 2016, respectively, to compare landscape utilization patterns of 5 RC and 4 CR individuals. Data were analyzed as repeated measures using mixed procedures of SAS. Separate analyses were conducted per age cohort. For cohort 1, ADG was greater ($P=0.03$) for RC1 than CR1 (0.18 vs 0.13 ± 0.09 kg). For cohort 2, ADG was greater ($P=0.01$) for CR2 than RC2 (0.22 vs 0.12 ± 0.10 kg). Moreover, BCS was not affected ($P>0.58$) for either cohort. Distance traveled daily by cohort 1 was not affected ($P>0.81$) by biotype, but CR2 walked farther during day and night than RC2 ($P<0.01$). CR1 followed more sinuous trajectories than RC1 counterparts from dusk to midnight ($P<0.01$). CR2 followed more sinuous movement trajectories than RC2 at night ($P<0.01$). Although some behavioral differences were found, these results imply that at a young age, CR grow faster than RC, but at an older age RC grow faster than CR.

USING GIS FOR HERDERS COMMUNITY ECOSYSTEM ASSESSMENT. CASE STUDY OF SELECTED SUMS IN KHUVSGUL, KHENTII AND KHOVD PROVINCES.

. Narangerel Davaasuren*¹, Tungalag Ulambayar²; ¹Open University, UK, Ulaanbaatar, Mongolia, ²Saruul Khuduu Environmental Research & Consultancy, Ulaanbaatar, Mongolia

ABSTRACT

Ecosystem services categories laid out by The Millennium Ecosystem Assessment MEA including provisional, regulatory, and cultural services captured the above links between ecosystem services and human well-being. The Nature Conservancy (TNC) Mongolia commissioned this study to gain a better understanding of herder priorities, perceptions and the current situation in its project sites to both better target their interventions, as well as have a baseline of information by which to compare and determine project impact in the future. The weighted density surfaces and kernel density GIS techniques were used in spatial analysis, and base data was collected using interview techniques. The herders were encouraged to pinpoint their camps locations using printed topographic maps. The interview data was processed using statistical methods and connected with camps locations, entered in GIS. Some findings were that relationship between household income and trends in ecosystems services the herders receive had shown the overexploitation of services in areas close to protected areas in Khuvsgul and close proximity to capital for Khentii herders was favorable in terms of having a higher income compare with other provinces.

GRAZING AND CLIMATE EFFECTS ON THE ECOLOGICAL STOICHIOMETRY OF DOMINANT SPECIES ON THE LOESS PLATEAU, CHINA

. Fujiang Hou¹, Lan Li², Xianjiang Chen², Shenghua Chang*², Saman Bowatte²; ¹Lanzhou University, Lanzhou, Peoples Republic, ²State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral Agriculture Science and Technology, Lanzhou University, Lanzhou 730020, China., Lanzhou, Gansu, Peoples Republic

ABSTRACT

The ecological stoichiometry is the study of investigating balance of energy and elements affected by organisms and their interactions in an ecosystem. In animal grazed grasslands energy and elements go through complex interactions. We examined the effects of different animal stocking rates on the elemental stoichiometry of three dominant grass species (*Stipa bungeana* (Sb), *Lespedeza davurica* (Ld), *Artemisia capillaries* (Ac)) grown on the loess plateau of China.

The experiment was conducted at Tianshui Grassland Research Station of the Lanzhou University, located in Huanxian County, Gansu Province, Western China. Twelve experimental plots (100 m×50 m) were established in 2001 with similar botanical composition. Tan sheep lambs grazed rotationally in three replicated 0.5 ha plots of four stocking rates (0, 2.7, 5.3 and 8.7 sheep/ha). Plant samples were collected in July to August in each year since 2001 to 2015 and the elemental composition (C, N, P, Zn, Mg, Fe, Mn, Ca, Cu) and the ratios of C/N, C/P and N/P were measured. We also investigated the effects of rainfall and temperature.

The 15-year measurements indicated stocking rates had no significant effect on the elemental composition of the plant species but the effects of plant species were significant. The C concentration was stable over time in all three species. The N concentration of the Ld was higher than other two species. The P concentration decreased 2001 to 2010 in all three species. Trace elements composition of the three species varied in different years. The C/N ratio was greater in Sb while N/P ratio was greater in Ld compared to other species. We found significant relationships of elemental composition and rainfall.

Our results indicate that plant identity and the environmental factors contribute more to the ecological stoichiometry of animal grazed grasslands of loess plateau than the grazing management.

Key words: Grazing, Loess plateau, ecological stoichiometry

ROTATIONAL GRAZING PROMOTE SHEEP PRODUCTIVITY RATHER THAN PLANT DIVERSITY IN ALPINE MEADOW OF THE QINGHAI-TIBETAN PLATEAU

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ABSTRACT

In an attempt to alleviate the problem of grassland degradation in Tibet, China's state and local authorities initiated a program in 2003 called 'retire livestock and restore pastures (Harris, 2010). As part of this campaign, introduced and carried out rotational grazing from developed countries by the government has been in progress for more than ten years (Kemp et al. 2013), which brings to light the question: is this program successful in the restoration of degraded alpine grasslands?

We set up a controlled grazing experiment that included CG-24, RG-48, RG-24 and NG in summer growing season. Specifically we examined the effect of grazing regimes on: i) sheep live weight gain of individual and hectare; ii) the above-ground community biomass and plant species diversity (plant species richness, Shannon-Weiner index and Camargo index of evenness). This is the only conventional sheep stocking rate and seasonality of stocking study conducted on the QTP. Statistical analyses used SAS software, Version 9.3 (SAS Institute Inc., Cary, NC, USA).

We found that sheep gained their live weight during summer season. There were no significant difference between continuous grazing and rotational grazing for live weight gain per sheep. Higher stocking rate (48 SM/ha) reduced sheep live weight gain. In contrast, sheep live weight gain per hectare of rotational grazing was significant higher than that of continuous grazing ($p < 0.05$). Twice stocking rate could increase sheep live weight gain per hectare significantly ($p < 0.05$). During summer season, there is no significant difference between continuous grazing and rotational grazing for standcrop and litter biomass. But they were different as time (month) changed. As a whole, grazing can increase plant diversity than no grazing and no difference in different grazing regime.

QUANTIFICATION OF PIOSPHERE - CASE STUDY OF YAK GRAZED IN ALPINE MEADOWS OF THE QINGHAI-TIBETAN-PLATEAU. Yi Sun*¹, Shuhua Yi², Fujiang Hou³; ¹Chinese Academy of Sciences, Lanzhou, Peoples Republic, ²Chinese Academy of Science, Lanzhou, Peoples Republic, ³Lanzhou University, Lanzhou, Peoples Republic

ABSTRACT

As the largest and highest grassland unit on the Eurasian continent, the Qinghai-Tibetan Plateau (QTP) plays a critical climatic role governing the Asian monsoon and is an important animal husbandry zone. Yaks are one of the two major ruminant species, playing an increasingly important role in supplying milk and meat to local residents and maintaining the ecological environment on the QTP rangeland. The piosphere effect, defined as a radial pattern of grazing animal influence on grassland is common in herbivore grazing systems where, for example, animals are penned overnight. However, to date, no direct quantification of animal distribution exists, which hinders the progress of studies on the interactions between grazing animal and vegetation. In this study, we selected a typical household-level ranching grassland with alpine meadow on QTP and monitored: 1) the hourly spatial distribution of each yak; 2) the monthly vegetation dynamics on fixed locations using unmanned aerial vehicle (UAV). We found 1) grazing pressure decreased with increasing distance from night pens in the early growing season; however this pattern reversed in the late growing season; 2) vegetation biomass increased with increasing distance from night pens through whole growing season; and 3) no relation was found between grazing pressure/vegetation dynamics with river distance in the pasture. The monitor and analysis method realized dynamic monitoring of whole animal herd with high frequency, resolution and efficiency, and low cost. Widespread and long-term monitoring will improve our understanding of piosphere and be beneficial for grassland grazing management.

POTENTIAL OF ACCELEROMETERS TO REMOTELY DETECT DISEASES, SUCH AS BOVINE EPHEMERAL FEVER IN CATTLE

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ABSTRACT

Bovine ephemeral fever (BEF), commonly known as three-day sickness, caused by bovine ephemeral fever virus which is transmitted by mosquitoes and other biting insects. The characteristic symptoms include stiffness, lameness, fever, nasal and ocular discharges, while in more severe cases the disease causes hypocalcemia which can generate cessation of rumination, muscle tremors, and constipation. These symptoms generally last on average 2 to 4 days. A study was conducted in Rockhampton, Queensland, Australia using accelerometers to measure the drinking behavior of eight beef heifers for a six-week period. Cattle were fitted with collars containing a triaxial accelerometer, with a sampling rate of 25 Hz. Two cattle were diagnosed by staff and later by a veterinarian with BEF during the experiment, the first on September 12, 2016 and the second on October 1, 2016. With the diagnosis, accelerometer data were analyzed to determine if the onset BEF could have been detected prior to the onset of clinical symptoms based on changes in activity patterns. Prior to the onset of BEF, normal grazing and resting activity patterns were readily identified from the sensor data. On the day heifers were diagnosed, but before symptoms were observed by staff, heifer activity was reduced. Motion intensity during the period heifers were ill showed long periods of less movement and period episodes of intense movements. These data suggest that heifers became less active when they were ill and corresponding stiffness, tremors and other symptoms may intensified periodic movements, such as walking. Accelerometers recorded clear changes in heifer activity after becoming ill with BEF compared to their behavior several days earlier, which suggests that these sensors may be useful in remotely detecting the onset of cattle diseases, such as bovine ephemeral fever, before clinical signs can be observed on rangelands under typical management scenarios.

POTENTIAL OF ACCELEROMETERS AND GPS TRACKING TO REMOTELY DETECT THE ONSET OF PERENNIAL RYEGRASS STAGGERS IN SHEEP

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ABSTRACT

Perennial ryegrass staggers (staggers) is a neurotoxic condition that is caused by consumption of grass (*Lolium perenne*) that is infected with certain *Epichloë* fungal endophyte strains that produce toxins that can adversely affect and potentially kill sheep. Symptoms include head shaking, changes in gait, stiffness and falling. Affected sheep can recover after removing them from pastures containing those endophyte strains. A study was conducted in Lincoln, New Zealand to determine if the onset of staggers could be identified with GPS tracking and accelerometers. Fourteen sheep per treatment grazed in either an endophyte-infected ryegrass pasture or an endophyte-free control pasture for 17 days in late March and early April. Sheep were fitted with collars containing a 3-axis accelerometer recording movements at 12 hertz. Three sheep per treatment were also tracked at 3-minute intervals with GPS receivers. Sheep were scored by an experienced observer for symptoms of staggers weekly and at the end of the study using a 0 to 5 scale. Control sheep did not display any symptoms of staggers and 10 sheep in the infected pasture displayed little or no symptoms (0 or 1 score). The other 4 sheep in infected pasture had scores from 2 to 4 at the end of the study. Sheep grazing in the infected pasture (4350 ± 63 m/day) moved slower ($P=0.04$) than sheep in the control pasture (4727 ± 56 m/day). Distance traveled varied among days, but there did not appear to be any temporal trends. Accelerometer data showed clear changes in behavior of affected sheep from the beginning to the end of the study. Accelerometers may be useful for remotely detecting the onset of perennial ryegrass staggers.

AN AGENT-BASED MODEL OF CATTLE GRAZING IN GEYER'S LARKSPUR HABITAT. Kevin Jablonski*, Randall Boone, Paul Meiman; Colorado State University, Fort Collins, CO

ABSTRACT

The many species of larkspur (*Delphinium* spp.) present one of the most serious, intractable, and complex challenges to livestock grazing management in the western United States. Larkspur plants contain numerous norditerpenoid alkaloids, which are potent neuromuscular paralytics that are particularly effective at killing cattle, with yearly herd losses estimated at 2-5% for those grazing in larkspur habitat. In addition, producers will often abandon or delay grazing in pastures with larkspur present, which creates a substantial opportunity cost and an impediment to the achievement of grazing management goals. Among the many challenges to improving our understanding of cattle-larkspur dynamics has been the difficulty of testing different grazing management strategies in the field, as the risk of dead animals is too great. Agent-based models (ABMs) provide a method of realistically testing alternate management strategies without risk to livestock. ABMs are bottom-up computational simulation tools that model the behavior of individuals as they interact with one another and the environment. They have been effectively applied in numerous disciplines, and have been recommended as an essential tool for understanding and managing complexity. We will introduce a spatially-explicit, behavior-based ABM of cattle grazing a real pasture with a dangerous amount Geyer's larkspur (*D. geyeri*). This model provides significant insight for producers dealing with larkspur and demonstrates the great potential of ABMs to address questions in livestock grazing management, including not just other discrete challenges but also fundamental aspects of livestock behavior amidst heterogeneity.

EVALUATING METHODS OF ESTIMATING FORAGE INTAKE BY GRAZING CATTLE.
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ABSTRACT

Daily forage intake of beef cattle on grazing lands can be variable depending on management, animal, and ecological factors, and is difficult to estimate. The animal unit (AU) concept is based on forage intake and is used to balance forage supply and demand on grazing lands. Forage demand is commonly reported as stocking rate (AU days of forage per ha; AUD/ha) and is calculated based on a ruminant consuming daily a certain percentage of its liveweight. There is disagreement among advisors and practitioners alike on the daily intake (AUD) of a grazing ruminant. The standard intake amount used by University Extension and federal agencies, such as the Natural Resources Conservation Service, ranges from 2.3% to 2.7% of liveweight (10 to 12 kg dry matter for a 450 kg animal). A stocking rate based on the 2.7% intake is lower than that of a 2.3% intake and likely results in reduced harvest efficiency and beef production; therefore, identifying and using accurate estimates of intake are critical. Research was conducted from 2013 through 2016 on a subirrigated meadow at the University of Nebraska-Lincoln Barta Brothers Ranch in the eastern Sandhills. Steers were rotated through pastures of two different grazing systems during the growing season. Immediately before and after the steers were moved to a new pasture, sample locations within the pastures were clipped at ground level, the clipped vegetation dried and weighed, and disappearance (intake) calculated. The difference in standing live vegetation biomass between the before and after clipping was considered intake. For the two grazing systems and 4 years of the study, estimates of forage intake were better predicted by the 2.3% of liveweight factor than the 2.7% of liveweight factor. These results confirm that the AUD equivalent of 10 kg DM/AUD is accurate.

THE FUTURE—COMBINING ENERGY PRODUCTION WITH RANGELAND CONSERVATION

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ABSTRACT

Alternative land use demands on rangelands are increasing as suburban expansion and energy development continue to rise. Land managers, owners, ranchers, and future energy developers need to work together to preserve rangeland production and the native species that rely on this habitat. Topaz Solar Farms, located on the Carrizo Plain in California exemplifies a successful partnership between agriculture, habitat conservation, and energy production. This 4,700-acre, 550-megawatt passive photo-voltaic solar farm is currently one of the largest solar projects in the world. Construction practices minimize environmental impacts while preserving natural resources, endangered species habitat, and existing agricultural land uses.

Monitoring studies found that native plant species occur more frequently in array fields than on reference sites. Average vegetation height is significantly greater in arrays compared with control sites. In 2017, grazing within 3348 acres of fenced arrays supported over 4000 head of sheep while aiding in habitat management for endangered species, invasive weed control, and fire fuel reduction. Monitoring tracks the federally listed San Joaquin kit fox, and state protected American badger within completed solar array fields. Site design preserves pronghorn antelope and other animal movement corridors. Topaz Solar Farms is an example for future energy projects of how collaboration between agencies, ranchers, conservationists, and developers can combine sustainable energy production, rangeland conservation, and rare species protection.