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Rangeland Ecology & Management Highlights

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Written and compiled by Jose S. Avila-Sanchez, Chloe E. Bates, Annalysa M. Camacho, Alexandria M. DiMaggio, Sarah Jacobson, Bradley K. Johnson, Michael T. Page, Edward C. Rhodes, Nicole J. Traub, and Humberto L. Perotto-Baldivieso

Forum: A change in the ecological understanding of rangelands in the Great Basin and Intermountain West, and implications for management: Revisiting Mack and Thompson (1982)

Barry L. Perryman, Brad W. Schultz, and Paul J. Meiman

The notion that rangelands west of the Rocky Mountains had evolved in the absence of herbivory has been prevalent in the literature for nearly 40 years. The 1982 thesis of Mack and Thompson led many to the conclusion that every undesirable outcome affecting western rangelands were attributable to the introduction of large domestic grazing animals. In this Forum paper, Perryman and others lay out archaeological and paleontological evidence suggesting that the lack of large hooved herbivores at the time of European settlement was but a blip in the evolutionary record spanning the previous 2.5 million years, and that key data were overlooked and/or misinterpreted. Additional research in the interim further underscored the pitfalls of this paradigm. Emphasis is placed on understanding ecological processes and the need to manage for decision-based outcomes, rather than attaining mythical pristine conditions that may not be realistic due to annual exotic invasive species and climate change.

Grazing behavior, forage quality, and intake rates of livestock grazing pastures occupied by prairie dogs

Jameson Brennan, Kenneth Olson, Patricia Johnson, Janna Block, and Christopher Schauer

Prairie dogs can reduce carrying capacity on rangelands through direct consumption of vegetation and by clipping plants, incidentally, competing with cattle. Other studies have suggested that forage quality and digestibility are greater on prairie dog towns than off towns, although quantifiable research is lacking. This study aimed to evaluate livestock grazing behavior, diet quality, and forage intake on pastures with varying degrees of prairie dog town cover. The results showed that cattle avoided prairie dog towns through the growing season, forage quality and intake rates were similar between prairie dog towns and off town sites. This study will inform land managers of potential forage contributions of on and off prairie dog town plant communities.

Modeling *Artemisia cana* landscape cover as a function of planting density and age to inform restoration of sagebrush habitats

Autumn D. Watkinson, M. Anne Naeth, and Shelley D. Pruss

Sagebrush, a plant that many at-risk species (like the greater sage grouse) heavily rely upon, has been in decline since European settlement. It occupies <60% of its historical range. In this study, a model of sagebrush cover as a function of age is developed to allow managers to calculate the densities of sagebrush seeds or plants required to obtain a specific amount of cover within a specified timeperiod. A strong relationship between stem diameter and age allows for a quick, non-destructive, method to age a patch of sagebrush. Using this model, managers can improve sagebrush cover for at-risk species; and select restoration sites where rapid growth of large sagebrush canopies can occur.

Using satellite-based vegetation data for short-term grazing monitoring to inform adaptive management

V.S. Jansen, C.A. Kolden, H.J. Schmalz, J.W. Karl, and R.V. Taylor

Using remotely sensed data to estimate traditional field-based measurements (i.e., biomass, cover, bare ground, utilization) in grasslands, is important for proper grazing management. However, these datasets are not necessarily useful or available to land managers or ranchers for practical applications. This study tested the relationship between remotely sensed biomass data and stocking rate at the pasture scale and field-based utilization estimates at the plot scale. For the pasture scale and plot scale estimates, they found fall mean biomass and the relative difference between summer and fall biomass were most consistent. The results coupled with managers' knowledge of pastures, showed why some pastures deviated from the trends. This study proved that remotely sensed data can relate to traditional field monitoring methods and be used to inform adaptivemanagement.

FeatherFlame: an arduino-based thermocouple datalogging system to record wildland fire flame temperatures *in agris*

Devan Allen McGranahan

The FeatherFlame system is a low cost, do-it-yourself alternative to the traditional thermocouples used by rangeland scientists and managers for measuring wildland fire behavior. Traditional thermocouples are costly and can be limited by the amount of information collected in the field. The FeatherFlame system facilitates high replication at multiple spatial scales and the compact design allows for reliable measurement in the field with good device protection from heat and flames.

Use of plant growth regulators to expand sagebrush germination rates for restoration efforts

Chelsea E. Keefer, Samuel B. St. Clair, Janae Radke, Phil S. Allen, Benjamin W. Hoose, Savannah Fahning, Nicholas K. Hayward, Tamzen K. Stringham, and Matthew D. Madsen

Unhospitable environmental conditions are a limiting factor for germination of Wyoming big sagebrush and low sagebrush, species used for restoration. Three types of plant growth regulators were applied to seeds with the objective of testing the feasibility of expanding the period of germination on these species. Results showed that germination periods could be accelerated or delayed with the use of these plant growth regulators and proves the need for field studies to further develop this strategy for seeds in highly variable climates.

Managing grazing on California rangelands in the context of state climate policy

Nicole Buckley Biggs and Lynn Huntsinger

About one third of total soil carbon stocks are stored in rangelands, making grazing systems of interest due to their ability to mitigate climate change by sequestering soil carbon. This article reviews the potential for and trade-offs in using grazing systems as a climate change mitigation tool on California's annual rangelands and the ability of grazing management to support state climate goals. The authors conclude that using managed grazing to augment soil organic carbon presents significant challenges on California annual rangelands and should not be prioritized as a climate change mitigation strategy unless for research and data collection. Policymakers are advised to protect existing soil carbon stocks by preventing rangeland conversion to development or intensified agriculture and need to consider potential impacts on various ecosystem services when assessing the value of grazing systems.

Activity and overlap among birds and mammals scavenging a bison carcass in shortgrass prairie

Haley Obermueller, Kate Wilkins, and Liba Pejchar

Bison are key species in grassland ecosystems due to their effects on plant communities and nutrient cycling however, little is known on their status for vertebrate scavengers. This study focused on interspecific and intraspecific scavenger

activity on a bison carcass using data from wildlife cameras. The authors analyzed 45,000 photos and found 86% of photos captured intraspecific activity (coyotes (51%), common raven (50%), black-billed magpie (14%), and golden eagle (0.11%)) and 14% captured interspecific activity (common raven and black-billed magpie (64%), coyote and black-billed magpie (25%), and coyote and common raven (7%)) of scavenging on the carcass over a 6-week period. This study admittedly was limited to one individual at one location. However, their findings provide evidence that bison carcasses may provide an important winter food source for vertebrate scavengers.

Technical Note: A rapid method to estimate root production in grasslands, shrublands, and forests

Kerry M. Byrne

Net primary production is a critical ecosystem property that researchers and land managers attempt to quantify across ecosystems globally. A large amount of net primary production, below-ground net primary production, is often not measured due to amount of labor intensity. The author provides an efficient method to estimate below-ground net primary production using root ingrowth cores and modifications to existing root-washing methods. The author provides a detailed step-by-step instruction guide on how to accomplish these estimates.

Vegetation canopy gap size and height: Critical indicators for wind erosion monitoring and management

Nicholas P. Webb, Sarah E. McCord, Brandon L. Edwards, Jeffrey E. Herrick, Emily Kachergis, Gregory S. Okin, and Justin W. Van Zee

Vegetation cover directly protects soil surfaces from erosive winds and reduces erosion by extracting momentum from the air. In this paper, the authors present why canopy gap size distribution and vegetation height are critical indicators of rangeland wind erosion and health. They compare the literature and conceptual models to demonstrate the importance of canopy gap size distribution and vegetation heights to help efforts to manage wind erosion hazards on rangelands.

Using adaptive management to restore grasslands invaded by tall fescue (*Schedonorus arundinaceus*)

Jaime J. Coon, Nicholas J. Lyon, Edward J. Raynor, Diane M. Debinski, James R. Miller, and Walter H. Schacht

Tall fescue (*Schedonorus arundinaceus*) is a highly invasive, cool season grass threatening diversity in the eastern Great Plains. One time uses of herbicide, native seeding, and cattle grazing were used to study the effect on the cover of tall fescue and native grasses and forbs over a 4-year period. Glyphosate spraying greatly reduced tall fescue and the addition of native seeding increased warm-season grass species. Although differences between grazed and ungrazed sites were not substantial, deferment of grazing in early stages is recommended for increased success of warm-season grass establishment.

Preemergent herbicide protection seed coating: A promising new restoration tool

Corinna M. Holfus, Roxanne C. Rios, Chad S. Boyd, and Ricardo Mata-González

Exotic annual grasses negatively impact ecosystem function in US sagebrush (*Artemisia L.*) steppe throughout the Great Basin region by outcompeting native perennial bunchgrasses, increasing fire ignition and frequency, and degrading soils by modifying the nutrient cycling process. Research has shown preemergent herbicide treatments effectively reduce annual grass abundance; however, this process injures or kills native perennial bunchgrass seedlings as well. The authors studied the effects of applying an activated carbon-based herbicide protection coating to individual bluebunch wheatgrass (*Pseudoroegneria spicata*) seeds in conjunction with a preemergent herbicide treatment in a laboratory environment. This proof-of-concept study allows for the possibility of concurrently performing seeding and weed control, although field studies are recommended to determine success rates in natural environments.

Sheep trampling modifies soil and plant C:N:P stoichiometry in a typical steppe of the Loess Plateau

Lan Li, Jing Zhang, Xiong Z. He, and Fujiang Hou

Nutrient cycling of terrestrial ecosystems is regulated by herbivores trampling topsoil and vegetation, selective foraging, and excreting feces and urine. However, the effects of trampling on soil-plant interactions and stoichiometry remain unclear. The researchers conducted a 2-consecutive-year field study to explore the effects of simulated sheep trampling intensity on soil and plant carbon:nitrogen:phosphorous (C:N:P) stoichiometry in a typical steppe of the Loess Plateau, China. Trampling increased total soil and plant concentrations of N and P, but decreased plant C. Soil ratios of C:N, C:P, and N:P remained stable; however, trampling decreased plant C:N and C:P ratios. Plants had a differential response to trampling depending on species, indicating the effect trampling has on plants is not equivalent to the impacts on the soil. This study provides evidence that the effects of livestock trampling versus grazing on grasslands need to be isolated, and suggests moderated trampling intensity (40 footsteps per square meter is equivalent to a stocking rate of 2.7 Tan sheep per hectare) does not negatively impact soil-plant interactions and may be compatible with rangeland restoration objectives.

Reduction of grazing capacity in high-elevation rangelands after black locust invasion in South Africa

Gerald Chikowore, Reyard Mutamiswa, Guy F. Sutton, Frank Chidawanyika, and Grant D. Martin

Invasive plant species have been a problem to native rangelands by disrupting the integrity and provision of ecosystem services for human well-being. In addition, invasions impact negatively native vegetation and biodiversity, by disrupting ecosystem interactions and changes in structure and function of the ecosystem. The objective of this study was to measure

the impact of the invasive alien plant black locust on native rangelands, by measuring different variables on invaded and non-invaded sites. This study finds the black locust invaded sites to have a reduced abundance and diversity of native grasses, with an addition of introduced grasses and forbs. The invasion of alien plants into a native rangeland leads to negative impacts and unfavorable plant succession, favoring future invasion of alien plants.

Drought alters the understory of pinyon-juniper woodlands indirectly through tree dieback

Samuel W. Flake and Peter J. Weisberg

The increasing tree mortality, due to severe drought, in dry forests and semiarid woodlands is cause for concern. However, increased mortality in trees has the potential to have indirect positive effects on understory vegetation. In this study, understory abundance before and at the end of a severe multiyear drought was compared in pinyon-juniper woodlands within the Nevada Great Basin, United States. While understory vegetation did exhibit greater abundance at sites with greater tree mortality, this relationship may also be affected by factors such as topography, elevation, and understory community structure. In the future, tree mortality may lead to changes in understory composition as different plants take the place of deceased trees.

Individual and combined effects of fall fire and growth-regulator herbicide on annual bromes

Lance T. Vermeire, Matthew J. Rinella, and Dustin J. Strong

Invasive winter annual grasses have negative impacts on grasslands. Fire and herbicides are common approaches to provide short-term control. This study tested the effect of individual and combined effects for Fall fire and the herbicide aminopyralid on annual brome. Spring application of aminopyralid decreased germinability but had no effect on biomass. Fire reduced canopy composition 3 out of 4 years during the study. Both fire and herbicide reduced forbs contribution to canopy cover; however, they did not provide enough control for the annual brome. Long-term commitments are required to control invasive species.

Improved microbial water quality associated with best management practices on coastal dairies and livestock grazing operations

Dylan J. Voeller, Brannon Ketcham, and Benjamin H. Becker

Runoff from dairy and livestock grazing operations has the potential to introduce bacteria to surface water bodies, creating a prospective risk to public health and ecological processes. Agricultural best management practices (BMPs) are a way to contain or lessen the delivery of pathogens into surface waters. In a 13-year study, fecal indicator bacteria (FIB) were monitored downstream of BMPs implemented on dairy and livestock operations in the Point Reyes National Seashore in California. Execution of BMPs resulted in a 54-99% decrease in FIB and a 6-fold increase in the frequency of samples meeting the regulatory water contact recreation standard. Conjointly, the authors successfully bridged the use of

fecal coliform and *Escherichia coli* data to create a continuous FIB dataset over the 13-year period. These results add to the body of literature attesting to the benefits of proper BMP implementation in watershed management.

Forage quantity and quality dynamics due to weathering over the dry season on California annual rangelands

Royce E. Larsen, Matthew W.K. Shapero, Karl Striby, LynneDee Althouse, Daniel E. Meade, Katie Brown, Marc R. Horney, Devii R. Rao, Josh S. Davy, Craig W. Rigby, Kevin B. Jensen, and Randy A. Dahlgren

During the dry summer months in the annual rangelands of California, aboveground biomass degrades which leads to loss of available forage and soil cover. The authors of this study examined biomass and nutritional losses of aboveground biomass production through the dry season (May-October) across three contrasting rainfall years on the Central Coast of California. The average fractional aboveground biomass loss over the summer weathering period was found to be 54.4% and was negatively correlated with peak biomass and positively but weakly correlated with forb percentage, both of which are related to annual rainfall. Forage quality metrics were also strongly affected by summer weathering, with a de-

crease in crude protein concentration and increases in fiber and lignin concentrations. These losses in forage biomass and nutrients should be considered when determining livestock grazing strategies.

Predicting cattle grazing behavior on rangeland using accelerometers

James E. Sprinkle, Joseph K. Sagers, John B. Hall, Melinda J. Ellison, Joel V. Yelich, Jameson R. Brennan, J. Bret Taylor, and James B. Lamb

Understanding cattle grazing behavior is a key component of beef cattle management however it can be labor intensive and difficult to obtain this information on a regular basis. The objective of this study was to evaluate the use of accelerometers for determining daily activity of cattle grazing rangelands. The accelerometers were successful at identifying patterns of grazing behavior and differentiated among climatic, grazing system, supplementation status, and residual feed intake. This study shows that accelerometers can be effective in determining mechanistic adaptations in grazing behavior of beef cattle on rangelands.