



Rangeland Ecology & Management Highlights

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Fall-winter grazing after fire in annual grass-invaded sagebrush steppe reduced annuals and increased a native bunchgrass

Kirk W. Davies, John D. Bates, Barry Perryman, and Sergio Arispe

Invasion of sagebrush steppe ecosystems by exotic annual grasses, such as cheatgrass and medusahead, is a growing concern. This invasion increases frequency of wildfires and further displacement of native vegetation, creating a toxic cycle in colonized systems. Fall-winter grazing by cattle has been discussed as a potential tool for reducing exotic annual grasses and encouraging perennial vegetation. This fall-winter grazing method was tested for four years following a wildfire in an annual grass-invaded Wyoming big sagebrush steppe. Postfire grazed areas showed less density of exotic annual grasses than ungrazed areas. In addition, Sandberg bluegrass density was greater in grazed areas vs. ungrazed, though results were inconclusive on overall effect for native perennial grasses. This study provides evidence that fall-winter grazing by cattle post-fire may reduce dominance of invasive annual grasses.

Tracking and sensor-based detection of livestock water system failure: A case study simulation

Colin Tobin, Derek W. Bailey, and Mark G. Trotter

Water is critical to the survival of cattle grazing in arid and semiarid rangelands. However, the time, labor, and technology invested in water monitoring increases the cost of grazing operations in expansive pastures. To explore less-expensive alternative measures, a subset of the herd was fitted with GPS collars and a portion of the subset were also equipped with triaxial accelerometers. A 4-hour water system failure was repeatedly simulated within a pasture study site located in Arizona, USA. GPS and accelerometer data from before, after, and during the simulation were analyzed for movement and behavior patterns that could serve as indicators of water system failure. Accelerometer data displayed a significant increase in movement intensity on the days of introduced failure and GPS data showed a significant decrease in distance traveled from the water source following a simulated failure. Analyzing animal behavior via real-time GPS tracking can be a cost-effective method to reduce the time and labor associated with identifying and repairing a water system failure thus increasing livestock health.

Assessing sustainability goals using big data: collaborative adaptive management in the Malpai borderlands

Brandon T. Bestlemeyer, Sheri Spiegel, Rich Winkler, Darrington James, Matthew Levi, and Jeb Williamson

Collaborative adaptive management (CAM) is an approach meant to bridge the gap between social and ecological goals. Assessing the results of this approach, however, is difficult. This study was conducted to develop a method of evaluating outcomes of this kind of management. Big data, involving long term spatial-temporal gridded or country-level datasets were used in addition to local information to compare the CAM focused Malpai borderlands landscape and surrounding non-CAM areas. The comparative big data approach of this study showed success in the Malpai Borderlands in meeting CAM goals. However, changes in climate, lowering water tables in the landscape, and demography changes will bring greater challenges to management in the future. Despite these changes, comparison showed the Malpai borderlands were higher in productivity than surrounding areas. The use of big data in coordination with local knowledge in this study is a novel approach that provides insight to the effects of collaborative adaptive management over a large landscape.

Using locally adapted seeds to restore native plants and arthropods after plant invasion and drought

Adam B. Mitchell, Andrea R. Litt, and Forrest S. Smith

Drought and non-native species can alter community mechanisms and restoration success. Climate change forecasts include increased aridity with more frequent and severe droughts. Climatic changes and increased land disturbance frequently lead to increased invasive species. The objective of this study was to investigate the effect of land disturbance and drought on native plant restoration. The study area, near Sinton, Texas, was dominated by Kleberg bluestem (*Dicanthium annulatum*) and other Old World bluestems (OWBs). Plot treatments included undisturbed, tilled but not seeded, and tilled and seeded. Twenty-five plant species were in the native seed mix including eight forbs and 18 grasses. Slender grama (*Bouteloua repens*), tallow weed bend (*Plantago spp.*), and Texas grama (*Bouteloua rigidisetata*) composed 59.17% of the seed mix. Rainfall was below average during each year of the study: 36% in 2011, 69% in 2012, and 76% in 2013. Drought severity was extreme and moderate in 2011 and 2012, respectively. Plots with and without seed had greater plant species richness than undisturbed plots dominated by OWBs. Arthropod richness was not significantly affected by seed treatments. However, arthropod richness increased as the drought conditions weakened in 2012 and 2013 regardless of the plots being undisturbed, seeded, or not seeded. The authors hypothesized that arthropods, which under normal circumstances consume seeds from the seedbank, had consumed the applied seed mix leaving the seedbank intact. This altered behavior allowed early successional and drought-tolerant species in the seedbank to become established. During droughts, seed addition may reduce consumption of the seed bank by arthropods. Range managers that

restore vegetative communities must account for the effects of multiple disturbances, including drought and non-native species, on community dynamics.

Soil salinity has species-specific effects on the growth and nutrient quality of four Texas grasses

Abigail R. Bell and Nicholas G. Smith

Evaporation of soil moisture can increase the salinity of shallow soils. Farmlands in xeric climates experience this reality regularly and exacerbate it with the repeated application and drying of irrigation water. This study investigated the effect of salinity on the establishment and nutritional value of four grasses in 9-week laboratory experiment. The grasses were little bluestem (*Schizachyrium scoparium* [Michx.] Nash), blue grama (*Bouteloua gracilis* [Willd. Ex Kunth] Lag. Ex Griffiths), sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.) and bermuda grass (*Cynodon dactylon* [L.] Pers.). Bermuda grass germinated consistently across the range of soil salinity, and it had the greatest biomass at the experiment's conclusion. Although blue grama decreased in germination with increasing salinity, both grama species had greater mass than little bluestem. Both grama species and little bluestem contained a greater percent nitrogen than bermuda grass. Bermuda grass had the highest carbon to nitrogen ratio of the four species. These variable effects across different species offers a multi-species approach to land conversion and range restoration. Range managers may look to bermuda grass to reestablish plant cover on soils with high salinity but may include blue grama and sideoats grama to increase the nutritional value of pasture grasses for grazers.

Trust is essential to the implementation of adaptive management on public lands

Aaron M Lien, Taylor Dew, George B Ruyle, Natalya Robbins Sherman, Natalia Perozzo, Marc Miller, and Laura Lopez-Hoffman

Adaptive management (AM) is an approach meant to allow experimentation and scientific learning in management of natural resources, which involves both the USFWS and ranchers. It has been hypothesized that this approach will lessen conflict between involved parties. To investigate this idea, the authors conducted semi structured interviews with ranchers and forest service personnel in Arizona and New Mexico areas where AM had been implemented ten years previously, and which had historically high conflict between ranchers and the USFWS. The results showed that AM itself did not reduce conflict, but rather, the three factors that determined success were objective range monitoring, open communication, and high levels of trust. The most deciding factor between high and low conflict areas was the trust between parties. The importance of trust will be essential for USFWS personnel to understand for future AM success.

Challenges of brush management treatment effectiveness in Southern Great Plains, United States

Reinhardt Scholtz, Samuel D. Fuhlendorf, Daniel R. Uden, Brady W. Allred, Matthew O. Jones, David E. Naugle, and Dirac Twidwell

Various brush management treatments are implemented in North America to improve rangelands affected by woodland expansion, including both mechanical and chemical treatments and prescribed fire. This study assessed the distribution of agency-supported methods of brush management across the southern Great Plains (Kansas, Oklahoma, and Texas) by comparing confidential private land records with a national inventory program.

Common management practices vary by state, but all three methods were shown to appear effective at local-scale sites (40-50 acres) with little to no net reduction in woodland habitat at regional scales. It is therefore recommended that the current management paradigm be examined and alternative practices that more effectively prevent regrowth of woody vegetation be implemented.

Ranch profitability of improving soil health on rangelands

Holly Dyer, Anna T. Maher, John P. Ritten, John Tanaka, and Kristie Maczko

Implementation of conservation practices are beneficial and often costly. This study evaluated ranch-level financial incentives for grazing management that resulted in improved soil health. Several hypothetical scenarios were considered to represent a central-Wyoming, profit-maximizing rancher. Modeled scenarios were compared with potential costs of practices that improved soil vitality. The net present value (NPV) of net benefits was determined positive if forage production increased immediately. However, immediate forage production is not likely, and most scenarios identified negative NPV benefits with higher implementation costs of rotational grazing than projected benefits from improved soil health. If soil-related conservation practices are to be widely adopted, financial assistance may be necessary for ranchers to break even.

The effects of continuous and rotational livestock grazing on forb quality and quantity: implications for pronghorn management

Jacob C. Locke, Justin T. French, Carlos E. Gonzales, Louise A. Harverson, Bonnie J. Warnock, and Shawn S. Gray

Forbs are a major component of pronghorn antelope diet in West Texas. Management practices of cattle grazing can affect many aspects of the vegetative community. Forb quality and quantity were measured under different grazing regimes; continuous, rotational, and ungrazed. Yearly variation in precipitation appeared to impact the outcomes associated with different management strategies. In wet conditions the rotational grazing regime increased productivity and quality over other regimes while drier conditions exhibited the greatest productivity and quality in ungrazed systems. Understanding the forage impacts of these different grazing strategies can help landowners manage for pronghorn antelope habitat.

Herbaceous production and soil nitrogen after mesquite mortality in Southern Great Plains (US) grassland

R. James Ansley, Tim J. Steffens, Caitlyn E. Cooper-Norris, and Tian Zhang

Honey mesquite (*Prosopis glandulosa*) can influence grass production and vegetation composition differently between subcanopy and intercanopy areas. This study compared herbaceous and soil nitrogen response between subcanopy and intercanopy (i.e., spaces between trees) microsites following a root-killing herbicide mesquite application. After 1 year, perennial grass and total herbaceous production were greater in treated sites in subcanopy and intercanopy areas, comprised primarily of Texas wintergrass. Composition of total herbaceous production varied considerably by the second year, however, mesquite removal yielded similar herbaceous production levels in each microsite. There was no strong association between soil inorganic N and increased herbaceous production when compared across all treatments and

microsites. This study suggests that grass forage production following mesquite control can deviate markedly from predicted results under variable conditions.

Perennial grass seedlings modify biomass and physiological traits in response to an annual grass neighbor

T.A. Jones, B.P. Bell, and Tom A. Monaco

Annual grasses such as downy brome can compromise perennial grass establishment associated with rangeland revegetation. The purpose of this study was to evaluate the influence of this neighboring annual grass on single-species perennial grass performance (seedling biomass production and water-relation traits) of bluebunch wheatgrass and Snake River wheatgrass. With downy brome present, both shoot dry matter and leaf area were reduced in both perennial grasses. Winter trails in the greenhouse resulted in low humidity conditions which drove high vapor pressure deficits leading to reduced water availability. In summer trails, perennial grasses were sensitive to heat and low water availability. Experimental populations of these species produced less shoot dry matter than older cultivars, suggesting that experimental varieties feature a more conservative growth strategy.

Outcome-based approaches for managing wildfire risk: institutional interactions and implementation within the “gray zone”

K. Wollstein, C.B. Wardropper, and D.R. Becker

The Bureau of Land Management (BLM) dynamically manages rangelands for multiple uses and is exploring implementing outcome-based approaches to provide greater flexibility in achieving desired ecological, social, and economic conditions. The authors conducted semi structured interviews with stakeholders in Idaho to examine perceptions of the implementation of such an approach. It was found that these perceptions were influenced by various factors, including the individual's beliefs of the efficacy of certain treatments and experience of the staff. It is therefore recommended that local context and interactions between policy and stakeholders be used to refine adaptations to reduce the degree of latitude provided in individual interpretation of policy.

Annual and 16-day rangeland production estimates for the western United States

Matthew O. Jones, Nathaniel P. Robinson, David E. Naugle, Jeremy D. Maestas, Matthew C. Reeves, Robert W. Lankston, and Brady W. Allred

Livestock, wildlife, and people depend on rangeland production. Production estimates have typically been done at finer scales via in-situ measurements. However, such measurements do not capture spatial heterogeneity in a geographical region, nor do they account for seasonal and temporal variation—two

factors that are key to effective management measures. By combining remote sensing methods with in-situ data aboveground biomass estimates could be produced in 16 day and annual intervals (1986–2019) for the entire western United States. Such data are critical for assessing and managing grass invasion and woody encroachment of rangeland systems. The enhanced temporal resolution of the data allows for better monitoring of factors such as climate and disturbance while the spatial resolution (30m) addresses the challenge of accounting for variability within and between datasets. Combining these data with local knowledge will also help address challenges at subregional scales (i.e., allotment, pasture, etc.)

Plant community assembly mechanisms of a subalpine meadow community along different successional time

Minxia Liu, Yibo Ma, Xinyu Wang, and Lu Xu

Successional processes influence plant community assemblages including species composition and diversity. This study evaluated the influence of plant composition and environmental factors as a function of species relatedness, nearest taxon (index), and species and phylogenetic diversity within five successional stages of a subalpine meadow community in the Qinghai-Tibetan Plateau. Results suggest that soil nitrate nitrogen and soil organic carbon significantly influence plant community composition along successional gradients. Early or middle successional community stages were primarily influenced by habitat filtering and late successional stages exhibited greater complexity including convergent phylogenetic structure. This information can be used to manage ecological restoration and improve community conservation.

Influence of seed conglomeration technology and planting season on Wyoming big sagebrush restoration

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A reduction of Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis*) over the last century has led to current efforts in reestablishing this species throughout western rangelands. The morphology associated with Wyoming big sagebrush seeds presents challenges for broadscale restoration using modern techniques. Combining modern techniques with seed conglomeration technology has shown promise in increasing the emergence and establishment of Wyoming big sagebrush. Seeding at the appropriate time or season can play an important role in restoration success. Traditionally, winter has been the recommended season for seeding Wyoming big sagebrush, however, results testing this recommendation were mixed, suggesting that seasonal flexibility in planting may still lead to successful outcomes.