Nevada Section Society for Range Management Suggested Reading: Fall 2020
Abstracts of Recent Papers on Range Management in the West

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Davies, K.W., J.D. Bates, and C.S. Boyd. 2020. Response of planted sagebrush seedlings to cattle grazing applied to decrease fire probability. Rangeland Ecology and Management. 73(5): 629-635.

Abstract:

Restoration of non-sprouting shrubs after wildfire is increasingly becoming a management priority. In the western U.S., Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) restoration is a high priority, but sagebrush establishment from seed is sporadic. In contrast, planting seedlings often successfully restores sagebrush, but is expensive and time consuming. After planting, hence, there is a need to protect the investment from disturbances such as fire that will erase gains in sagebrush recovery. Grazing is likely the only tool that can be applied feasibly across the landscape to decrease wildfire probability, but there are concerns that grazing and associated activities (e.g. trampling) may negatively impact sagebrush seedlings. We investigated effects of grazing by cattle, applied as a fine fuel management strategy, on planted sagebrush seedlings at five blocks for five years. Grazing substantial reduced exotic annual grasses, large perennial bunchgrasses, and total herbaceous cover, thus achieving fuel management goals. Sagebrush cover and reproductive efforts were almost 2-fold greater in grazed compared to non-grazed areas in the final year of the study. This suggests that grazing favored sagebrush, a generally unpalatable shrub, recovery, likely by reducing competition from highly palatable herbaceous vegetation. Density of sagebrush, however, was similar between grazed and non-grazed areas. This research demonstrates that grazing can be strategically applied to reduce the probability of wildfire in areas with planted sagebrush seedlings; thereby, protecting the investment in sagebrush recovery. With more refinement, it also appears that grazing can be utilized to accelerate the recovery of sagebrush and potentially other woody vegetation habitat by modifying the competitive relationship between herbaceous and woody vegetation.

Pyke, D.A., S.E. Shaf, M.A. Gregg, and J.L. Conley. 2020. Weed-suppressive bacteria applied as a spray or seed mixture did not control *Bromus tectorum*. Rangeland Ecology and Management. 73(6): 749-751.

Abstract:

We conducted two case studies testing effectiveness of a soil-borne bacteria, *Pseudomonas fluorescens* strain D7, in controlling Bromus tectorum (cheatgrass) when mixed with native seeds sown after a fire and when sprayed on a native community with high abundances of *B. tectorum*. Each case study area (162 ha) compared treatments with D7 present and absent and was replicated four times (20.3 ha each) in a completely randomized design. Response variables (foliar cover, aboveground biomass, and density of *B. tectorum*; density of sown native plants) were measured pretreatment for the sprayed area and each year for 3 yr after treatment at both study areas and were evaluated as a repeated measures analysis. Foliar cover, biomass, and density of *B. tectorum* with sprayed or seed mixture applications did not differ between D7-treated and untreated areas at any time within the study ($F_{1,6} \leq 1.42$; $P \geq 0.28$). D7 as a seed mixture did not significantly impact densities of native seedlings ($F_{1,6} = 1.27$; $P = 0.30$) at any time during the study. Results contrasted with previous D7 studies that showed effective control of *B. tectorum* within 3 yr of treatment. Since bioherbicidal methods are being commonly applied, we believe that

reporting negative results is important for future meta-analytical studies that provide managers with information on the likelihood for weed-suppressive bacteria to effectively control weeds.

Germino, M.J. and B.E. Lazarus. 2020. Weed-suppressive bacteria have no effect on Exotic or native plants in sagebrush-steppe. Rangeland Ecology and Management. 73(6): 756-759.

Abstract:

Approaches and techniques for control of exotic annual grasses are a high priority in rangelands including sagebrush steppe. Strains of the soil bacterium *Pseudomonas fluorescens* have been proposed to be selectively pathogenic to multiple species of exotic annual grasses ("Pf," weed-suppressive bacteria, "WSB"). However, defensible tests of the target and nontarget effects of these WSB strains in the field are needed. We evaluated the effects of D7 and MB906 strains of Pf WSB in sagebrush steppe invaded by cheatgrass (*Bromus tectorum* L), medusahead (*Taeniatherum caput-medusae* L. Nevski), and other exotic annual grasses. We evaluated the WSB strains with and without herbicides (imazapic, rimsulfuron) or discing to mix surface-spray of the WSB into deeper soils, and we replicated these tests in three ecoregions that differed in soils and climate. Over 3 yr after treatment, neither WSB strain affected cover of exotic annual grasses, perennial bunchgrasses, or the total community, either with WSB alone or in combination with herbicides or discing. WSB has received considerable attention and is being applied across large rangeland areas, but the WSB strains and methods applied here were ineffective. We recommend any future use of WSB be applied in an experimental fashion, with experimental design and measurement of responses, until its effects can be proven.

Blank, R.R., C.D. Clements, T. Morgan, D. Harmon, and F. Allen. 2020. Suppression of cheatgrass by perennial bunchgrasses. Rangeland Ecology and Management. 73(6): 766-771.

Abstract:

Long-term control of the invasive annual grass cheatgrass is predicated on its biological suppression. Perennial grasses vary in their suppressive ability. We compared the ability of a non-native grass ("Hycrest" crested wheatgrass) and two native grasses (Snake River wheatgrass and bluebunch wheatgrass) to suppress cheatgrass. In a greenhouse in separate tubs, 5 replicates of each perennial grass were established for 96 d, on which two seeds of cheatgrass, 15 cm apart, were then sown in a semicircular pattern at distances of 10 cm, 30 cm, and 80 cm from the established perennial bunchgrasses. Water was not limiting. After 60 d growth, cheatgrass plants were harvested, dried, weight recorded, and tissue C and N quantified. Soil N availability was quantified at each location where cheatgrass was sown, both before sowing and after harvest. Relative to cheatgrass grown at 80 cm, all perennial grasses significantly reduced aboveground biomass at 30 cm (68% average reduction) and at 10 cm (98% average reduction). Sown at 10 cm from established perennial grasses, cheatgrass aboveground biomass was inversely related with perennial grass root mass per unit volume of soil. All cheatgrass sown at 10 cm from "Hycrest" crested wheatgrass died within 38 d. Before sowing of cheatgrass, soil 10 cm from established perennial grasses had significantly less mineral N than soil taken at 30 cm and 80 cm. Relative to cheatgrass tissue N for plants grown at 80 cm, cheatgrass nearest to the established perennial grasses contained significantly less tissue N. All perennial grasses inhibited the $NO2^-$ to $NO3^-$ nitrification step; for "Hycrest" crested wheatgrass, soil taken at 10 cm from the plant had a molar proportion of $NO2^-$ in the $NO2^- + NO3^-$ pool of > 90%. In summary, a combination of reduced nitrogen availability, occupation of soil space by perennial roots, and attenuation of the nitrogen cycle all contributed to suppression of cheatgrass.

Amme, N., C.A. Pague, and M. D. Redmund. 2020. Change in piñon-juniper woodland cover since Euro-American settlement: Expansion versus contraction associated with soil properties. Rangeland Ecology and Management. 73(6): 847-855.

Abstract:

Woodland and forest ecosystems across western North America have experienced increased density and expansion since the early 1900s, including in the widely distributed piñon-juniper vegetation type of the western United States. Fire suppression and grazing are often cited as the main drivers of these historic changes and have led to extensive tree-reduction treatments across the region. However, much of the scientific literature on piñon-juniper expansion dates back only to the early 1900s, which is generally half a century after Euro-American settlement. Yet US General Land Office (GLO) surveys provide valuable insight into the historical extent and density of woodland and forest ecosystems as surveyors would note where on the landscape they entered and exited woodlands or forests and provided qualitative estimates of relative tree density. This study uses these GLO surveys to establish piñon-juniper woodland extent in the late 19th century at the incipient stages of Euro-American settlement in southeastern Colorado and compares these data with 2017 aerial imagery of woodland cover. We found substantial amounts of woodland contraction, as well as expansion: ≈61% of historically dense woodland is now savanna or open (treeless), whereas ≈57% of historically open areas are now savannas or woodlands. The highest rates of expansion occurred on shallow, rocky soil types with low soil available water capacity, which support little herbaceous vegetation and were consequently less likely to be affected by fire suppression or grazing. Meanwhile, the significant contractions in woodland extent occurred on deeper, upland soils with higher soil available water capacity, which were likely where early settlement and tree cutting was most prevalent. Our results provide mixed support for the widespread assumption of woodland expansion since Euro-American settlement in southeast Colorado and suggest that the expansion that has occurred in our study area is unlikely a result of past grazing or fire suppression.

Stowell, S.M. Love, R.B. Gagne, D. McWhirter, W. Edwards, and H.B. Ernest. 2020. Bighorn sheep genetic structure in Wyoming reflects geography and management. Journal Wildlife Management. 84(6): 1072-1090.

Abstract:

Aligning wildlife management boundaries with accurate biological units promotes effective conservation and management practices that reflect ecological and evolutionary processes. Neutral genetic markers allow for quantitative delineation of population structure without *a priori* assumptions or biases. In the United States, bighorn sheep (*Ovis canadensis*) are a charismatic component of Wyoming's biodiversity and a species that provides important viewing and hunting opportunities. Bighorn sheep abundances are relatively stable throughout Wyoming, and the species is managed by administrative units identified using expert knowledge, distribution and movement data, and geographic and administrative boundaries. We used a panel of 38 variable microsatellite loci and 512 base pairs of mitochondrial DNA sequence to identify the genetic structure throughout the state and in translocation source herds, quantify the extent of genetic diversity within each genetic cluster, and estimate the degree of gene flow among herds using blood and tissue samples collected 1989–2017. We identified genetic structure of Rocky Mountain bighorn sheep in the major mountain ranges of Wyoming, with strong support for ≥5 genetic clusters using microsatellite loci. These genetic clusters generally aligned with current management units, whereas mitochondrial data showed a more complex mosaic that was not geographically patterned. Genetic variation estimated from both markers was high within each herd and comparable among herds. The assignment of individuals reflected a combination of geographic isolation and translocation, which has been extensive. Our results provide a state-wide assessment of genetic diversity and structure that will enhance management by understanding the outcomes of translocation, identifying the source of unknown individuals, and parameterizing disease ecology models.

Jones, P.F., A.F. Jakes, D.R. Eacker, and M. Hebblewhite. 2020. Annual pronghorn survival of a partially migratory population. Journal Wildlife Management. 84(6): 1114-1126.

Abstract:

The importance of conserving migratory populations is recognized across a variety of ungulate taxa, yet the demographic benefits of migration remain uncertain for ungulate populations that exhibit partial migration. We hypothesized that migratory pronghorn (*Antilocapra americana*) would experience greater survival compared to residents by moving longer distances to avoid severe winter weather and access higher quality forage. We used a Bayesian time-to-event approach to analyze the fates of 175 radio-collared adult female pronghorn monitored over 8 biological years (2004–2011) in the Northern Sagebrush Steppe ecosystem. Annual survivorship of migratory pronghorn was 7% higher on average compared to residents but not statistically different. Migratory pronghorn had higher survivorship in summer and winter compared to residents, and few mortalities were observed during the short autumn and spring migration periods. Mortality risk for both movement tactics intensified under more severe winter weather; winter weather severity alone best explained annual pronghorn mortality risk. The top model predicted survival rates to decline on average by 56% over the range of observed winter climatic conditions. To minimize human impacts to pronghorn during extreme climatic events, we recommend working with transportation departments and land managers to enhance pronghorn crossings of roads and railroads, and landholders to modify fences to wildlife-friendly standards.

Brown, C.L., J.B. Smith, M.J. Wisdom, M.M. Rowland, B. Spitz, and D. A. Clark. 2020. Evaluating indirect effects of hunting on mule deer spatial behavior. Journal Wildlife Management. 84(7): 1246-1255.

Abstract:

Mule deer (*Odocoileus hemionus*) are widely hunted throughout western North America and are experiencing population declines across much of their range. Consequently, understanding the direct and indirect effects of hunting is important for management of mule deer populations. Managers can influence deer mortality rates through changes in hunting season length or authorized tag numbers. Little is known, however, about how hunting can affect site fidelity patterns and subsequent habitat use and movement patterns of mule deer. Understanding these patterns is especially important for adult females because changes in behavior may influence their ability to acquire resources and ultimately affect their productivity. Between 2008 and 2013, we obtained global positioning system locations for 42 adult female deer at the Starkey Experimental Forest and Range in northeast Oregon, USA, during 5-day control and treatment periods in which hunters were absent (pre-hunt), present but not actively hunting (scout and post-hunt), and actively hunting male mule deer (hunt) on the landscape. We estimated summer home ranges and 5-day use areas during pre-hunt and hunt periods and calculated overlap metrics across home ranges and use areas to assess site fidelity within and across years. We used step selection functions to evaluate whether female mule deer responded to human hunters by adjusting fine-scale habitat selection and movement patterns during the hunting season compared to the pre-hunt period. Mule deer maintained site fidelity despite disturbance by hunters with 72 ± 4% (SE) within-year overlap between summer home ranges and hunt use areas and 54 ± 7% inter-annual overlap among pre-hunt use areas and 56 ± 7% among hunt use areas. Mule deer diurnal movement rates, when hunters are active on the landscape, were higher during the hunting period versus pre-hunt or scout periods. In contrast, nocturnal movement rates, when hunters are inactive on the landscape, were similar between hunting and non-hunting periods. Additionally, during the hunt, female mule deer hourly movements increased in areas with high greenness values, indicating that mule deer spent less time in areas with more vegetative productivity. Female mule deer maintained consistent habitat selection patterns before and during hunts, selecting areas that offered more forest canopy cover and high levels of vegetative productivity. Our results indicate that deer at Starkey are adopting behavioral strategies in response to hunters by increasing their movement rates and selecting habitat in well-established ranges. Therefore, considering site fidelity behavior in management planning could provide important information about the spatial behavior of animals and potential energetic costs incurred, especially by non-target animals during hunting season.

Abu-Zanat, M.M.W., A.K. Al-Ghaaithi, and M. W. Akash. 2020. Effect of planting *Atriplex* seedlings in micro-catchments on attributes of natural vegetation in arid rangelands. Journal of Arid Environments. 180: 104199.

Abstract:

Forage productivity of degraded rangelands is low and can be increased through development of small structures across the land slope which capture overland flow and store it in the soil profile for subsequent plant use. Establishment of forage shrubs in micro-catchment structures is commonly practiced to boost forage production on degraded rangelands but its impact on natural vegetation is usually overlooked. This study aimed to compare the effect of planting 8-month-old seedlings of *Atriplex halimus* in contour ridges versus zero intervention on vegetation attributes of degraded rangelands. Six sites planted with *Atriplex halimus* in contour ridges were selected in Jordan Badia. Attributes of natural vegetation and *Atriplex* plants were monitored during March, April, and May of 2017 representing early, mid, and late-spring grazing. Percent cover, species richness, fresh, and dry weights of vegetation forage of treated and untreated areas averaged 30.0 and 12.4%, 2.9 and 1.7 species/m2, 1566 and 695 kg/ha, and 383 and 154 kg/ha, respectively. *Atriplex* browse contributed 15% to total forage production of treated areas.

Restoration of degraded arid rangelands through planting forage shrubs in contour ridges created topographic features that helped in harnessing surface runoff, created better growing conditions for vegetation and improved its attributes.

Pedrini, S., A. Balestrazzi, M.D. Madsen, K. Bhalsing, S.P. Hardegree, K.W. Dixon, and O.A. Kildisheva. 2020. Seed enhancement: Getting seeds restoration-ready. Restoration Ecology. 28: 266-275.

Abstract:

Seed enhancement technologies such as seed priming and seed coating, developed by the agricultural seed industry, are standard procedures for the majority of crop and horticultural seeds. However, such technologies are only just being evaluated for native plant seeds despite the potential benefits of such treatments for improving restoration effectiveness. Key approaches applicable to native seed include: (1) seed priming, where seeds are hydrated under controlled conditions, and (2) seed coating, in which external materials and compounds are applied onto seeds through a diversity of treatments. These technologies are commonly employed to accelerate and synchronize germination and to improve seed vigor, seedling emergence, establishment, and to facilitate mechanized seed delivery to site, through standardizing seed size and shape. Seed enhancement technologies have now been tested on native seeds to overcome logistical and ecological barriers in restoration. However, further research is needed to extend the application of seed enhancements to a broader array of species, ecosystems, and regions as well as to evaluate new and innovative approaches such as the incorporation of beneficial soil microorganisms and plant growth regulators in the coatings. As techniques in native seed enhancement develop, these approaches need to be capable of being scaled-up to provide the tonnages of seed required for global restoration.

Shaw, N., R.S. Barak, R.E. Campbell, A. Kirmer, S. Pedrini, K. Dixon, and S. Frischie. 2020. Seed use in the field: delivering seeds for restoration success. Restoration Ecology. 28: 276-285.

Abstract:

Seed delivery to site is a critical step in seed-based restoration programs. Months or years of seed collection, conditioning, storage, and cultivation can be wasted if seeding operations are not carefully planned, well executed, and draw upon best available knowledge and experience. Although diverse restoration scenarios present different challenges and require different approaches, there are common elements that apply to most ecosystems and regions. A seeding plan sets the timeline and details all operations from site treatments through seed delivery and subsequent monitoring. The plan draws on site evaluation data (e.g. topography, hydrology, climate, soil types, weed pressure, reference site characteristics), the ecology and biology of the seed mix components (e.g. germination requirements, seed morphology) and seed quality information (e.g. seed purity, viability, and dormancy). Plan elements include: (1) Site treatments and seedbed preparation to remove undesirable vegetation, including sources in the soil seed bank; change hydrology and soil properties (e.g. stability, water holding capacity, nutrient status); and create favorable conditions for seed germination and establishment. (2) Seeding requirements to prepare seeds for sowing and determine appropriate seeding dates and rates. (3) Seed delivery

techniques and equipment for precision seed delivery, including placement of seeds in germination-promotive microsites at the optimal season for germination and establishment. (4) A monitoring program and adaptive management to document initial emergence, seedling establishment, and plant community development and conduct additional sowing or adaptive management interventions, if warranted. (5) Communication of results to inform future seeding decisions and share knowledge for seed-based ecological restoration.