Nevada Section Society for Range Management Suggested Reading: Summer 2018

Abstracts of Recent Papers on Range Management in the West

Prepared by Charlie Clements, Rangeland Scientist, USDA Agricultural Research Service, Reno, NV

Table of Contents

NV-SRM Suggested Reading

Summer 2018

Davies, K.W, C.S. Boyd, M.D. Madsen, and A. Hulet. 2018. **Evaluating a Seed Technology for Sagebrush Restoration Across an Elevation Gradient: Support for Bet Hedging.** Rangeland Ecology and Management. 71(1):19-24.

Abstract:

Big sagebrush (*Artemisia tridentata* Nutt.) restoration is needed across vast areas, especially after large wildfires, to restore important ecosystem services. Sagebrush restoration success is inconsistent, with a high rate of seeding failures, particularly at lower elevations. Seed enhancement technologies may overcome limitations to restoration success. Seed pillows are one such technology designed to improve seed-soil contact in broadcast seedings by providing a favorable medium for seedling establishment and growth. Seed pillows have shown promising results in greenhouse studies; however, they have not been evaluated in the field. We compared broadcast-seeding seed pillows with broadcast-seeding bare seed in 2 yr across a large, burned elevation gradient. Compared with bare seed, we found no evidence that seed pillows improved sagebrush establishment and growth across the elevation gradient. Though our results suggest that seed pillows do not increase the likelihood of successful sagebrush restoration, they were successful at times when bare seeds were not, and the same was true for bare seeds. At least one of the two treatments was successful at 50% of the elevations over the 2 seeding yr. This suggests that a bet hedging approach, seeding both bare seed and seed pillows, may increase the probability of success. Further supporting the use of bet hedging, if both methods were used and seeding occurred in both years, success would have been 86%. Sagebrush density and cover varied by elevation. In the first-yr seeding, sagebrush density and cover generally increased with increasing elevation. In the second-yr seeding, sagebrush density and cover were greatest at the lowest and highest elevations. We speculate that at the lower elevations an unusually wet spring combined with limited herbaceous vegetation provided an ideal environment for sagebrush establishment and growth. Our results also demonstrate, counter to common assumptions, that lower elevations sagebrush seedings can be successful.

Dittel, J.W., D. Sanchez, L.M. Ellsworth, C.N. Morozumi, and R. Mato-Gonzalez. 2018. **Vegetation Response to Juniper Reduction and Grazing Exclusion in Sagebrush-Steppe Habitat in Eastern Oregon.** Rangeland Ecology and Management. 71(2):213-219.

Abstract:

Western juniper expansion is one of the largest threats to conserving sagebrush steppe ecosystems in the northwestern United States. Juniper expansion has degraded the sagebrush steppe by altering fire regimes and outcompeting shrubs and herbaceous vegetation for limited resources. We characterized the effect of juniper removal in a severely degraded sagebrush steppe habitat for 3 yr following juniper cutting. In addition, we measured the effect of low-intensity seasonal grazing on plant community recovery through cattle exclusion treatments. We monitored plant community composition (exotic annual grasses, preferred grasses, preferred forbs, and shrubs); fuel loads; and juniper recruitment in a factorial design of juniper removal and grazing exclusion. We found that although there were significant differences between cut and uncut juniper treatments, there were no consistent trends across all 3 yr. Our results suggest that other factors, such as timing of precipitation, may also have strong short-term effects on plant community composition. We detected no significant grazing effects during the study period, suggesting the current grazing regime is appropriate for the area. The cutting of juniper increased total fuel loads and herbaceous fuel loads. Compared with open interspace, a twofold increase in juniper seedlings and saplings was detected beneath juniper piles, which will act as sources for future juniper encroachment.

Denton, E.M., B.S. Smith, E.P. Hamerlynck, and R.L. Sheley. 2018. **Seedling Defoliation and Drought Stress: Variation in Intensity and Frequency Affect Performance and Survival.** Rangeland Ecology and Management. 71(1):25-34.

Abstract:

Our ability to restore rangelands is limited, and it is unknown if seedling herbivory on its own, or in interaction with other stressors, is a major contributor to restoration failure. To address this, we conducted two experiments: a No Defoliation (ND) experiment (n = 48), in which seedlings from three perennial grasses (crested wheatgrass [*Agropyron cristatum* {(L.} Gaertn.], bluebunch wheatgrass [Psuedoroegnaria *spicata* {Pursh} Á. Love], Sandberg bluegrass [*Poa secunda* J Presl]) were subjected to wet and dry water regimes for 4 mo, and a concurrent Defoliation (D) experiment (n = 95), in which seedlings were factorially assigned to two defoliation treatments—frequency (LOW, HIGH) and intensity (30% vegetation removal, 70% vegetation removal). Indicators of seedling performance were aboveground and belowground biomass (AGB and BGB), root:shoot ratio, tillering, and mortality. The effect size statistic, Hedge's g, allowed for comparisons between performance measures. Water stress induced reductions in most performance measures: BGB (g = ND: –1.3; D: –1.6), root:shoot ratio (g = ND: n.s.; D: –0.2), and tillering (g = ND: –1.7; D: –1.2), though not significantly for all species. For ABG, water stress interacted with defoliation, reducing performance less at an intensity of 70% (g = –2.0) as opposed to 30% (g = –3.0), but not always significantly in the former. Water stress also caused less reduction in AGB when no defoliation occurred (ND: –0.8; g = D: –2.5). Intensity and frequency of defoliation interacted; seedlings were generally resistant to reductions in performance except at high frequency, 70% defoliation. *Agropyron cristatum* and *P. spicata* displayed similar sensitivity to treatments, mostly in terms of changes in AGB and BGB, while *P. secunda* also experienced increased mortality and reduced tillering. If these differences in sensitivity result in differential survival, herbivory could impact species postrestoration population demographics.

Swanson, J.C., P.J. Murphy, S.R. Swanson, B.W. Schultz, and K. McAdoo. 2018. **Plant Community Factors Correlated with Wyoming Big Sagebrush Site Responses to Fire.** Rangeland Ecology and Management. 71(1):67-76.

Abstract:

Fire kills Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) and promotes cheatgrass (*Bromus tectorum* L.), a highly flammable and invasive annual in sagebrush communities with compromised resistance. To focus management on resistance and resilience of Wyoming big sagebrush communities with varying species composition, we studied 51 paired sites with burned and unburned areas. We quantified soil surface and foliar cover in 12 cover groups. Comparisons identified vegetation or soil surface factors that significantly ($p \leq 0.05$) correlated (Spearman's rank correlation coefficient = ρ) to burned area community composition. Cheatgrass cover in burned areas was greater where unburned areas had more cheatgrass cover ($\rho = 0.75$), litter cover ($\rho = 0.31$), and sagebrush plant canopy volume ($\rho = 0.40$), and less bare soil ($\rho = -0.39$) and cryptogam cover ($\rho = -0.32$). Cheatgrass cover in burned areas was not significantly correlated with unburned area perennial grass or forb cover. Burned area perennial grass cover appeared to be related to more perennial grass ($\rho = 0.77$) and native forb cover ($\rho = 0.30$), but less cheatgrass cover ($\rho = -0.39$) in unburned areas. Burned area native herbaceous dominance (native minus exotic herbaceous foliar cover) correlated with less cheatgrass cover ($\rho = -0.65$) and sagebrush canopy volume ($\rho = -0.34$) in unburned areas and with more perennial grass ($\rho = 0.30$) and sagebrush relative cover ($\rho = 0.39$) in adjacent unburned areas. Postfire site dominance could be of either native or exotic plants where cheatgrass cover on adjacent unburned sites was < about 15%. Native species however, never dominated or increased in dominance where cheatgrass was above 15%. Results suggest that cheatgrass cover before a fire played a strong role in determining postfire plant communities; this suggests management should focus on prefire and postfire management of cheatgrass and litter. Perhaps prescriptions and priorities should be more nuanced on the basis of driving variables of postfire response hypothesized to be cheatgrass, perennial grass, and shrub abundance.

Davies, K.W., C.S. Boyd, and J. D. Bates. 2018. **Eighty Years of Grazing by Cattle Modifies Sagebrush and Bunchgrass Structure.** Rangeland Ecology and Management. 71(3):275-280.

Abstract:

Grazing by cattle is ubiquitous across the sagebrush steppe; however, little is known about its effects on sagebrush and native bunchgrass structure. Understanding the effects of long-term grazing on sagebrush and bunchgrass structure is important because sagebrush is a keystone species and bunchgrasses are the dominant herbaceous functional group in these communities. To investigate the effects of long-term grazing on sagebrush and bunchgrass structure, we compared nine grazing exclosures with nine adjacent rangelands that were grazed by cattle in southeast Oregon. Grazing was moderate utilization (30 − 45%) with altering season of use and infrequent rest. Long-term grazing by cattle altered some structural aspects of bunchgrasses and sagebrush. Ungrazed bunchgrasses had larger dead centers in their crowns, as well as greater dead fuel depths below and above the crown level compared with grazed bunchgrasses. This accumulation of dry fuel near the meristematic tissue may increase the probability of fire-induced mortality during a wildfire. Bunchgrasses in the ungrazed treatment had more reproductive stems than those in the long-term grazed treatment. This suggests that seed production of bunchgrasses may be greater in ungrazed areas. Sagebrush height and longest canopy diameter were 15% and 20% greater in the ungrazed compared with the grazed treatment, respectively. However, the bottom of the sagebrush canopy was closer to the ground in the grazed compared with the ungrazed treatment, which may provide better hiding cover for ground-nesting avian species. Sagebrush basal stem diameter, number of stems, amount of dead material in the canopy, canopy gap size, and number of canopy gaps did not differ between ungrazed and grazed treatments. Moderate grazing does not appear to alter the competitive relationship between a generally unpalatable shrub and palatable bunchgrasses. Long-term, moderate grazing appears to have minimal effects to the structure of bunchgrasses and sagebrush, other than reducing the risk of bunchgrass mortality during a fire event.

Summers, D.D. and B.A. Roundy. 2018. **Evaluating Mechanical Treatments and Seeding of a Wyoming Big Sagebrush Community 10 Yr Post Treatment.** Rangeland Ecology and Management. 71(3):298-308.

Abstract:

Increased cover of perennial grasses and forbs would increase the wildlife and forage value of many Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis* Beetle & Young) communities, as well as increase their resistance to weeds. We compared six mechanical treatments in conjunction with seeding a Wyoming big sagebrush community in northern Utah over a 10-yr period. The treatments included disk plow followed by land imprinter, one-way Ely chain, one- and two-way pipe harrow, all applied in fall, and meadow aerator applied in fall and spring. A mixture of native and introduced grasses and forbs was broadcast seeded at 18.3 kg PLS ha^{-1} after the disk and before the imprinter and all other treatments. The experiment was installed in three randomized blocks, and density and cover data were collected before treatment in 2001 and 1, 2, 5, and 10 yr after treatment. All treatments initially reduced sagebrush and residual herbaceous cover and increased seeded species cover compared with the untreated control. By 10 yr after treatment, sagebrush cover was 24.5% ± 0.35% on the control, 1.6% ± 0.28% on the disk imprinter treatment, and 11.7% ± 0.79% on all other treatments. At that time, seeded grass cover was 16.5% ± 1.22% on the disk imprinter treatment and an average of 2% ± 0.1% on all other mechanical treatments. Sagebrush seedlings were recruited in all of the mechanical treatments, but least in the disk imprinter treatment. After 10 yr, the untreated control was dominated by decadent sagebrush and rabbitbrush, the disk imprinter treatment was dominated by seeded perennial grasses, and the other mechanical treatments shared dominance of sagebrush and native perennial grasses. Mechanical treatments changed the composition of this community while retaining sagebrush, but greatest understory increases were associated with greatest control of sagebrush and establishment of seeded species by disk imprinting.

Barga, S. and E.A. Leger. 2018. **Shrub Cover and Fire History Predict Seed Bank Composition in Great Basin Shrublands.** Journal Arid Environments. 154:40-50.

Abstract:

Dormant seeds in the soil are an important contribution to the regenerative potential of an area. Understanding factors that affect seed bank dynamics in arid regions provides insight into how communities respond to disturbance and environmental change. We characterized seed banks in a Great Basin sagebrush steppe system, using field surveys and seed bank studies to compare 17 sites that differed in above-ground vegetation, fire history, and grazing use. We asked whether shrub cover, ground cover, climate, or disturbance history were predictive of seed densities, diversity, the presence of rare species, and similarity between above- and below-ground communities. Fire frequency and a coarse measure of grazing use were not highly predictive of seed bank dynamics, with the exception that sites that burned <10 years ago had greater above- vs. below-ground similarity. Shrub cover predicted multiple below-ground characteristics: *Ericameria nauseosa* was associated with increased density of introduced species, *Chrysothamus viscidiflorus* was associated with increased densities of native annual species, and *Artemisia tridentata* was associated with increased richness of rare native species. Shrub cover estimates were predictive of seed bank composition, and suggest that areas dominated by *A. tridentata* would have the greatest restoration potential within their seed banks.

Lukacs, P.M., M.S. Mitchell, M. Hebblewhite, B.K. Johnson, H. Johnson, M. Kauffman, K.M. Proffit, P. Zager, J. Brodie, K. Kersey, A.A. Holland, M. Hurley, S. McCorquodale, A. Middleton, M. Nordhagen, J.J. Nowak, D.P. Walsh, and P.J. White. 2018. **Factors Influencing Elk Recruitment Across Ecotypes in the Western United States.** Journal of Wildlife Management. 82(4):697-710.

Abstract:

Ungulates are key components in ecosystems and economically important for sport and subsistence harvest. Yet the relative importance of the effects of weather conditions, forage productivity, and carnivores on ungulates are not well understood. We examined changes in elk (*Cervus canadensis*) recruitment (indexed as age ratios) across 7 states and 3 ecotypes in the northwestern United States during 1989–2010, while considering the effects of predator richness, forage productivity, and precipitation. We found a broad-scale, long-term decrease in elk recruitment of 0.48 juveniles/100 adult females/year. Weather conditions (indexed as summer and winter precipitation) showed small, but measurable, influences on recruitment. Forage productivity on summer and winter ranges (indexed by normalized difference vegetation index [NDVI] metrics) had the strongest effect on elk recruitment relative to other factors. Relationships between forage productivity and recruitment varied seasonally and regionally. The productivity of winter habitat was more important in southern parts of the study area, whereas annual variation in productivity of summer habitat had more influence on recruitment in northern areas. Elk recruitment varied by up to 15 juveniles/100 adult females across the range of variation in forage productivity. Areas with more species of large carnivores had relatively low elk recruitment, presumably because of increased predation. Wolves (*Canis lupus*) were associated with a decrease of 5 juveniles/100 adult females, whereas grizzly bears (*Ursus arctos*) were associated with an additional decrease of 7 juveniles/100 adult females. Carnivore species can have a critical influence on ungulate recruitment because their influence rivals large ranges of variation in environmental conditions. A more pressing concern, however, stems from persistent broad-scale decreases in recruitment across the distribution of elk in the northwestern United States, irrespective of carnivore richness. Our results suggest that wildlife managers interested in improving recruitment of elk consider the combined effects of habitat and predators. Efforts to manage summer and winter ranges to increase forage productivity may have a positive effect on recruitment.

Carlisle, J.D., D.A. Keinath, S.E. Albeke, and A.D. Chalfoun. 2018. **Identifying Holes in the Greater Sage-Grouse Conservation Umbrella.** Journal of Wildlife Management. 82(5):948-957.

Abstract:

The umbrella species concept, wherein multiple species are indirectly protected under the umbrella of a reserve created for one, is intended to enhance conservation efficiency. Although appealing in theory and common in practice, empirical tests of the concept have been scarce. We used a real-world, semi-protected reserve established to protect a high-profile umbrella species (greater sage-grouse [*Centrocercus urophasianus*]) to investigate 2 potential mechanisms underlying the concept's successful application: reserve size and species similarity. We estimated how much habitat protection the established reserve provided to 52 species of conservation concern associated with vegetation communities where greater sage-grouse occur. To illustrate the importance of reserve size, we compared the effectiveness of the established reserve to alternative greater sage-grouse reserves of various sizes and to simulated reserves of equal size but sited with no regard for greater sage-grouse. We further assessed whether key species' traits were associated with different levels of protection under the umbrella reserve. The established umbrella reserve protected 82% of the state's greater sage-grouse population and 0–63% of the habitat of the background species examined. The reserve outperformed equally sized, simulated reserves for only 12 of 52 background species. As expected, larger alternative reserves served as better umbrellas, but regardless of reserve size, not all species received equal protection. The established reserve was most effective at protecting the habitat of species that were most similar to the umbrella species (i.e., avian species, those highly associated with sagebrush plant communities, and those with widespread habitat). In contrast, the habitat of species with restricted distributions, particularly when combined with vegetation associations not closely matching the umbrella species, was not protected as well by the umbrella reserve. Such species require additional, targeted attention to achieve conservation objectives. Successful application of the umbrella species concept requires careful consideration of the characteristics of the umbrella species, the reserve delineated on its behalf, and the similarity of the umbrella species to its purported background species.

Germain, S.J., R.K. Mann, T.A. Monaco, and K. E. Veblen. 2018. **Short-Term Regeneration Dynamics of Wyoming Big Sagebrush at Two Sites in Northern Utah.** Western North America Naturalist. 78(1):7-16.

Abstract:

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is a widespread shrub across the western United States, and there is great interest among scientists and land managers in its ecology and conservation, particularly with regard to maintaining structural heterogeneity of sagebrush stands for wildlife habitat and livestock forage. Yet little is known about its short-term regeneration dynamics and the implications of those dynamics for changes in stand structure. We examined changes among sagebrush size classes across 3 years, as well as emergence of sagebrush from seed bank and seed rain samples at 2 sagebrush shrubland sites in northern Utah: a lower-density site (1.4 plants/m^2, SE 0.11) with no recent history of manipulation and a higher-density site (1.9 plants/m^2, SE 0.21) that had recently been treated with herbicide to reduce sagebrush cover. On both sites, numbers of sagebrush plants in the largest size class decreased over the 3-year time period, while dead and medium-sized sagebrush plants increased. At the higher-density herbicide-treated site, this size class shift appeared to be driven by growth of small plants into the medium size class, likely associated with reductions in numbers of (and competition from) large plants. At the lower density site, it appears that densities of large plants declined because the plants shrank in size, possibly due to herbivory. Sagebrush seed rain did not differ between fall and spring assessments. Forbs had the greatest representation in the seed bank, followed by grasses and then sagebrush, though the number of sagebrush seeds may be sufficient for seedling recruitment. These results illustrate that shifts among sagebrush size classes, especially transitions of small shrubs into the medium size class, may be a primary and immediate pathway of stand recovery, in addition to recruitment from seed. These findings underscore the importance of sagebrush stand structure to plant community health and may aid in anticipating responses to disturbances such as drought or herbivory.