

Nevada Section Society for Range Management Suggested Reading: Spring 2021
Abstracts of Recent Papers on Range Management in the West

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Grant-Hoffman, M.N. and H.L. Plank. 2021. [Practical post-fire sagebrush shrub restoration techniques](#). *Rangeland Ecology and Management*. 74: 1-8.

Abstract:

Wildfire is increasing in frequency and size in the western United States with climate change and invasive species such as cheatgrass. This increase is also causing an increase in the need for restoration techniques, especially in low-elevation, arid shrublands. Sagebrush shrublands are home to the threatened Gunnison sage-grouse and can take decades, if not longer, to recover after fire. We investigated management-friendly restoration techniques aimed at increasing sagebrush cover in a sagebrush system important to Gunnison sage-grouse and impacted by fire in western Colorado. We tested several restoration techniques that could be replicated in management actions to mitigate stressors on sagebrush recruitment, specifically herbivory by large ungulates, water limitation, and competition with other plants. We found that sagebrush grew and survived better when planted as transplanted seedlings versus seeds, when planted in areas where herbicide had been applied versus when vegetation was removed by hand tools, and when caged to prevent herbivory than when not caged. Surprisingly, providing supplementary water did not improve sagebrush transplant growth or survival over use of a microsite (small structure made of wood collected from the burn scar). Constructed microsities were meant to provide protection from wind, retain moisture, and provide shade. Overall, our results indicate that if sagebrush seedlings are provided shelter and structure, then survival can approach natural (not planted) rates and sagebrush can be successfully established in low-elevation sites.

Mata-Gonzalez, R., M.A.B. Abdallah, and C.G. Ochoa. 2021. [Water use by mature and sapling western juniper \(*Juniperus occidentalis*\) trees](#). *Rangeland Ecology and Management*. 74: 110-113.

Abstract:

A common argument for western juniper (*Juniperus occidentalis*) control in Oregon is the amount of water saved due to reduction in the number of trees. Yet a good understanding of water use by mature trees and sapling regrowth following mature juniper removal has not been documented. Such information is important to better assess how much water can be saved by juniper control. We used sap flow sensors to monitor water use by mature juniper in a control area and saplings in an area where juniper control occurred in 2005. Sap flow data collected between May 2017 and Sep 2019 showed the period of highest water use was in the summer, although this varied each year. In July 2017 (wettest yr of the study), mature trees used 144 L/d, approximately twice as much as in the average of July 2018 and 2019 (dry yr). During the period of maximum water uptake, mature trees used between 45 and 69 times more water than saplings depending on precipitation and, consequently, soil water availability. In summary, 1) juniper water use varies greatly with precipitation and 2) because of the large difference between mature and sapling trees, juniper control results in considerable water savings, even after a 14-yr period of juniper regrowth.

Ridder, L.W., J.M. Perren, L.R. Morris, B.A. Endress, R.V. Taylor, B.J. Naylor. 2021. [Historical fire and *Ventenata dubia* invasion in a temperate grassland](#). *Rangeland Ecology and Management*. 75: 35-40.

Abstract:

Ventenata (*Ventenata dubia* L.) is an invasive annual grass that has rapidly expanded its range across temperate grassland and shrub-steppe ecosystems in western North America. However, there is little published regarding its ecology, especially its relationship with fire on rangelands. The objective of this study was to examine the effect of fire on *ventenata* invasion in the Pacific Northwest Bunchgrass (PNB) Prairie. Given the influence of fire on the invasion of other annual grasses such as cheatgrass (*Bromus tectorum* L.), we expected that fire would facilitate the spread and increase in abundance of *ventenata*. In addition, we considered that annual variation in precipitation might mask the effect of fire and drive the year-to-year variation in production of *ventenata*. Therefore, we resampled 56 plots in 2015 and 2016 where frequency and foliar cover of *ventenata* had been recorded in 2008 and where 12 of these plots had burned in the past 15 yr. We then compared *ventenata* abundance (frequency and foliar cover) between burned and unburned plots within each sampling yr (2008, 2015, and 2016), as well as the change in abundance over time. Our data revealed that *ventenata* frequency and cover increased on all plots. However, there was not significantly higher abundance in burned plots in any of the sampling years. In addition, *ventenata* abundance did not increase more in burned plots over time. Our findings suggest that, unlike cheatgrass, fire may not be a driving factor in the spread and increase of *ventenata* across the PNB Prairie. This finding has important implications for the management and control of *ventenata*, as well as the conservation of the PNB Prairie.

Davies, K.W., J.D. Bates, and R. O'Connor. 2021. [Long-term evaluation of restoring understories in Wyoming big sagebrush communities with mowing and seeding native bunchgrasses](#). *Rangeland Ecology and Management*. 75: 81-90.

Abstract:

Restoring degraded plant communities is a global challenge and a major priority for land managers and conservationists. Degraded Wyoming big sagebrush communities (*Artemisia tridentata* ssp. *wyomingensis* [Beetle & A. Young] S.L. Welsh) have high sagebrush cover with a depleted perennial herbaceous understory. They are widespread in western North America and are a priority for restoration because they provide habitat for sagebrush-associated species and an important forage base for livestock production. Mechanically reducing sagebrush with mowing has been attempted to restore the understory in these communities but often fails because large native perennial bunchgrasses do not increase and exotic annual grasses proliferate. Seeding large native perennial bunchgrasses after mowing sagebrush may increase their density or cover and thereby limit exotic annual grasses. Native perennial bunchgrasses are slow growing; thus, long-term studies are needed to evaluate this treatment strategy. We evaluated mowing followed by drill-seeding large native perennial bunchgrasses in southeastern Oregon for 11 yr post treatment. Large bunchgrass cover and density were approximately 2 × greater with mowing followed by seeding compared with the untreated control. However, mowing, with and without seeding, increased exotic annual grasses and decreased biological soil crusts. Sagebrush cover was less in mowed treatments compared with the untreated control, but sagebrush cover increased over time. Mowing and seeding native bunchgrasses was less successful than desired, particularly since exotic annual grasses increased substantially. This treatment may be improved by reducing the disturbance

associated with mowing and drill seeding, decreasing exotic annual grass competition, and increasing the establishment of native perennial bunchgrasses. The results of our study indicate that seeding native bunchgrasses into degraded Wyoming big sagebrush communities has potential as a restoration treatment but needs refinement to improve success.

Pyle, L.A., R.L. Sheley, and J.J. James. 2021. [Timing and duration of precipitation pulses and interpulses influence seedling recruitment in the Great Basin](#). *Rangeland Ecology and Management*. 75: 112-118.

Abstract:

Precipitation pulses and interpulse dry periods are major drivers of dryland ecosystem function globally, yet how the patterning and timing of precipitation inputs and dry periods influence seedling recruitment in these systems is poorly understood. We conducted two experiments to understand how limited and variable patterns of precipitation inputs may influence recruitment of bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Löve). In the first experiment, we evaluated how precipitation magnitude and dry-d interval during spring influenced recruitment. Ambient precipitation was excluded during spring, and we experimentally applied 5 levels of water (25, 35, 45, 55, and 65 mm) and 5-dry-d durations (1, 2, 4, 6, or 8 dry d between waterings) to plots sown with *P. spicata*. In the second experiment, we evaluated how the seasonal timing and duration of dry d influenced recruitment. All ambient precipitation was excluded through late winter and spring, and we experimentally applied three levels of dry-d duration (10, 20, and 30 d) four times during the growing season (February, March, April, and May) to plots sown with *P. spicata*. We observed strong, nonlinear interactive effects of precipitation amount and dry-d interval on recruitment where the midpoint dry-d treatment (4 d) interacted with low water availability to drive a major decline in recruitment. We also found strong evidence that recruitment was limited by dry periods occurring in late winter as opposed to dry periods occurring through spring, with recruitment decreasing over 40% during February dry periods compared with dry periods in March, April, or May. By understanding how precipitation pulses and interpulse dry periods interact to drive recruitment, we can refine efforts to develop weather-centric restoration frameworks, as well as hone ongoing efforts to identify plant materials and seed enhancement technologies that may buffer effects of variable precipitation on recruitment.

Zimmer, S.N., G.J. Groszklos, P. Belmont, and P. B. Adler. 2021. [Agreement and uncertainty among climate change impact models: A synthesis of sagebrush steppe vegetation projections](#). *Rangeland Ecology and Management*. 75: 119-129.

Abstract:

Ecologists have built numerous models to project how climate change will impact rangeland vegetation, but these projections of future changes are difficult to validate, making their utility for land management planning unclear. In the absence of direct validation, researchers can ask whether projections from different models are consistent. High consistency across models, especially those based on different assumptions, would increase confidence in using projections for planning. Here, we analyzed 19 models of climate change impacts on sagebrush (*Artemisia tridentata* Nutt.), cheatgrass (*Bromus tectorum* L.), pinyon-juniper (*Pinus* L. spp. and *Juniperus* L. spp.), and forage production on Bureau of Land

Management (BLM) lands in the US Intermountain West. These models consistently projected the potential for pinyon-juniper declines and forage production increases. In contrast, models of cheatgrass mainly projected no climate change impacts, while sagebrush models projected no change in most areas and declines in southern extremes. In most instances, vegetation projections from high- and low-emission scenarios differed only slightly. The projected vegetation impacts have important management implications for agencies such as the BLM. Pinyon-juniper declines would reduce the need to control pinyon-juniper encroachment, and increases in forage production could benefit livestock and wildlife populations in some regions. Sagebrush conservation and restoration projects may be challenged in areas projected to experience sagebrush declines. Similar projections from high- and low-emission scenario models may increase confidence to consider model projections in planning. However, projected vegetation impacts may also interact with increasing future wildfire risk in ways single-response models do not anticipate. In particular, forage production increases could increase management challenges related to fire.

Keefer, C.E., S.B. St. Clair, J. Radke, P.S. Allen, B.W. Hoose, S. Fahning, N.K. Hayward, T.K. Stringham, and M.D. Madsen. 2021. [Use of plant growth regulators to expand sagebrush germination rates for restoration efforts](#). *Rangeland Ecology and Management*. 76: 48-55.

Abstract:

Seed germination during inhospitable environmental conditions can be a major barrier to direct seeding efforts in dryland systems. In the sagebrush steppe, Wyoming big sagebrush and low sagebrush are important shrub species used in restoration; however, seeding success is highly sporadic due to interannual and intraseasonal weather variability. It may be possible to improve restoration success by expanding the period of seed germination to increase the chances some seeds will germinate within a window that is favorable for plant establishment. Our objective was to determine if we could expand the period of germination using plant growth regulators (PGRs) applied in a conglomerated seed coating to Wyoming big sagebrush and low sagebrush. The seed of each species was 1) left untreated; 2) conglomerated; 3) conglomerated and treated with two concentrations of a germination inhibitor, abscisic acid (ABA); or 4) conglomerated and treated with two different germination promoters, gibberellic acid (GA3) and 1-aminocyclopropane carboxylic acid (ACC) (6 treatments total). Seeds were incubated in a loam soil at five constant temperatures (5–25°C) for approximately 3 mo. Results indicate that seed treatments with PGRs can delay or accelerate germination. For example, at 5°C, which is the temperature most similar to when the seeds germinate in the field, ABA delayed the time for 50% of the seeds to germinate by a maximum of 28 d and 38 d and the germination promoters decreased this time by 9 d and 11 d for Wyoming big sagebrush and low sagebrush, respectively. Field studies are now needed to determine if the bet-hedging strategy developed in this study will increase the likelihood of seeding success. Although our study focused on sagebrush, there is merit to evaluate the use of PGRs on other species, particularly where seed is being sown in highly variable environments.

Panting, B.R., P.A. Stephens, T.H.E. Mason, and M. Apollonia. 2021. [Factors influencing survival rates of pronghorn fawns in Idaho](#). *Journal Wildlife Management*. 85(1): 97-108.

Abstract:

Pronghorn (*Antilocapra americana*) occur throughout western North America. In Idaho, USA, following intensive hunting to reduce crop depredations in the late 1980s, pronghorn populations have not rebounded to desired levels. Because neonatal survival in ungulates is one factor limiting population growth, we evaluated cause-specific mortality and the influence of intrinsic and extrinsic factors on survival rates of 217 radio-collared pronghorn fawns across 3 study areas in Idaho during 2015–2016. For intrinsic variables, we determined the sex and body mass index (BMI) for each fawn. For extrinsic variables, we determined the abundance of predators and alternate prey, estimated the normalized difference vegetation index (NDVI) for 1 month pre- and post-parturition, and measured fecal nitrogen and diaminopimelic acid (DAPA). We considered NDVI as a measure of plant productivity, and fecal nitrogen and DAPA as possible proxies of diet quality. We predicted NDVI, fecal nitrogen, and DAPA would be positively related to the nutritional status of females and positively related to fawn survival. We used Program MARK with known fate models to estimate semi-monthly survival rates of pronghorn fawns for the first 4 months post-parturition. During both years, the leading cause of fawn mortality was coyote (*Canis latrans*) predation (58%), followed by unknown causes of mortality (18%), unknown predation (12%), predation by bobcats (*Lynx rufus*; 6%), predation by golden eagles (*Aquila chrysaetos*; 3%), and other (3%). Mean fawn survival for the 4 months post-parturition across years and study sites was 0.42 ± 0.04 (SE; range = 28–62%). The top survival model included BMI, lagomorph abundance, and DAPA and had a model weight of 83.3%. All 3 variables were positively related to pronghorn fawn survival. Because females with increased nutrition generally have heavier fawns, BMI was likely correlated to diet quality, which was supported by the positive relationship between DAPA and fawn survival. We hypothesize that high lagomorph abundance created an alternate prey base to buffer coyotes from preying on pronghorn neonates. We found no influence of measures of NDVI (pre- and post-parturition), fecal nitrogen, or predator abundance on fawn survival. Management actions providing high-quality forage for pronghorn are likely to contribute to production of heavier fawns having the highest chance of survival.

Rodgers, P.A., H. Sawyer, T.W. Mong, S. Stephens, and M.J. Kauffman. 2021. [Sex-specific behaviors of hunted mule deer during rifle season](#). *Journal Wildlife Management*. 85(2): 215-227.

Abstract:

Animal populations face increased threats to mobility and access to critical habitat from a variety of human disturbances including roads, residential development, agriculture, and energy development. Disturbance from human hunting is known to alter habitat use in ungulates, but recent work suggests that

hunting may also trigger the onset of migration. Whether this holds true across ungulate species and hunting systems warrants further empirical testing. We used global positioning system location data from mule deer (*Odocoileus hemionus*) in south-central Wyoming, USA, to evaluate the sex-specific effects of hunting on habitat selection and migratory behavior from 2016 to 2018. We modeled habitat selection before and during hunting season using a step selection function, and we used time-to-event models to evaluate if hunting triggered migration. We found habitat selection and migration timing to be sex specific. Males responded to hunting season by selecting security habitat away from motorized routes, whereas females used habitat through hunting season that retained higher forage quality. Weather, as indexed by temperature and precipitation (i.e., snowfall), influenced migration timing for males and females. Migration timing in males was influenced by migration distance, where individuals traveling >50 km tended to migrate earlier than individuals moving <50 km. For deer that survived to rifle season, hunting was less influential on migration timing than environmental factors. Rifle season increased the likelihood of migration by 2% in females and <0.01% in males compared to outside rifle season. Our findings suggest that roadless areas on mule deer summer ranges and within migration corridors reduce the effects of hunting disturbance. Consequently, managers may consider limiting the use of motorized vehicles as a method for reducing effects on migration from hunting disturbance.

Riley, I.P., K.J. Conway, B.S. Stevens, and S.B. Roberts. 2021. [Aural and visual detection of greater sage-grouse leks: Implications for population trend estimates](#). *Journal Wildlife Management*. 85(3):508-519.

Abstract:

Counts of greater sage-grouse (*Centrocercus urophasianus*) at leks have been used in harvest management, Endangered Species Act listing decisions, and land management policies for over half a century. Lek count sampling methods focus on counting male sage-grouse at known leks, primarily those observed visually from roads or vantage points, but leks are likely missed that are unknown prior to the survey and are difficult to detect while driving between known lek sites. One way to ameliorate this shortfall may be to conduct short point-count surveys at multiple stops along lek-survey routes or while driving between lek counts, thereby detecting newly established or unknown leks. To evaluate the feasibility of this approach, we estimated aural and visual detection probability of active sage-grouse leks during 1-minute point-count surveys at known distances and examined the effects of environmental factors on aural lek detection in southern Idaho, USA, 2016–2017. Our results demonstrate that field observers can aurally detect sage-grouse leks at approximately 3 times greater distances compared to detecting leks visually. The probability of hearing an active lek was highest near the peak of male and female attendance (8 Apr), within an hour of sunrise, on relatively calm and cold days, when the observer was at a higher elevation relative to the lek, and during conditions with no background noise. Detection probability declined with distance and the probability of aural detection was 0.59 at 1 km from a lek when other variables were held at their means. Hence, conducting ≥ 3 1-minute surveys along a lek route would be expected to detect $\geq 93\%$ of all leks within 1.5 km of each survey under the average environmental conditions in our study. Our results suggest that surveys could greatly improve detection of unknown or newly established leks and can facilitate a more accurate assessment of sage-grouse population trends through lek counts. Moreover, our results demonstrate how environmental factors influence the detection of leks during surveys, and therefore which variables should be considered for inclusion in any future revisions of lek count protocols or in analyses of lek count data.

Munoz, D.A., P.S. Coats, and M. Ricca. 2021. [Free-roaming horses disrupt greater sage-grouse lekking activity in the Great Basin](#). *Journal of Arid Environments*. 184:104304.

Abstract:

Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) and free-roaming horses (*Equus caballus*) co-occur within large portions of sagebrush ecosystems within the Great Basin of western North America. In recent decades, sage-grouse populations have declined substantially while concomitant free-roaming horse populations have increased drastically. Although multiple studies have reported free-roaming horses adversely impacting native ungulate species, direct interactions between free-roaming horses and sage-grouse have not been documented previously. We compiled sage-grouse lek count data and associated ungulate observations during spring of 2010 and 2013–2018. We used Bayesian multinomial logistic models to examine the response of breeding male sage-grouse to the presence of native (i.e. mule deer, pronghorn) and non-native (i.e. cattle, free-roaming horses) ungulates on active sage-grouse leks (traditional breeding grounds). We found sage-grouse were approximately five times more likely to be present on active leks concurrent with native ungulates compared to non-native ungulates. Of the four different ungulate species, sage-grouse were least likely to be at active leks when free-roaming horses were present. Our results indicate that free-roaming horse presence at lek sites negatively influences sage-grouse lekking activity. Because sage-grouse population growth is sensitive to breeding success, disruption of leks by free-roaming horses could reduce breeding opportunities and limit breeding areas within sage-grouse habitat.

Hamerlynck, E.P. and R.C.O'Connor. 2021. [An assessment of seed head and flag leaf contributions to reproductive effort in sagebrush steppe bunchgrasses](#). *Journal of Arid Environments*. 187:104442.

Abstract:

North American sagebrush-steppe bunchgrasses primarily establish from seed; however, the importance of parental plant carbon from flag leaves or within the seed head itself to reproduction in perennial bunchgrasses is unknown. To address this, we experimentally removed flag leaves and shaded seed heads to assess their importance to reproduction in the exotic bunchgrass crested wheatgrass (*Agropyron cristatum*), which has high seed head photosynthetic capacity and readily establishes from seed, and the native grass, squirreltail (*Elymus elymoides*), which has lower seed head photosynthetic capacity and does not establish as readily from seed. We hypothesized that inflorescence shading would have a greater negative impact on crested wheatgrass reproduction than in squirreltail. In crested wheatgrass, shading did not affect total propagule production but did reduce both total filled seeds and filled seed specific mass (dry mass per unit area). Flag leaf removal stimulated seed filling and increased seed specific mass, especially in unshaded seed heads, suggesting flag leaves are competitive carbon sinks in crested wheatgrass. In contrast, flag leaf removal and shading in squirreltail resulted in similar reductions in total propagules, fewer filled seed produced and lower specific seed mass, indicating similar contributions to reproductive effort by both structures. These results indicate seed head photosynthetic activity is an adaptive reproductive feature in both grasses, but the contrasting effects of flag leaf removal may reflect long-term adaptive responses to grazing pressures that differed in crested wheatgrass's native range compared to those in North American sagebrush steppe.

Stephens, S.L., J.W. van Wagendonk, J.K. Agee, and R.H. Wakimoto. 2021. [Introduction to the article by Harold Biswell: Prescribed burning in Georgia and California compared](#). *Fire Ecology* 17: 9.

Abstract:

Harold Biswell first learned about the benefits of prescribed fire in forest management when he was a Forest Service researcher in Georgia, USA. After he accepted a professorship in the School of Forestry at the University of California, Berkeley, USA, he was surprised to find out that prescribed fire was not an accepted practice in California. He set out to conduct a series of studies to explore the effects of prescribed fire in forests of California and compare those effects to those he observed in Georgia. Professor Harold Biswell published an article in the *Journal of Range Management* in 1958 in which he compared prescribed burning in California and Georgia, USA, pine (*Pinus* L.) forests titled “Prescribed Burning in Georgia and California Compared” (Biswell 1958). The first question that has to be asked is why was this article published in a range management journal when the focus was on forests? Biswell was hired as a range management faculty member in the School of Forestry at University of California, Berkeley (UC Berkeley), USA, so he had more connections to the *Journal of Range Management*. Additionally, most forestry faculty members in his department did not support prescribed fire research in forests, which probably led him to pick this outlet. Biswell was very interested in prescribed burning and thought his research could lead to better decisions for managing pine forests.