HIGHLIGHTS

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Multidisciplinary, Multisite Evaluation of Alternative Sagebrush Steppe Restoration Treatments: The SageSTEP Project

J. McIver and M. Brunson

Fire regimes in sagebrush (*Artemisia tridentata* spp.) steppe are changing due to cheatgrass (*Bromus tectorum*) invasion and woodland expansion. The Sagebrush Steppe Treatment Evaluation Project (SageSTEP) is an experiment that evaluates short-term ecological effects of prescribed fire, mowing, cutting, mastication, and herbicides, all of which are treatments intended to counter fire regime changes. SageSTEP is composed of 21 sites that span a wide range of ecological conditions, and provides information sufficient to test hypotheses on threshold conditions and ecological resilience. SageSTEP studies many ecosystem components, including the fuel bed, vegetation, soils, hydrology, birds, and butterflies, and evaluates social acceptance and economics of alternative fuel reduction treatments in sagebrush steppe.

Resilience and Resistance of Sagebrush Ecosystems: Implications for State and Transition Models and Management Treatments

J. C. Chambers, R. F. Miller, D. I. Board, D. A. Pyke, B. A. Roundy, J. B. Grace, E. W. Schupp, and R. J. Tausch

Invasion of annual exotics and expansion of piñon (*Pinus* spp.) and juniper (*Juniperus* spp.) trees are altering sagebrush ecosystems. We used fire and mechanical treatments to examine differences in resilience to disturbance and resistance to exotics in sagebrush sites with varying environments. Warm and dry sites had lower resilience to treatment and resistance to exotics than cooler and moister sites. Resilience and resistance increased with perennial grass and forb cover, especially on warmer and drier sites. Fire was generally the more severe treatment. We incorporate our results on resilience and resistance into state-and-transition models to aid management decisions on site-specific treatments.

Region-Wide Ecological Responses of Arid Wyoming Big Sagebrush Communities to Fuel Treatments

D. A. Pyke, S. E. Shaff, A. I. Lingren, E. W. Schupp, P. S. Doescher, J. C. Chambers, J. S. Burnham, and M. M. Huso

We studied plant community response to removing Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) or cheatgrass (*Bromus tectorum*). We used fire, mowing, and the herbicide tebuthiuron to reduce sagebrush and the herbicide imazapic to reduce cheatgrass while recording plant recovery over 3 years. Fire and mowing increased bare ground and decreased biological soil crusts, but did not impact herbaceous plants groups over 3 years whereas imazapic controlled cheatgrass while it increased bare ground further and decreased cover of some desirable plants. Soil measures indicate cheatgrass may be poised to increase, but 3 years is insufficient to determine ecological consequences of these fuel treatments.

Response of Conifer-Encroached Shrublands in the Great Basin to Prescribed Fire and Mechanical Treatments

R. F. Miller, J. Ratchford, B. A. Roundy, R. J. Tausch, A. Hulet, and J. Chambers

Conifer removal projects have been implemented throughout the Great Basin with varying results. Fire and mechanical treatments were applied to evaluate the potential consistency of vegetation response across the region to tree removal. In the burn, bare ground immediately increased in the first year but declined as a result of increases in perennial grasses and forbs in years 2 and 3. In the mechanical treatment, perennial grasses increased in the first year and shrub cover and biological crusts did not decline as they did in the burn. The increase in invasive annuals was also greater in the burn.

Understory Cover Responses to Piñon–Juniper Treatments Across Tree Dominance Gradients in the Great Basin

B. A. Roundy, R. F. Miller, R. J. Tausch, K. Young, A. Hulet, B. Rau, B. Jessop, J. C. Chambers, and D. Eggett

Piñon (*Pinus* spp.) and juniper (*Juniperus* spp.) tree encroachment into sagebrush (*Artemisia tridentata* spp.) communities reduces understory plant cover and increases risk of severe wildfire. We measured effects of prescribed fire and mechanical tree reduction on understory cover 2 and 3 years after treatment in relation to pretreatment tree cover on 11 Great Basin sites. Tree reduction at low to midlevel tree dominance resulted in a perennial herbaceous-dominated plant community after fire or a shrub/perennial herbaceous-dominated plant community after mechanical treatment; mechanical treatment at high tree dominance resulted in a perennial herbaceous-dominated community. Appropriate piñon and juniper reduction can be used to maintain shrub cover, improve perennial herbaceous cover, and reduce canopy fuels.

Piñon–Juniper Reduction Increases Soil Water Availability of the Resource Growth Pool

B. A. Roundy, K. Young, N. Cline, A. Hulet, R. F. Miller, R. J. Tausch, J. C. Chambers, and B. Rau

Managers use fire and mechanical treatments to control piñon (*Pinus* spp.) and juniper (*Juniperus* spp.) tree encroachment into sagebrush–bunchgrass communities. We measured the effect of reducing trees in areas with differing canopy cover on timing of soil water availability. Reducing trees increased time of soil water availability during the spring growing season up to 3 weeks when applied at high initial tree cover. Although this additional time of soil moisture helps support increased shrub and perennial grass growth, it could also support weed dominance on susceptible sites that lack perennial grass cover.

Soil Resources Influence Vegetation and Response to Fire and Fire-Surrogate Treatments in Sagebrush-Steppe Ecosystems

B. M. Rau, J. C. Chambers, D. A. Pyke, B. A. Roundy, E. W. Schupp, P. Doescher, and T. G. Caldwell

Land managers seeking ways to reduce woody sagebrush cover and increase resistance to exotic annual grass invasion should consider climate, soil, and vegetation conditions before selecting and implementing treatments. Data from the Sagebrush Steppe Treatment Evaluation Project suggests that soil resource availability has significant influence on resistance to exotic invasion. Sites with higher average annual rainfall and soil clay content were more likely to respond favorably to management than drier sites with large gaps between perennial plants. Management treatments that reduce

shrub cover slowly over time and minimize increases in soil resources are most likely to be successful on marginal sites.

Short-Term Effects of Tree Removal on Infiltration, Runoff, and Erosion in Woodland-Encroached Sagebrush Steppe

F. B. Pierson, C. J. Williams, P. R. Kormos, and O. Z. Al-Hamdan

Tree removal is commonly prescribed to reduce negative impacts of woodland encroachment in sagebrush (*Artemisia tridentata* spp.) steppe. We used small-plot rainfall simulations to evaluate short-term (1- to 2-year posttreatment) effects of burning and tree mastication on hydrology and erosion at two woodlands. Burning increased runoff/erosion from areas underneath trees and shrubs, but had no effect on runoff/erosion from erosion-prone interspaces. In contrast, masticated tree debris enhanced infiltration and reduced erosion in interspaces. The results indicate burning may increase short-term erosion risk and that mastication is a good alternative treatment for more immediate reductions in soil erosion during understory recovery following tree removal.

Short-Term Butterfly Response to Sagebrush Steppe Restoration Treatments

J. McIver and E. Macke

Sagebrush (*Artemisia tridentata* spp.) steppe in the interior West has recently been encroached by woodland species and threatened by invading cheatgrass (*Bromus tectorum*). The authors studied the effects of prescribed fire, mowing, and cutting treatments designed to reduce encroachment and invasion on butterfly species. Treatments had modest effects on butterfly abundance, richness, and species composition. Most significant responses were positive, correlated with increases in cover of herbaceous species, which are the primary larval food plants and adult nectar sources for butterflies. Modest treatment responses indicate that few unintended consequences would be expected from application of these kinds of treatments on a wide scale.

Ecological Scale of Bird Community Response to Piñon–Juniper Removal

S. T. Knick, S. E. Hanser, and M. Leu

We studied the response of bird communities to prescribed fire and mechanical treatment to assess the effectiveness of these management actions to convert piñon–juniper (*Pinus* spp.–*Juniperus* spp.) woodlands into functioning sagebrush systems. Prescribed fires at four study locations in Utah, Nevada, Idaho, and Oregon were patchy and incomplete. Consequently, none of the sagebrush-obligate bird species colonized any survey sites treated with prescribed fire because trees still remained in the landscape for up to 5 years post-treatment. The only two survey sites colonized by sagebrush-

obligate birds were located adjacent to an existing sagebrush landscape and had complete juniper removal by mechanical treatment.

Utilizing National Agriculture Imagery Program Data to Estimate Tree Cover and Biomass of Piñon and Juniper Woodlands

A. Hulet, B. A. Roundy, S. L. Petersen, S. C. Bunting, R. R. Jensen, and D. B. Roundy

With the encroachment of piñon (*Pinus* spp.) and juniper (*Juniperus* spp.; P-J) woodlands onto sagebrush (*Artemisia tridentata* spp.) steppe rangelands, there is an increasing interest in rapid, accurate, and inexpensive quantification methods to estimate tree canopy cover and aboveground biomass. Using object-based image analysis (OBIA) and National Agriculture Imagery Program (NAIP) imagery, we evaluated the relationship between remotely sensed P-J canopy cover with ground-measured P-J canopy cover and aboveground biomass. Land managers can use OBIA methods combined with NAIP imagery to estimate P-J woodland cover and associated aboveground biomass on broad spatial scales. However, inaccuracies between OBIA estimates and ground measurements increased when tree canopy cover was greater than 40%.

Acceptance, Acceptability, and Trust for Sagebrush Restoration Options in the Great Basin: A Longitudinal Perspective

R. Gordon, M. W. Brunson, and B. Shindler

Land managers in the Great Basin face an interrelated set of ecological, economic, and social challenges while working to create management strategies that are ecologically sound and socially acceptable. In longitudinal surveys of the region's urban

and rural communities we examined the social acceptability of management practices commonly used to restore sagebrush-dominated rangelands. Overall, acceptability remained constant over the study period and was not related to respondents' knowledge or concerns about rangeland health. The best predictor was trust in agencies' ability to implement management practices, suggesting efforts to increase acceptance should focus on building trust rather than simply providing information.

A Synopsis of Short-Term Response to Alternative Restoration Treatments in Sagebrush-Steppe: The SageSTEP Project

J. McIver, M. Brunson, S. Bunting, J. Chambers, P. Doescher, J. Grace, A. Hulet, D. Johnson, S. Knick, R. Miller, M. Pellant, F. Pierson, D. Pyke, B. Rau, K. Rollins, B. Roundy, E. Schupp, R. Tausch, and J. Williams

Fire regimes in sagebrush steppe are changing due to cheatgrass (*Bromus tectorum*) invasion and woodland expansion. The Sagebrush Steppe Treatment Evaluation Project evaluates ecological effects of alternative treatments intended to counter fire regime changes. Woody vegetation reduction by prescribed fire, mechanical treatments, or herbicides initiated a cascade of effects, beginning with increases in available nitrogen and soil water, followed by increases in herbaceous vegetation. Spatio-temporal heterogeneity among sagebrush steppe ecosystems indicates that there is no "recipe" for choosing management actions on any specific area. Evaluation and monitoring may be the best chance managers have for arresting woodland expansion and cheatgrass invasion.

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