Grazing management to reduce wildfire risk in invasive annual grass prone sagebrush communities

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On the Ground

- Wildfires and incidents of large fires have increased substantially in the past few decades, in part from increases in fine, dry fuels. Fine fuel management is needed, and grazing is likely the only tool applicable at the scale needed to have meaningful effects.
- Moderate grazing decreases wildfire probability by decreasing fuel amount, continuity, and height and increasing fuel moisture content. Grazing, through its modification of fuels, can improve fire suppression efforts by decreasing flame lengths, rate of fire spread, and fire severity.
- Logistical, social, and administrative challenges exist to using grazing to decrease fire probability. Some of these challenges can be overcome by using off-season (i.e., fall-winter) grazing, but other challenges will require persistent efforts as well as science to support management changes.

Keywords: fire probability, fuel management, grazing, shrub steppe, wildfire.

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Introduction

Wildfires were historically infrequent in the sagebrush (*Artemisia* spp.) ecosystem and shifted dominance between sagebrush and perennial grasses.[1,2] Parts of the sagebrush ecosystem are now experiencing unprecedented increases in large fires and severe wildfire years.[3,4] Annual grass invasion of the sagebrush ecosystem is a major driver of the increase in fire frequency and large fires that threaten life and property.[3] Invasive annual grasses alter postfire community recovery by competitively excluding native perennial grasses and thus developing an annual grass-fire cycle. Wildfires fueled by annual grasses are costly to society and the sagebrush ecosystem. Though not exclusive to sagebrush communities, annual federal fire suppression costs have exceeded $2 billion in recent years.[5] The cost to society is much greater than the cost of wildfire suppression. Postfire plant community restoration is expensive and may never achieve prefire conditions because of postfire exotic plant invasions.

The concomitant increase in wildfires, specifically large fires, and invasive annual grasses are likely to perpetuate into the future. Wildfire frequency is expected to increase with climate change.[6–8] These wildfires are also likely to be more severe,[9] which would likely reduce native perennials and favor invasive annual grasses and other exotic species. Invasive annual grasses are expected to become more dominant and prolific because of increasing atmospheric CO_2 concentrations, warmer winters, and altered precipitation patterns as well as an earlier onset of fire season and more wildfires.[10–12] The expansion of invasive annual grasses greatly increases the probability of frequent, large fires. Clearly, management is needed to reduce the probability of wildfire.

In the effort to decrease the risk of large wildfires, there has been a heavy focus on suppression efforts as well as fuel breaks and green stripping to provide fire fighters safe and effective areas to stage suppression efforts (see Wollstein et al., this issue).[13] These are valuable resources for managing wildfires; however, their effectiveness is limited and they come with a cost. To be effective, fuel breaks and green stripping must be readily accessible by fire suppression equipment (i.e., installed along existing roads). Fuel breaks and green strips are costly to install and, without constant management, can revert to their prior fuel characteristics or become dominated by invasive annual grasses.[14] Management of fuels, particularly highly flammable fine fuels, across the vast areas between fuel breaks and green strips is necessary to have meaningful reductions in wildfire probability (i.e., the likelihood of fuel conditions being conducive for successful ignition and spread of fire assuming an ignition source is present). Grazing by livestock

Figure 1. Fuel characteristics in a winter grazed area and an ungrazed exclosure in southeastern Oregon. Grazing treatment was only applied for 1 year. Note the accumulation of prior years' growth, predominately invasive annual grasses (e.g., cheatgrass [*Bromus tectorum* L.]) in the exclosure. Plant community composition was similar between the grazed area and exclosure at the time the exclosure was built. Photo courtesy of Kirk Davies.

is often the most feasible and efficient tool for managing fine fuels across vast sagebrush rangelands.[15] However, the effects of grazing management on fuels and subsequent fire probability as well as the challenges to implementing grazing in a complex social-ecological system have not been synthesized. We synthesize and provide insight from a panel discussion on using grazing management to reduce wildfire probability that was part of the December 2020 Invasive Annual Grass Workshop organized by the High Desert Partnership, the SageCon Partnership, and Oregon State University.

Grazing effects on fuels and fire

Grazing can substantially alter fuel characteristics in rangelands, including reducing fuel continuity, height, and amount, and increases fuel moisture in sagebrush and annual grass communities.[16–18] Grazing increases fuel moisture by decreasing dead plant materials, particularly prior years' growth of annual and perennial grasses (Fig. 1). Moderate grazing also reduces litter buildup on perennial bunchgrass crowns and decreases the likelihood of fuel rich dead centers developing in the crowns of bunchgrasses.[19] Thus, grazing can affect a combination of fuel characteristics.

Grazing can be used to induce compositional changes in the plant community that can alter fuel characteristics. Fall-winter grazing can decrease highly flammable invasive annual grasses and increase perennial bunchgrasses.[20–22] This likely occurs because litter on the soil surface provides safe sites for invasive annual grass germination and seedling growth, so the reduction of litter, by fall-winter grazing, may cause a shift from invasive annual grasses to perennial bunchgrasses.[20,23] Targeted spring grazing also can reduce invasive annual grasses (Fig. 2) and promote native bunchgrasses, but must be applied carefully.[24,25] Additionally, moderately grazing pre fire reduces fire severity, which decreases invasive annual grass postfire abundance and cover.[22,26] By reducing abundance of invasive annual grasses, grazing is likely greatly affecting fuel characteristics. Annual grass-invaded areas have greater fine fuel amount and continuity and dry out earlier than perennial-dominated communities.[27] Compositional changes to plant communities through grazing can be a valuable tool for decreasing fire probability beyond the physical effects of reducing fuel.

The influence of grazing on fuels affects the probability of fire in these communities. Moderate fall or spring grazing decreases the likelihood of an ignition source coming in contact with flammable fuel.[28] If fuel is ignited, grazed areas are less likely to have the fire spread from the initial ignited fuel to other fuel, which is a prerequisite for fire propagation.[28] When a fire occurs, flame length, rate of spread, and intensity are less in grazed areas.[15] This would increase suppression effectiveness because the fire would grow slower.

When and where to use grazing as a fuel treatment

Grazing is not necessary in all years or locations to reduce fire probability. Fire is also a natural driver in sagebrush communities that prevents conifer encroachment and promotes vegetation heterogeneity.[29] Thus, excluding all fires is not logical and may be counterproductive to conserving sagebrush communities, especially in areas with sufficient perennial bunchgrasses and high biotic and abiotic resiliency.[29] Furthermore, not all grazing is the same and its effects vary by timing, frequency, and intensity and are dependent on plant community characteristics. Improper grazing management in

Figure 2. Spring grazing applied on left side of fence to reduce invasive annual grasses in medusahead (*Taeniatherum caput-medusae* [L.] Nevski) invaded rangelands in southeastern Oregon. Photo courtesy of Kirk Davies.

sagebrush communities can also have undesirable negative effects that may increase the probability of fire. Specifically, repeated heavy grazing during the growing season can decrease native perennial grasses and lead to subsequent dominance by invasive annual grasses[30,31] and likely an increase in fire frequency.[32]

The likelihood of fire propagation varies substantially among years. Most big fire years occur after a year or two of above average plant production followed by a dry year.[33] Thus, grazing applied to reduce fire probability would likely be most advantageous in above-average plant production years. Extending the grazing season or applying off-season grazing (i.e., fall-winter) could be used to reduce excessive fuels. Off-season grazing, because fuel loads are known, can be more efficient than attempting to graze to a specific target during the growing season when plants (i.e., fuels) are growing.[20] Perennial bunchgrasses are also less susceptible to grazing damage when they are dormant.

Grazing also can be applied strategically to protect high priority areas. For example, many wildfires start in invasive annual grasslands and spread to adjacent sagebrush communities,[3] thus grazing could potentially be used to decrease fuels in annual grasslands at the interface with sagebrush communities providing critical habitat for sagebrush-associated wildlife (see Creutzburg et al., this issue).[34] Grazing also can be used to decrease fire risk where restoration efforts have been applied, especially if fire would reverse restoration benefits. Where sagebrush has been established after fire, a subsequent fire is the biggest threat to sagebrush restoration success. Cattle grazing can be used to reduce fire probability and thereby protect sagebrush restoration efforts.[24] However, there is a logistical challenge of having enough grazers when and where the need is greatest. Strategically focusing grazing in areas that provide essential ecosystem services increases the likelihood of achieving successful restoration by reducing fire probability.

Administrative, logistical, and social considerations for grazing

Although there is ample evidence of the efficacies of grazing to alter fuels, fire probability, and fire behavior, implementation of grazing to reduce fire likelihood must also consider the social and policy context within which grazing management occurs.[35] Here, we highlight considerations related to 1) the multiple landownerships and associated administrative requirements that underlie grazing management in sagebrush communities, 2) ranch-level logistics for implementing grazing for fuels management, and 3) social acceptability of broad-scale grazing to manage fire risk.

In the sagebrush ecosystem of the western United States, many ranchers use a network of public and private lands for meeting the annual forage needs of their livestock. This mixed-tenure scenario can present administrative challenges for ranchers and public land managers.[36–38] A rancher's annual grazing plan may include multiple jurisdictions and therefore, their grazing practices must conform to the administrative requirements of each jurisdiction. Rangeland productivity is highly variable and current policies and regulations cannot necessarily accommodate flexibility to, for example, deploy grazing in response to real-time fuel conditions on a federally administered grazing allotment.[35,39]

There are instances of public land managers integrating some flexibility into grazing permit administration. For example, Bureau of Land Management (BLM) grazing regulations provide for "biological thinning" for fuels reduc-

Box 1
Example of dormant-season grazing to manage invasive annual grasses and associated fire risk implemented in the Burns Bureau of Land Management District in Oregon.

The Upton Mountain example

The Upton Mountain allotment is over 5,600 ha (13,838 acres) near Drewsey, Oregon, in the Burns Bureau of Land Management (BLM) District. Twelve fires have occurred on the allotment since 1981 and >90% of the area has burned since 1996. With each fire, medusahead and cheatgrass (*Taeniatherum caput-medusae* [L.] Nevski and *Bromus tectorum* L., respectively) have spread with 90% of the allotment estimated to have been converted from sagebrush communities to annual and perennial grasslands.

To address the prevalence and competitive advantage of invasive annual grasses and the associated wildfire risk in the Upton Mountain allotment, the grazing permittee worked with staff at the Three Rivers BLM Field Office and researchers at the University of Nevada-Reno to alter grazing management to 1) reduce annual grasses (and litter) and increase perennial bunchgrasses, and 2) reduce the probability of large, severe wildfires.

This included implementing dormant season grazing in annual grass-dominated pastures in the Upton Mountain allotment. This required a change in the season of use on the grazing permit, as well as authorization of Temporary Non-Renewable (TNR) Animal Unit Months (AUMs) to graze annual grasses above the AUMs specified on the grazing permit. Authorization of AUMs via TNR allowed the permittee and BLM to assess the amount of annual grasses in the pasture each fall and accordingly graze at levels that will effectively reduce fuel loads. During dormant season grazing, utilization was monitored biweekly to ascertain thresholds were not exceeded (i.e., 50% utilization of perennial bunchgrasses or when cattle ceased to select annual grasses). Annual grass litter was reduced and maintained at low levels since the first year of dormant season grazing, although invasive annual grasses continued to be present in perennial plant interspaces.

Authorizing dormant-season grazing required consideration of the grazing permittee's operational needs as well as the BLM's resource objectives, including protecting habitat for species of conservation concern, such as greater sage-grouse (*Centrocercus urophasianus*). The permittee and staff at the Three Rivers BLM Field Office had a shared goal of managing fuel loads and reducing further spread of invasive annual grasses; frequent conversations between the parties culminated in the co-development of the new grazing plan. Lastly, the BLM perceived the grazing management changes to be relatively low risk. A University of Nevada-Reno demonstration project on the Upton Mountain allotment examined the efficacy of dormant season grazing to reduce annual grass cover, litter seed production, and competition with desirable plants. As a result, when authorizing the change in season of use on the grazing permit and TNR AUMs, the BLM minimized their vulnerability to a potential appeal from a public closely scrutinizing grazing permit administration in southeastern Oregon.

tion and reducing the likelihood of wildfire.[31] Accordingly, the Burns BLM District in Oregon authorized targeted grazing of medusahead and cheatgrass (*Taeniatherum caput-medusae* [L.] Nevski and *Bromus tectorum* L., respectively) at levels above the permitted animal unit months (AUMs) by issuing the grazing permittee Temporary Non-Renewable (TNR) AUMs. Because annual grass productivity is highly variable annually (e.g., Schmelzer et al.),[20] the need for targeted grazing is determined by the amount of medusahead and cheatgrass available in a pasture each fall and winter. Thus, authorization of AUMs (beyond those in the terms and conditions of the grazing permit) via TNR offers the grazing permittee flexibility to respond to variability in annual grass production and, in response, implement targeted grazing at levels to effectively control fuel loads (Box 1; see also Wollstein et al.).[35]

There are additional ranch-level considerations associated with using grazing to reduce fuel loads or create or maintain fuel breaks. These include water and supplement provisioning, fencing, and labor needed to ensure that appropriate utilization levels are reached to achieve management objectives.[20,40,41] Importantly, because annual productivity in the sagebrush ecosystem varies widely, it is difficult to predict the amount of available forage, as well as the appropriate stocking rate and duration of grazing required to effectively manage fuels after the cessation of plant growth. In exceptionally productive years, ranchers may find they do not possess enough livestock to significantly reduce fuel loads in an area using grazing. Ranchers should be prepared to provide alternative sources of feed in dry years when grasses are less productive. Therefore, grazing to reduce fire risk must also be compatible with production goals (see Box 1 for example).

In addition to ecological effects, public land management agencies must consider the social acceptability of proposed management activities.[42] Gordon et al.[43] found that although livestock grazing to reduce fine fuels was generally more acceptable to Great Basin residents than mechanical or chemical treatments, the best predictor of social acceptance of any management practices was trust in the public land managers' ability to implement the practices. This poses challenges for public land managers and ranchers seeking to use broad-scale grazing to manage fire risk; the broader public must trust land managers' ability to effectively administer grazing. Otherwise, members of the public who are opposed to grazing may use litigation to slow or halt agency action.[42,44,45] As a result, agency staff hesitates to advance changes to grazing permits or Allotment Management Plans that may draw attention from a historically litigious public.[35]

Conclusions

The increase in wildfires in the sagebrush ecosystem is largely driven by invasive annual grasses, which necessitates a more proactive approach to fire management. Fuels management through grazing has great potential to help fill this need, because grazing can be an effective tool to reduce fire probability by decreasing fine fuel continuity, height, and amount as well as increasing fuel moisture content in annual grass prone sagebrush communities. This can decrease the likelihood that ignition sources propagate a wildfire as well as decrease flame lengths, rate of fire spread, and fire severity, thereby increasing fire suppression effectiveness. The effectiveness of grazing to decrease fire probability can be improved by integrating grazing with other fire management efforts, such as in Potential Operational Delineations (described in Wollstein et al., this issue).[13] Using grazing to manage fire probability has logistical, social, and policy challenges that need to be overcome for it to be effectively used. To deploy grazing as a tool to reduce fine fuels on vast landscapes, fuels management must be integrated as an explicit objective in grazing administration. Grazing needs to be applied with care to ensure desired objectives are achieved and to prevent undesirable compositional shifts in plant communities. However, grazing is likely the most practical treatment that can be feasibly applied across vast rangelands to modify fuel characteristics to decrease fire probability.

Declaration of Competing Interest

The content of sponsored issues of *Rangelands* is handled with the same editorial independence and single-blind peer review as that of regular issues.

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