Grazing History Influences the Response of Sagebrush Plant Communities to Fire

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SUMMARY

Response to fire differed in moderately grazed areas compared to areas protected from livestock grazing since 1936. Long-term protection from livestock grazing resulted in cheatgrass (*Bromus tectorum*) invasions following fire, while moderately grazed areas were not invaded. After burning, cheatgrass biomass production and density were more than 49- and 15-fold greater, respectively, in the areas protected from grazing than moderately grazed areas. These differences were still evident 14 years post-fire and demonstrate that grazing history can have significant influence on the ability of plant communities to tolerate fire. These results suggest that moderate levels of livestock grazing may be needed in sagebrush-steppe communities to protect the habitat of sage-grouse and other sagebrush-obligate wildlife species.

INTRODUCTION

The impacts of livestock grazing prior to fire on native plant communities are relatively unknown. Because domestic livestock grazing is not part of the historical disturbance regime for Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) communities in the Intermountain West (Mack and Thompson 1982), some have suggested that its impacts would be negative (Fleischner 1994, Noss 1994). Historical disturbances are often considered a requirement to maintain native plant communities and this has resulted in the reconstruction of historical disturbance regimes to direct ecosystem management. However, some ecosystems have experienced irrevocable changes in environmental conditions and biotic potentials that could potentially alter the response of plant communities to disturbances. For example, climate change or invasive plants may result in different responses from plant communities to disturbances than would be expected under historical conditions.

We evaluated the impacts of grazing and no grazing prior to fire in Wyoming big sagebrush plant communities. Understanding the impacts of grazing prior to fire in Wyoming big sagebrush plant communities is important because most of these plant communities are grazed by domestic livestock, are at risk of burning, and provide valuable habitat for wildlife. With the introduction of exotic annual grasses such as cheatgrass (*Bromus tectorum*), the impact of grazing or no grazing prior to fire in Wyoming big sagebrush plant communities is unknown.

METHODS

The study was conducted on the Northern Great Basin Experimental Range (NGBER) in southeastern Oregon about 56 km west of Burns, Oregon. Treatments were: 1) ungrazed unburned, 2) ungrazed burned, 3) grazed unburned, and 4) grazed burned. Ungrazed treatments were implemented with the erection of 4.9-acre domestic livestock grazing exclosures in 1936. The grazed treatments were areas adjacent to the exclosures and had moderate livestock grazing (30-40 percent of available forage used) until 1990. In the fall of 1993, prescribed burns were applied to both the grazed and ungrazed treatments. Average fine fuel loads were about 100 lbs/acre greater in the ungrazed than grazed treatments prior to burning. Vegetation characteristics were sampled in 2005, 2006, and 2007 (12, 13, and 14 years post-burning).

RESULTS

Density

Large perennial bunchgrass and cheatgrass densities were influenced by the interaction of burning and grazing ($P < 0.01$; Fig. 1). Large perennial bunchgrass density was lowest in the ungrazed burned treatment and highest in the grazed burned treatment with an approximately 1.9-fold difference between the two treatments. Burning decreased perennial bunchgrass density in the ungrazed treatment but did not influence bunchgrass density in the grazed treatment. Cheatgrass density was 15-fold greater in the ungrazed burned treatment than the other treatments. Perennial forb density was decreased by burning ($P < 0.01$), but was not influenced by grazing ($P = 0.36$).

Biomass

Large perennial bunchgrass production generally increased with burning ($P < 0.01$; Fig. 2). Bunchgrass production increased more with burning in the grazed compared to the ungrazed treatment. Burning the grazed treatment increased perennial bunchgrass production 1.6-fold. Cheatgrass biomass production was 49-fold more in the ungrazed burned treatment than in the other three treatments ($P < 0.01$; Fig. 2). Perennial forb biomass production decreased 3-fold when the ungrazed treatment was burned ($P < 0.01$). Biomass production of annual forbs, consisting mostly of exotics, increased with burning ($P < 0.01$). However, annual forb production was lowest in the ungrazed unburned treatment and highest in the ungrazed burned treatment. In the ungrazed burned treatment, cheatgrass produced more biomass than all the perennial herbaceous vegetation combined.

DISCUSSION

Grazing history influenced the response of Wyoming big sagebrush plant communities to fire. Moderately grazing sagebrush plant communities with livestock increased the ability of the native herbaceous plant community to tolerate fire and thus, prevented cheatgrass invasion. The invasion of the ungrazed treatment post-fire has probably changed the future disturbance regime of those communities. The invasion of cheatgrass often increases fire frequency due to an increase in the amount and continuity of fine fuels. The invasion of cheatgrass and, subsequently, the altered future disturbance regime will negatively impact sage-grouse, pygmy rabbits, and other sagebrush-obligate wildlife species.

Moderate grazing probably mediated the effects of fire because it reduced the amount of fine fuel. Less fuel, especially around perennial bunchgrasses, probably increased the survival of native herbaceous perennial vegetation. The accumulation of fuels on perennial grasses has been demonstrated to increase mortality from burning (Odion and Davies 2000). Mortality of perennial bunchgrasses would potentially open the plant community to cheatgrass invasion. Davies (2008) demonstrated that perennial bunchgrasses were the most critical plant functional group for preventing exotic annual grass invasions.

Although domestic livestock grazing was not part of the historical disturbance regime of these plant communities, it may now be needed because of new pressures from invasive plants and climate change. However, individual circumstances will dictate the value of emulating historical disturbance regimes for maintaining native plant communities. In our specific example, the historical disturbance regime of Wyoming big sagebrush plant communities is estimated to have consisted of 50- to greater than 100-year fire-return intervals (Wright and Bailey 1982, Mensing et al. 2006) and lacked large herbivore grazing pressure (Mack and Thompson 1982). Emulating this disturbance regime for Wyoming big sagebrush plant communities did not produce the expected effect of shifting the dominance from shrubs to native forbs and perennial grasses. Long-term protection from livestock grazing followed by fire resulted in substantial cheatgrass invasion and a large increase in non-native forbs.

MANAGEMENT IMPLICATIONS

Preventing grazing in Wyoming big sagebrush plant communities weakened the ability of the perennial herbaceous vegetation to tolerate fire. Moderate livestock grazing appears to be beneficial to the long-term sustainability of Wyoming big sagebrush plant communities. Preventing grazing to protect sagebrush plant communities may actually facilitate their demise and accelerate the plight of sagebrush obligate-wildlife species.

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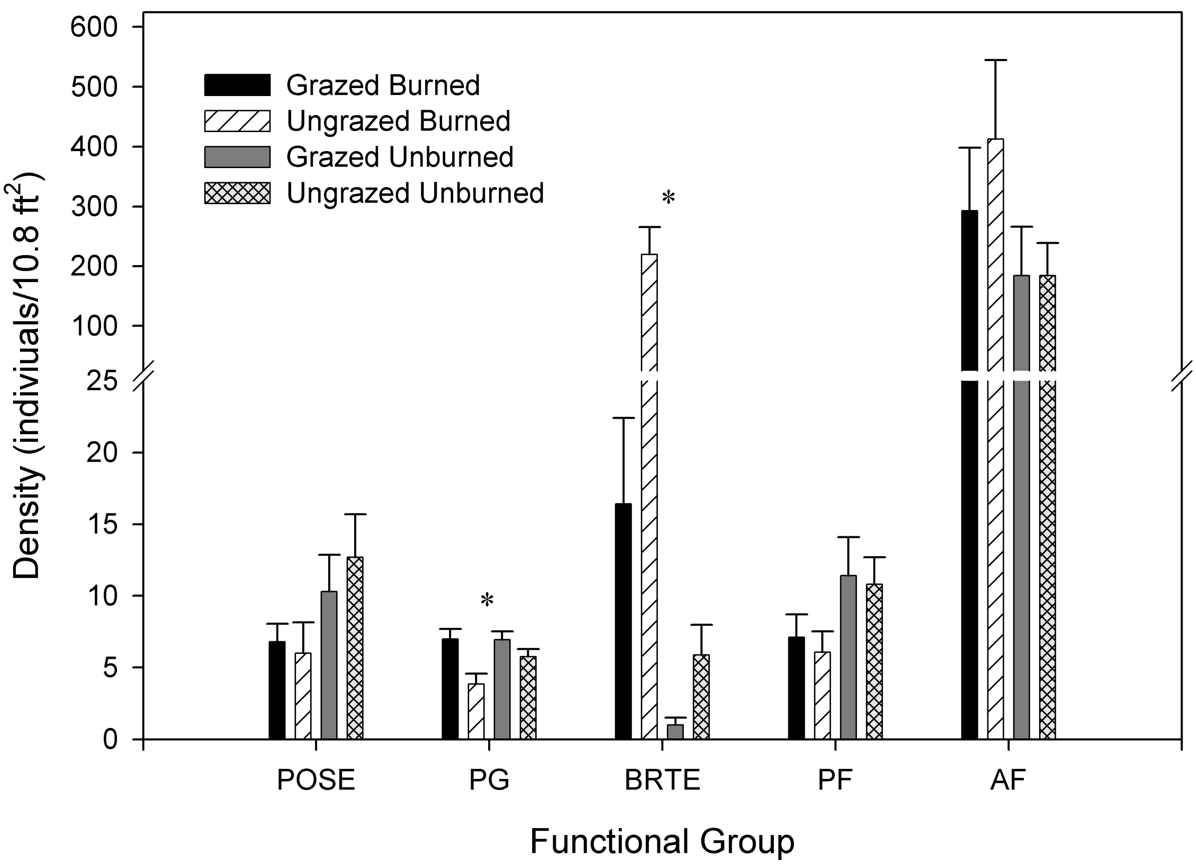

Figure 1. Plant functional group density (mean + S.E.) of the treatments averaged over 2005, 2006, and 2007 at the Northern Great Basin Experimental Range. POSE = Sandberg bluegrass PG = tall perennial bunchgrass, BRTE = cheatgrass, PF = perennial forb, and AF = annual forb. Ungrazed = livestock excluded since 1936, Grazed = moderately grazed by livestock until 1990, Burned = prescribed fall burned in 1993, and Unburned = no prescribed burning. Asterisk (*) indicates significant interaction between grazing and burning treatments for that functional group (P < 0.05).

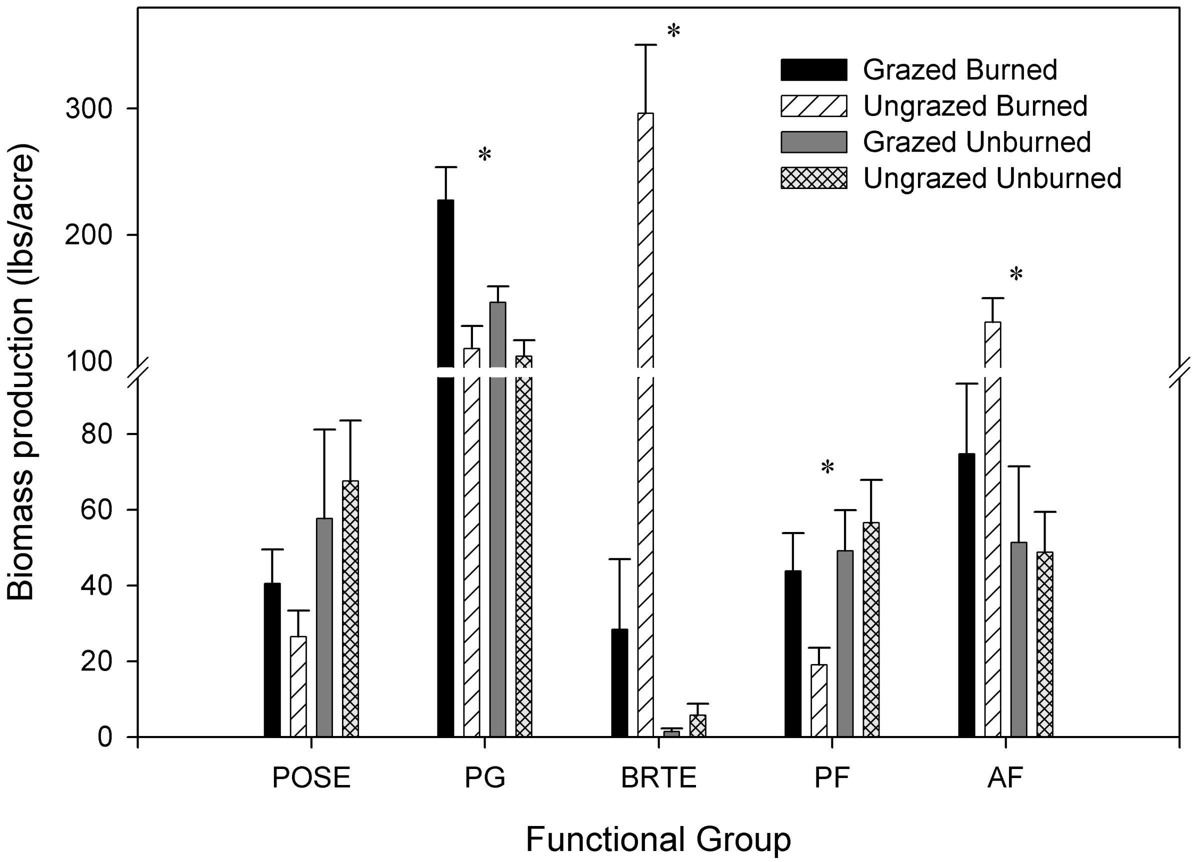

Figure 2. Plant functional group biomass production (mean + S.E.) of the treatments averaged over 2005, 2006, and 2007 at the Northern Great Basin Experimental Range. POSE = Sandberg bluegrass, PG = tall perennial bunchgrass, BRTE = cheatgrass, PF = perennial forb, and AF = annual forb. Ungrazed = livestock excluded since 1936, Grazed = moderately grazed by livestock until 1990, Burned = prescribed fall burned in 1993, and Unburned = no prescribed burning. Asterisk (*) indicates significant interaction between grazing and burning treatments for that functional group (P < 0.05).