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Original Research

Plant Community Factors Correlated with Wyoming Big Sagebrush Site Responses to Fire☆,☆☆

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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 ($p \le 0.05$) 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.

Introduction

Fire is a natural phenomenon in Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) and other sagebrush communities in the Great Basin (Gruell, 1985; Gruell and Swanson, 2012; McAdoo et al., 2013). Potential benefits include reduction of woody plants, decreasing the risk of high-intensity fire (Bates et al., 2009); increased production of herbaceous vegetation, e.g., for sage-grouse (Wambolt and Payne, 1986; Drut et al., 1994; Davies et al., 2007; Bates et al., 2009); and improved habitats for some wildlife species (Peek et al., 1979; Wirth and Pyke, 2003). Where fire increases the abundance of herbaceous perennials, sagebrush communities may maintain heterogeneity (Miller and Eddleman, 2001) and resist invasion by cheatgrass, *Bromus tectorum* (Chambers et al., 2007; Davies et al., 2008; McAdoo et al., 2013). By precluding cheatgrass establishment,

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short-term fire return intervals facilitated by this exotic annual grass may be averted (Young and Clements, 2009; Chambers et al., 2014a).

Other research has demonstrated that fire in Wyoming big sagebrush communities may degrade essential wildlife habitat (Beck et al., 2012), lead to the loss of biological crust and thereby accelerate soil erosion (Miller et al., 2013), and decrease plant community resilience and resistance to exotic invasion (Beck et al., 2012; Miller et al., 2013). These contradictory findings likely arise from a variety of factors including differences among communities in physical features (soil, topography, elevation, climate) and species composition before fire, especially the balance of native perennial and sagebrush or exotic annual grasses (Swanson et al., 2016). In addition, temporal differences in vegetation expression (West and Yorks, 2002) and in fire frequency may alter fire outcomes. Miller et al. (2013) reviews research on factors that affect the trajectory of sagebrush communities after fire (summarized with other literature in Table S1, available online at http://dx.doi.org/10.1016/j.rama.2017.06.013).

Wyoming big sagebrush communities are normally warmer and drier than other *Artemisia* communities (Chambers et al., 2014a). Our review of the literature (see Table S1) suggests that most studies on the effects of fire on more aridic sagebrush communities have involved prescribed burns. Prescribed fires normally involve propellants (e.g., diesel fuel) for ignition and spread and are often conducted during spring—early summer or fall, when fire escape risks are lower than in mid-to-late summer. Early-season fires may be particularly damaging to germinating and regenerating herbaceous plants (Bunting et al., 1987). Hence, the effects of prescribed fire on Wyoming big sagebrush may not match those of typical wildfires. Yet, with respect to the recovery of sagebrush plants, Lesica et al. (2007) found no differences between prescribed and wild fires.

In a broad regional study, we sought to identify factors that affect the outcomes of fire, especially wildfire, on aridic sagebrush communities. Our study of 51 burned Wyoming big sagebrush communities encompassed the range of major land resource areas (MLRAs; USDA, 2006), ecological sites, and topographical situations present across north-central Nevada (and extreme northeastern California; Fig. 1). Although observational, our study paired burned areas with matched, adjacent unburned areas in order to better isolate the effects of fire. We hypothesized that this paired analysis would allow us to identify key features in unburned Wyoming big sagebrush communities, both physical and biological, that predict the outcomes in burned communities. Because of the importance of native perennial and invasive annual

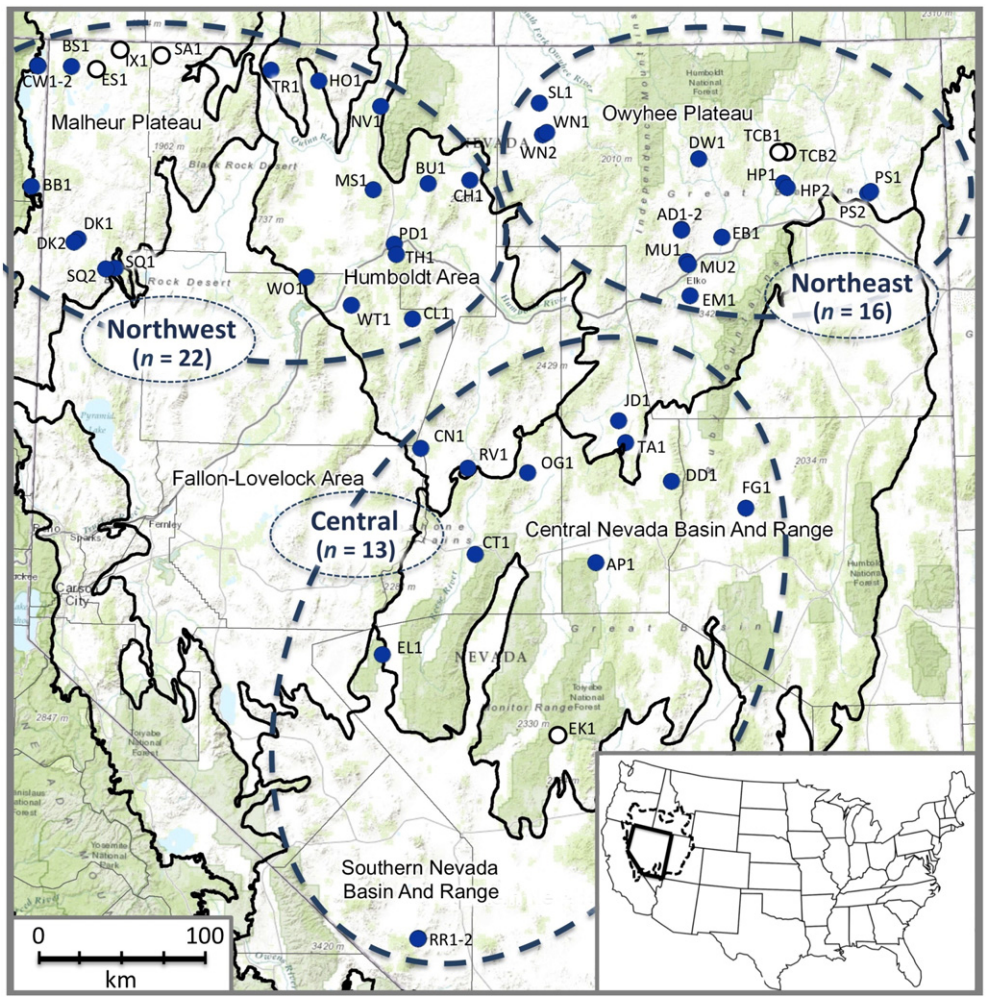

Figure 1. Locations of 51 fire study sites across northern and central Nevada and extreme northeastern California. Filled circles are wildfires, and open circles are prescribed burns (overplotting indicated by a '-' within the site label). Dashed ellipses group sites by region and survey year: northwest (NW, 2011), central (CE, 2012), and northeast (NE, 2010). Five major land resource areas (MLRAs), bounded in black, contain study sites: Malheur High Plateau ($n = 12$), Humboldt Area ($n = 12$), Owyhee High Plateau ($n = 17$), and Central and Southern Nevada Basin and Range ($n = 10$, pooled in analyses because of only 2 southern sites). County lines are light gray. Map inset shows the study area (*solid line*) within the range of the Great Basin (*dashed line*) in the western United States.

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