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Ungulate exclusion, conifer thinning and mule deer forage in northeastern New Mexico

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ABSTRACT

The southwestern United States has experienced expansion of conifer species (*Juniperus* spp. and *Pinus ponderosa*) into areas of semi-arid grassland over the past century. The expansion of conifers can limit palatable forage and reduce grass and forb communities. Conifer species are sometimes thinned through hydraulic mulching or selective cutting. We assessed the effects of these treatments on mule deer (*Odocoileus hemionus*) habitat in northeastern New Mexico to determine if conifer thinning improved cover of preferred forage species for mule deer in areas with and without ungulates. We measured plant cover and occurrence of preferred forage species in the summers of 2011 and 2012. An ongoing regional drought probably reduced vegetation response, with preferred forage species and herbaceous cover responding to conifer thinning or ungulate exclusion immediately following treatment, but not the following year. In 2011, areas that received thinning treatments had a higher abundance of preferred forage when compared to sites with no treatment. Grass coverage exhibited an immediate response in 2011, with ungulate exclosures containing 8% more coverage than areas without exclosures. The results suggest that conifer thinning and ungulate exclusion may elicit a positive response, however in the presence of drought; the positive effects are only short-term.

1. Introduction

In the southwestern United States there has been a shift in structure and composition of vegetation communities within the past century, as juniper (*Juniperus* spp.) and ponderosa pine (*Pinus ponderosa*) stands have expanded and tree densities have increased (Belsky, 1996; Jacobs and Gatewood, 1999; Allen et al., 2002; Stoddard et al., 2008). These conifer expansions affect millions of hectares in the western U.S. (O'Rourke and Odgen, 1969; Pieper, 1990; Moore et al., 1999; Ansley et al., 2006). The expansion of juniper and ponderosa pine has had detrimental impacts on grassland systems, reducing herbaceous understory vegetation communities, exposing more bare ground, increasing soil erosion, depleting the soil-stored seed bank and disrupting the hydrological functioning of many sites (Allen et al., 2002; Stoddard et al., 2008). The causes of these conifer expansions are often attributed to anthropogenic factors such as overgrazing and fire suppression, exacerbated by recurring drought (Touchan et al., 1996; Clements and Young, 1997; Jacobs and Gatewood, 1999; Ansley et al., 2006).

Dense juniper and ponderosa stands often represent new stable plant communities that are very resistant to change. In areas of juniper and ponderosa removal, reestablishment of conifers is common where control efforts are not conducted frequently (Gottfried and Severson, 1994; Ansley and Rasmussen, 2005). These forests are often considered undesirable foraging habitat for ungulates due to the poor quality of available forage and lack of palatable understory plants caused by canopy closure and soil degradation (Kufeld et al., 1973; Lutz et al., 2003; Bender, 2006, Bender et al., 2007b) (Table 1). In areas that lack preferred species, Mule deer (*Odocoileus hemionus*) often exhibit low body fat and require larger home ranges to acquire adequate forage to maintain body condition (Boeker et al., 1972; Lawrence et al., 2004; Bender et al., 2007a, 2007b; Parker et al., 2009; Tollefson et al., 2010, 2011).

Selective cutting and hydraulic mulching have been used as restoration techniques aimed at returning areas of juniper and

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Table 1
Preferred grass, sedge, forb and shrub species found at the NRA Whittington Center, 2011–2012. Designation of preference by mule deer follows Kufeld et al. (1973) and Bender (2006).

Growth Form	Family	Species	Annual/Perennial
Graminoid	Cyperaceae	*Carex* spp.	Perennial
		Bouteloua curtipendula	Perennial
		B. eriopoda	Perennial
		B. gracilis	Perennial
		Schizachyrium scoparium	Perennial
Woody	Asteraceae	*Artemisia frigida*	Perennial
		A. ludoviciana	Perennial
	Chenopodiaceae	*Krascheninnikovia lanata*	Perennial
	Fagaceae	*Quercus gambelii*	Perennial
	Rosaceae	*Cercocarpus montanus*	Perennial
Forb	Asteraceae	*Helianthus praetermissus*	Perennial
	Chenopodiaceae	*Bassia prostrata*	Perennial
	Fabaceae	*Melilotus officinalis*	Annual/Perennial
		Psoralidium lanceolatum	Perennial
		Sphaeralcea coccinea	Perennial

ponderosa expansion to their original grassland-savanna ecotypes (O'Rourke and Odgen, 1969; Covington et al., 1997; Jacobs and Gatewood, 1999; Ansley and Rasmussen, 2005; Bates and Svejcar, 2009). Active forest thinning and restoration projects are becoming more common in juniper and ponderosa zones in the Midwest, Southwest, and the West (Severson and Boldt, 1977; Gibbs et al., 2004; Ansley and Rasmussen, 2005; Coultrap et al., 2008). Thinning of juniper and ponderosa can result in increased forage availability, affecting habitat use by mule deer (Gibbs et al., 2004). Immediate increases in herbaceous production and cover are often observed after thinning, though over the longer term (e.g., 7 years or more) production and cover can begin to decrease as conifers re-establish if treatments are not reapplied (Ansley and Rasmussen, 2005; Coultrap et al., 2008).

Ungulate exclusion can help elucidate the effect of herbivores on vegetation and has been used to assess the impacts of white-tailed deer (*Odocoileus virginianus*) (Ross et al., 1970; Webster et al., 2005; Goetsch et al., 2011) and livestock (Thaxton et al., 2010). Exclusion has also been used to reduce the intensity of browsing on plant communities in an attempt to increase herbaceous production and community diversity in areas of high ungulate densities (Webster et al., 2005; Goetsch et al., 2011) or where invasive ungulates have become problematic (Thaxton et al., 2010). Following ungulate exclusion there is often an increase in juvenile plants, especially forb species, and plant production and diversity. However, areas that are exposed to higher than average ungulate densities for extended periods of time often experience long-term effects that dictate how the community responds following the removal of grazing pressure due to seed bank degradation and increasing prevalence of invasive species (Webster et al., 2005; Thaxton et al., 2010; Goetsch et al., 2011).

To evaluate the impact of conifer removal on mule deer forage resources, we measured herbaceous response (herbaceous cover and herbaceous plant species richness) during the summers of 2011 and 2012 in areas that were subjected to confer thinning and areas that did not receive thinning treatments (control). Ungulate exclosures were constructed in both areas, with unfenced control plots paired with each exclosure. We hypothesized that areas which received conifer thinning would experience an increase in herbaceous cover and herbaceous plant species richness. We further hypothesized that areas of ungulate exclusion would experience an increase in herbaceous cover and herbaceous plant species richness due to the removal of grazing pressure. Lastly, we hypothesized that areas of thinning and ungulate exclusion would display the largest increases in cover and richness.

2. Material and methods

2.1. Study area

The NRA Whittington Center (WC; 36° 47′ N, 104° 30′ W), near the city of Raton, in Colfax County, in north-eastern New Mexico covers over 12,950 ha of semi-arid grassland and forest, and ranges in elevation from 2037 to 2400 m. Vegetation at the WC is similar to plant communities elsewhere in northeastern New Mexico (Armentrout and Pieper, 1988). Lower elevations (2000–2,300 m) are mostly grasslands and include species such as blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), little bluestem (*Schizachyrium scoparium*), and sand dropseed (*Sporobolus cryptandrus*). Fringed sagebrush (*Artemisia frigida*), winterfat (*Krascheninnikovia lanata*), and Gambel's oak (*Quercus gambelii*) are also common. At higher elevations (above 2300 m) the vegetation is dominated by Rocky Mountain juniper (*Juniperus scopulorum*), one-seed juniper (*Juniperus monosperma*), pinyon pine (*Pinus edulis*), ponderosa pine and Douglas fir (*Pseudotsuga menziesii*). The boundaries of the WC are fenced by three-strand barbed wire that has excluded livestock grazing since 1973 (Hild and Wester, 1998). Elk (*Cervus canadensis*), pronghorn (*Antilocapra americana*), mule deer, black bears (*Ursus americanus*) and mountain lions (*Puma concolor*) are also present.

The climatic conditions at the WC depend on aspect and elevation. The temperature varies throughout the year with high and low averages of 28.0° C and 12.9° C in July to 7.1° C and −7.3° C in January. Average annual precipitation on the WC is approximately 414 mm (SD = 110 mm), with the majority (62%) occurring between May and August (NOAA Weather Station COOP ID 297280; http://www.wrcc.dri.edu/).

In 2008 the WC began a series of opportunistic vegetation treatments in an effort to improve habitat conditions for mule deer by thinning juniper on 33 ha in Main Canyon. A hydraulic thinning head attached to an excavator was used to cut and mulch the woody vegetation to its base. This treatment continued in March 2009 and included another 97 ha of juniper and Gambel's oak-brush, creating 130 contiguous ha of treated vegetation in Main Canyon. In April 2010, juniper was thinned in 29 ha of Coal Canyon, again using a hydraulic thinning head. Finally, a private timber company began thinning areas of ponderosa pine, Douglas fir, and white fir (*Abies concolor*) at higher elevations via selective logging in 2010. Logging sites (hereafter referred to as timber) were selected based on ease of access and harvestable tree densities. Trees that were smaller than roughly 50 cm in diameter were cut at the stump and delimbed. Cut limbs were then gathered and left at the site for burning at the discretion of the center. In order to quantify the effect of thinning treatments, we recorded tree density and canopy cover, as well as understory herbaceous plant species richness and mule deer forage resource abundance in each of the thinned and unthinned areas.

2.2. Sampling methods

We sampled two areas (Main Canyon and Coal Canyon) where juniper was thinned through hydraulic mulching and one area (Timber Site) where ponderosa pine was thinned by selective logging. We paired each area with an adjacent, unthinned control. With the addition of the permanent control areas, six permanent experimental areas were established: Main Thinned (juniper thinned by hydraulic thinning in Main Canyon), Main Unthinned (juniper not thinned in Main Canyon), Coal Thinned (juniper thinned by hydraulic thinning in Coal Canyon), Coal Unthinned (juniper not thinned in Coal Canyon), Timber Thinned (ponderosa and other conifers thinned by selective logging at higher