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Original Research

Small-Scale Woodland Reduction Practices Have Neutral or Negative Short-Term Effects on Birds and Small Mammals☆

Sara P. Bombaci *, Travis Gallo, Liba Pejchar

Colorado State University, Fort Collins, CO 80523, USA

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ABSTRACT

Woodland reduction has been under way for decades to improve habitat for certain wildlife species, increase forage for livestock, improve watershed function and reduce soil erosion, and increase plant community heterogeneity. Land managers have implemented a variety of techniques to reduce woodlands. Yet most studies on outcomes are observational and focus on plant communities; fewer studies experimentally compare the relative effects of woodland reduction methods on wildlife. We conducted an experiment to evaluate the effects of three mechanical tree removal methods on habitat use by native birds and abundance of small mammals in the first 2 yr after treatment. Located in the Piceance Basin, Colorado, United States, this study consisted of seven replicated 1-ha stands of pinyon-juniper woodland treated with chaining, roller-chop, hydro-ax, as well as untreated plots ($n = 28$ plots). We found no differences in initial bird habitat use or small mammal abundance among the woodland reduction treatment methods. However, we found evidence that habitat use was significantly lower in all woodland reduction treatment plots than in control plots for birds of dense woodland and open woodland habitats, and that use was positively associated with tree cover. Furthermore, no grassland or shrubland obligate birds used the treatment plots, suggesting that small-scale woodland reduction treatments may not provide attractive habitat for shrubland or grassland birds, at least within 2 yr following treatment. Because some bird species responded negatively to all methods of woodland reduction treatments, and no bird or small mammal species responded positively, the initial effects of small-scale chaining, roller-chop, and hydro-ax treatments on wildlife should not be overlooked.

Introduction

Pinyon (*Pinus* spp.) and juniper (*Juniperus* spp.) woodlands have expanded over the past 100 − 150 yr into many sagebrush and grassland areas (Romme et al., 2009), which has had diverse ecosystem consequences. Increased woodland overstory has been associated with decreased diversity and cover of shrubs and grasses (Tausch et al., 1981; Miller et al., 2000), reduced soil seed bank density (Koniak and Everett, 1982), increased erosion potential, altered water availability and watershed function (Roundy and Vernon, 1999; Kormos et al., 2017), and impacts to habitat for sagebrush obligate wildlife (Falkowski et al., 2017). The practice of clearing or reducing pinyon and juniper woodland stands (henceforth referred to as woodland reduction) is commonly used to control conifer encroachment (Redmond et al., 2014), improve habitat for wildlife species of conservation concern (Baruch-Mordo et al., 2013; Bergman et al., 2014), increase forage for livestock (Aro, 1971; Belsky, 1996), improve watershed function and reduce soil erosion (Roundy and Vernon, 1999), reduce fuels under fire mitigation plans (Schoennagel and Nelson, 2011), and/or increase plant community heterogeneity (Miller et al., 2014).

The use of woodland reduction is likely to continue as these practices are included in regional or federal management plans for rare or economically important wildlife species (e.g., mule deer *Odocoileus hemionus* Rafinesque, sage grouse *Centrocercus* spp.) (US Bureau of Land Management, 2011; Baruch-Mordo et al., 2013; DOI, 2013; Bergman et al., 2014; Stephens et al., 2016), as well as for fuel reduction under the National Fire Plan (Schoennagel and Nelson, 2011). However, pinyon and juniper woodlands support a high diversity of animal species and provide specialized or critical habitat for some species (Bombaci and Pejchar, 2016). Therefore, conversion of pinyon and juniper woodlands may have important implications for the maintenance of regional biodiversity (Gallo and Pejchar, 2016; Gallo et al., 2016). To sustain diverse native assemblages in areas undergoing pinyon and/or juniper removal, it is important to understand the effects of different woodland reduction practices on diverse wildlife species.

Land managers have implemented a variety of techniques to reduce woodlands and/or to improve sagebrush habitat (e.g., mechanical

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* Correspondence: Sara P. Bombaci, Colorado State University, 1474 Campus Delivery, Fort Collins, CO 80523, USA. Tel.: +1 505 688 9324.
E-mail address: sara.bombaci@colostate.edu (S.P. Bombaci).

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removal, prescribed burning, and thinning [see Jones et al., 2013; Bombaci and Pejchar, 2016]). Although comparisons of wildlife responses between prescribed burning or thinning treatments and mechanical treatments have been made in pinyon-juniper habitat (Kundaeli and Reynolds, 1972; Turkowski and Watkins, 1976; Short et al., 1977; Severson, 1986), few studies have experimentally compared the relative effects of different mechanical woodland reduction methods on wildlife (Bombaci and Pejchar, 2016). Thus, we know little about whether animal species respond differentially to various mechanical woodland reduction methods. Furthermore, many previous studies on the effects of mechanical woodland reduction on wildlife have occurred in chaining treatments (dragging a boat anchor chain attached to two bulldozers across a stand, which uproots and kills trees) (O'Meara et al., 1981; Tausch and Tueller, 1995; Ranglack and du Toit, 2015; Bombaci and Pejchar, 2016). Hydro-ax (full mastication of trees using an articulating mower) and roller-chop (crushing of trees with a heavy bladed drum attached to a bulldozer) methods are also being used to reduce woodlands, but few studies have evaluated how wildlife in pinyon-juniper and sagebrush steppe ecosystems have responded to the vegetation and structural changes associated with these practices (Bombaci and Pejchar, 2016). Different mechanical woodland reduction methods generate different soil disturbance patterns that are likely to produce unique patterns of vegetation reestablishment (Stephens et al., 2016). These differences may affect how certain animal species respond to post-treatment conditions. Thus, understanding the comparative effects of various mechanical woodland reduction strategies on nongame species is ecologically interesting and has important conservation implications.

We used a series of small (1-ha) experimental plots to evaluate the initial effects that three different mechanical woodland reduction methods (chaining, hydro-ax, and roller-chop) have on small mammal abundance and bird habitat use. This experiment was originally designed to compare the effect of these different mechanical woodland reduction methods on grass, herb, and shrub regeneration and production. Although these plots were small in scale, we considered this to be a valuable and rare opportunity to use an experimental approach to assess short-term effects of different mechanical tree reduction methods on birds and small mammals.

We hypothesized that bird habitat use in treatment and control plots would vary by functional group (i.e., birds of dense woodland habitat, open woodland habitat, or shrubland-grassland habitat; see methods for functional group classification). Specifically, we predicted lower use of all woodland reduction treatments compared with control plots by birds of dense woodlands, higher use of all treatments compared with control plots by birds of shrublands and grasslands, and that habitat use would not differ among all treatments and control plots for birds of open woodlands. We did not expect bird habitat use to vary among treatment types since we predicted that birds would respond more strongly to the wholesale removal of trees than to the finer-scale differences in vegetation and substrate cover generated by the different treatment methods. Furthermore, we suspected that the experimental plots may be too small to assess differences in bird use among treatment methods.

In contrast to birds, we hypothesized that small mammals would respond differentially to fine-scale differences in vegetation and substrate cover among the treatment types. Hydro-ax treatments often alter forest structure by reducing all trees to a uniform layer of fine mulch, whereas chaining and roller-chop treatments leave larger woody debris within the treatment plots, likely providing better protective cover for small mammals. Previous studies have found a positive relationship between the abundance of several small mammal species and slash (i.e., dead woody debris; Baker and Frischknecht, 1973; Severson, 1986; Kruse, 1999). Therefore, we hypothesized that small mammal abundance would be higher in chaining and roller-chop plots because these treatment types have higher slash cover, abundance would be lower in hydro-ax plots that have lower slash cover, and abundance would be lowest in control plots with almost no slash cover. Lastly, we hypothesized that the percent cover of different vegetation characteristics, especially shrub, herb, and grass cover, would also influence small mammal abundance. We did not consider a group-level response to treatments for small mammals because we did not expect to observe a large enough diversity of small mammal species to create meaningful functional groups.

Methods

Study Area

This study was conducted in the Piceance Basin, northwest Colorado. United States. Dominant land uses include energy extraction, domestic livestock grazing, and recreational hunting. Topography in the Piceance Basin ranges from high plateaus to deeply incised valleys. The arid steppe climate of the Piceance Basin varies both spatially and temporally due to the diverse topography and vegetation cover in the region (Wymore, 1974). Vegetation communities in the Piceance Basin range from bottomland irrigated pastures and croplands to upland sagebrush and pinyon-juniper woodland, to higher-elevation spruce, fir, and aspen forest (Wymore, 1974; Lendrum et al., 2012). Irrigated lowlands represent < 1% total cover, whereas upland pinyon-juniper and sagebrush communities characterize the dominant cover type (35% and 32%, respectively) (Wymore, 1974).

Woodland overstory in our study area was composed primarily of pinyon pine (*Pinus edulis* Engelm.) and Utah juniper (*Juniperus osteosperma* Torr.), and understory shrubs were mainly serviceberry (*Amelanchier* Medik.), bitterbrush (*Purshia tridentata* Pursh), snowberry (*Symphoricarpos rotundifolius* A. Gray), mountain mahogany (*Cercocarpus montanus* Raf.), and big sagebrush (*Artemisia* spp.). We did not identify sagebrush to subspecies, but the region includes a mix of big sagebrush (*Artemisia tridentata* Nutt.), mountain big sagebrush (*Artemisia tridentata* Nutt. subsp. *vaseyana* Rydb.), and Wyoming big sagebrush (*Artemisia tridentata* Nutt. subsp. *wyomingensis* Beetle and Young). The dominant understory forbs, grasses, and grasslike plants included phlox (*Phlox* L. spp.), Lewis flax (*Linum lewisii* Pursh), tansyaster (*Machaeranthera* Nees. spp.), plains pricklypear cactus (*Opuntia polyacantha* Haw.), sedges (*Carex* L. spp.), wildrye (*Elymus* L. spp.), Indian ricegrass (*Achnatherum hymenoides* [Roem. & Schult.] Barkworth), bluegrass (*Poa* L. spp.), and western wheatgrass (*Pascopyrum smithii* [Rydb.] Á. Löve) (Stephens et al., 2016). Although cheatgrass (*Bromus tectorum* L.) was sparse in the area before treatments were applied, it increased on treatment plots 2 years after tree removal (Stephens et al., 2016). Historical climate records from the Western Regional Climate Center (station #055048 1981 − 2010 thirty-year average) indicate that total annual precipitation in the study area averaged 430 mm, and average monthly temperatures ranged from a low of − 18°C in January to a high of 29°C in July.

Study Design and Site Selection

Tree reduction treatments were applied by Colorado Parks and Wildlife in a randomized complete block design in two locations in the Piceance Basin (a northern site at 39°55'26.89"N, 108°12'38.82"W and a southern site about 4.5 km away at 39°54'23.19"N, 108°15'39.05"W). Our sites were embedded in a large continuous stand of pinyon-juniper, away from any boundaries between advancing conifer and sagebrush habitats (Stephens et al., 2016). We estimated that stands at these locations were approximately 100 yr old, but we did not measure stand age empirically, and some trees may be several hundred yr old (Stephens et al., 2016). The northern site was estimated to be in a late phase II successional stage of woodland development, and the southern site was estimated to be in a late phase III stage (Stephens et al., 2016). Treatment plots were established on slopes ranging from 5% to 20%. The plots ranged in elevation from 2000 to 2165 m. The study design included four polygons in a northern site and three