Rangeland Ecology & Management 70 (2017) 106–115

Contents lists available at ScienceDirect

Rangeland Ecology & Management

journal homepage: http://www.elsevier.com/locate/rama

Sage Grouse Groceries: Forb Response to Piñon-Juniper Treatments☆

Jonathan D. Bates [a,*], Kirk W. Davies [a], April Hulet [b], Richard F. Miller [c], Bruce Roundy [d]

[a] Rangeland Scientists, US Department of Agriculture—Agricultural Research Service, Eastern Oregon Agricultural Research Center, Burns, OR 97720, USA
[b] Assistant Professor, Department of Forest, Rangeland, and Fire Sciences, University of Idaho, Moscow, ID, 83844, –1142, USA
[c] Professor Emeritus, Department of Animal and Rangeland Sciences, Oregon State University, Corvallis, OR 97331, USA
[d] Professor, Plant & Wildlife Sciences, Brigham Young University, Provo, UT 84601, USA

ARTICLE INFO

Article history:
Received 1 January 2016
Received in revised form 14 March 2016
Accepted 25 April 2016

Key Words:
conifer woodland
fuel reduction
juniper
prescribed fire
sagebrush

ABSTRACT

Juniper and piñon coniferous woodlands have increased 2- to 10-fold in nine ecoregions spanning the Intermountain Region of the western United States. Control of piñon-juniper woodlands by mechanical treatments and prescribed fire are commonly applied to recover sagebrush steppe rangelands. Recently, the Sage Grouse Initiative has made conifer removal a major part of its program to reestablish sagebrush habitat for sage grouse (*Centrocercus urophasianus*) and other species. We analyzed data sets from previous and ongoing studies across the Great Basin characterizing cover response of perennial and annual forbs that are consumed by sage grouse to mechanical, prescribed fire, and low-disturbance fuel reduction treatments. There were 11 sites in western juniper (*Juniperus occidentalis* Hook.) woodlands, 3 sites in singleleaf piñon (*Pinus monophylla* Torr. & Frém.) and Utah juniper (*Juniperus osteosperma* [Torr.] Little), 2 sites in Utah juniper, and 2 sites in Utah juniper and Colorado piñon (*Pinus edulis* Engelm). Western juniper sites were located in mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) steppe associations, and the other woodlands were located in Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis*) associations. Site potential appears to be a major determinant for increasing perennial forbs consumed by sage grouse following conifer control. The cover response of perennial forbs, whether increasing (1.5- to 6-fold) or exhibiting no change, was similar regardless of conifer treatment. Annual forbs favored by sage grouse benefitted most from prescribed fire treatments with smaller increases following mechanical and fuel reduction treatments. Though forb abundance may not consistently be enhanced, mechanical and fuel reduction conifer treatments remain good preventative measures, especially in phase 1 and 2 woodlands, which, at minimum, maintain forbs on the landscape. In addition, these two conifer control measures, in the short term, are superior to prescribed fire for maintaining the essential habitat characteristics of sagebrush steppe for sage grouse.

Introduction

During the past 150 years, juniper (*Juniperus* spp.) and piñon (*Pinus* spp.) coniferous woodlands have increased 2- to 10-fold in 9 ecoregions (Omernik 1987) spanning the Intermountain Area of the western United States (Romme et al. 2009). Woodland expansion is especially well documented in the Great Basin and Oregon High Desert where woodlands are estimated to occupy about 12 million hectares (Miller et al. 2005; Suring et al. 2005; Weisberg et al. 2007; Miller et al. 2008). About 90% of woodland expansion has occurred in sagebrush (*Artemisia* spp.) steppe habitat (Miller et al. 2011). Control of piñon-juniper woodlands by mechanical treatments and prescribed fire has been applied since the 1950s. The early objectives of woodland control were to increase forage for livestock, restore big-game habitat, and improve watershed function (Tidwell 1987). These objectives remain a component of current woodland control programs; however, over time others have been added to address multiple resource priorities. Most recently, targeted conifer removal has been conducted on large scales to restore sagebrush habitat for greater sage grouse (*Centrocercus urophasianus*) and other shrub steppe species through private-public land partnerships associated with the Sage Grouse Initiative (SGI) (SGI 2014; NRCS 2015). Sage grouse are sensitive to conifer presence, abandoning lek sites when tree cover exceeds 4% and avoiding sites when trees begin exceeding 1 m in height (Casazza et al. 2011; Baruch-Mordo et al. 2013). Increases in conifer cover and density cause declines in cover and structure provided by sagebrush and bunchgrasses, as well as reducing the abundance of perennial and annual forbs (Miller et al. 2000, 2005; Casazza et al. 2011; Knick et al. 2013a, 2013b; Roundy et al. 2014). Forbs are seasonally important,

☆ The Eastern Oregon Agricultural Research Center is jointly funded by the US Department of Agriculture—Agricultural Research Service and Oregon State Agricultural Experiment Station.
* Correspondence: Jonathan D. Bates, US Dept of Agriculture—Agricultural Research Service, Eastern Oregon Agricultural Research Center, Burns, OR 97720, USA. Tel.: +1-541-573-8932.
E-mail address: jon.bates@oregonstate.edu (J.D. Bates).

http://dx.doi.org/10.1016/j.rama.2016.04.004

amounting to 50 — 80% of the diet of sage grouse during prenesting and brood-rearing in the spring and summer (Barnett and Crawford 1994, Drut et al. 1994).

There is no information on how conifer treatments directly benefit sage grouse, although some inferences can be made on the basis of treatment method and the woodland phase treated. For example, mechanical control of conifers in phase 1 and 2 woodlands will maintain or quickly recover the major characteristics of shrub-steppe habitat, as treatment disturbance is minimal compared to fire (Maestas et al. 2015). Prescribed fire in these two woodland phases removes sagebrush with recovery taking 20 to 40 years on mountain big sagebrush (*A. tridentata* ssp. *vaseyana* [Rydb.] Beetle) sites (Harniss and Murray 1973; Lesica et al. 2007; Ziegenhagen and Miller 2009) and likely longer periods of time on Wyoming big sagebrush (*A. tridentata* ssp. *wyomingensis* Beetle and A. Young) steppe (Baker 2006; Beck et al. 2009; Wambolt and Payne 1986). Fire may enhance the response of forbs used by sage grouse, although published data are limited and often conflicting. Burning in Wyoming big sagebrush communities has not been effective at increasing perennial forb abundance, and the responses of annual forbs have mainly been dominated by invasive species (Fischer et al. 1996; Bates et al. 2009; Beck et al. 2009). In mountain big sagebrush communities, perennial and annual forbs have increased or not changed after fires and cutting (Bates et al. 2009, 2014; Davies et al., 2011a, 2011b). Information on the response of species and genera specifically consumed by sage grouse has, however, been limited (Nelle et al. 2000; Miller et al. 2014).

We analyzed data sets from previous and ongoing studies that contain detailed forb genera and species response to conifer treatments in sagebrush steppe. Specifically, we evaluated the cover response of perennial and annual forbs, consumed by sage grouse, to mechanical, prescribed fire (landscape level), and fuel reduction treatments. Here, fuel reduction treatments are winter and spring burning of cut trees and slash with minimal site disturbance to shrub and herbaceous components. Treatments were conducted in woodlands in five western states spanning all three woodland expansion phases (for phase descriptions see Miller et al. 2005; Romme et al. 2009). We hypothesized that 1) fire treatments would have greater forb cover response compared with fuel reduction or mechanical tree control and untreated controls, 2) perennial forb response would be greater following prescribed fire treatments in phase 1 and 2 woodlands compared with phase 3 woodlands and controls, 3) in mechanical treatments, perennial forb cover in phase 1 and phase 2 woodland treatments would not differ from untreated controls and would be greater than treated phase 3 woodlands, and 4) annual forb cover would be greater in phase 3 woodlands than phase 1 and 2 woodlands after mechanical treatment.

Methods

Study Sites

Sites were located in southwest Idaho, Nevada, California, eastern Oregon, and Utah. Studies included woodland treatments performed on single sites and others spanning multiple sites. Data collections ranged from the first 3 to 10 years post treatment (Table 1). Commonalities among the studies were that 1) conifer treatments were applied to woodlands expanding into big sagebrush steppe and sage grouse habitat and 2) before treatment, the understory was largely composed of native grasses and forbs and exotic invasive species were either absent or minor components of the herb layer. There were 11 sites in western juniper (*Juniperus occidentalis* spp. *occidentalis* Hook.) woodlands, 3 sites in singleleaf piñon (*Pinus monophylla* Torr. & Frém.) and Utah juniper (*Juniperus osteosperma* [Torr.] Little), 2 sites in Utah juniper, and 2 sites in Utah juniper and Colorado piñon (*Pinus edulis* Engelm). Western juniper sites were in northwestern California, eastern Oregon, and southwestern Idaho and were located in mountain big sagebrush steppe associations (Table 1). These sites were the Hart Mountain (Hart Mt), Northern Great Basin Experimental Range (NGBER), High Desert (two sites; Otley Ranch, Squaw Butte), Joint Fire Science mountain big sagebrush (JFSMTN), South Mountain (Owyhee), and Steens Mountain (Steens Mt.) studies. Sites for the other woodlands were in eastern Nevada and western Utah and were located in Wyoming big sagebrush steppe associations and were the Joint Fire Science Wyoming big sagebrush (JFSWYO) sites. Further site descriptions are referenced in the associated literature (see Table 1), except for the NGBER study, which was new. The NGBER site is a mountain big sagebrush/Idaho fescue (*Festuca idahoensis*) association located on north- and east-facing slopes (10 — 20%) at 1500–1650 m. The ecological site is a Droughty Loam 11–13 PZ (NRCS 2006; 2010). Before treatment, juniper canopy cover averaged 15% and tree density (>1.5 m tall) averaged 145 trees ha^{-1}. The intercanopy was 51% bare ground, sagebrush cover was 6.1%, and Idaho fescue and perennial forbs were the main herbaceous species. The site was classified as a phase 2 woodland because trees codominated with shrub and perennial herbaceous plants. For woodland phase classification we used criteria developed by Miller et al. (2000, 2005).

Experimental Design and Treatment Application

The Owyhee, High Desert, Hart Mt, NGBER, JSFMTN, and JSFWYO studies were randomized complete block designs, and the Steens Mt. study was a completely randomized design (see Table 1). Treatment applications are briefly described in Table 1, and, aside from the NGBER study, further details can be referenced in the citations for each study.

The NGBER site included prescribed fire and fuel reduction treatments, as well as untreated controls, each replicated five times. Treatment plots were 0.4 ha — 1.0 ha. In the prescribed fire treatment, 10 — 20% of the trees were cut in October 2010 and left to dry for 11 months before the fire application. The felled trees were used to augment shrub and herbaceous fuels to maximize killing of remaining live trees. Prescribed fire plots were burned 19 September, 2011 using strip head fires. All remaining live trees and sagebrush were killed by the fires. All fine surface fuels were consumed, and few sagebrush skeletons remained. Burning of felled juniper consumed all 1-hr, 10-hr, and 100-hr fuels and partly consumed 1000-hr fuels. Large perennial bunchgrass density was reduced by almost 30% from 19.2 ± 0.7 to 13.8 ± 1.1 plants m^{-2}. All trees in the fuel reduction treatment were felled in June 2011. After 8 months all felled trees were burned individually on 8–9 February, 2012 using drip torches with 50:50 diesel and gas mixture. Fuel consumption was confined to the felled juniper, and burning consumed 1-hr and 10-hr fuels. Sagebrush cover and perennial plant densities were unaffected. Fuel reduction treatments referenced in this article were similarly of low disturbance, with felled trees burned in the winter and spring.

Vegetation Measurements

Canopy cover of perennial and annual forbs was measured inside 0.2-m^2 (0.4 × 0.5 m) frames at 3-m intervals along 50-m transects in the Steens Mt., Owyhee, Hart Mt, and NGBER studies. The number of transects were four or five in each treatment replicate depending on the study. Canopy cover in the High Desert studies was sampled in three zones (interspace, beneath felled tree, around the stump) and pooled by weighted average to determine whole-plot effects for juniper control treatments (Bates et al. 2014). Canopy cover in the JFSMTN and JFSWYO was sampled with the point-intercept method along 30-m transects (Herrick et al. 2009; Miller et al. 2014) between 2006 and 2014. Additional sampling detail is provided in the references provided in Table 1.

Analysis

Cover of perennial and annual forbs was sorted to species and genera known to be consumed by sage grouse as reported by Klebenow and