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Mechanical fuel treatment effects on vegetation in a New Mexico dry mixed conifer forest

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ABSTRACT

While the main objective of many silvicultural treatments in the western US is to reduce fire potential, their effects on overstory regeneration, midstory and herbaceous communities is of importance to land managers. To quantify these effects, we measured overstory regeneration, midstory density by species, herbaceous biomass, species richness and cover in commercial and non-commercial treatments with differing slash prescriptions in dry mixed conifer stands of south central New Mexico. Results indicated that overstory regeneration and shrub density were not significantly affected by treatments, although they did increase at one site which appeared to be more mesic than the others. Herbaceous biomass increased 4 years post-treatment in one non-commercial scatter treatment and 3 years post-treatment in the commercial treatment. Species richness was not affected by any of the treatments. Cover of grasses and forbs remained low in all treatments. Soil cover increased in the commercial treatment; however, it decreased each year following treatment.

1. Introduction

While numerous studies have addressed the impact of commercial harvesting treatments on vegetation response, there is lack of information addressing non-commercial treatments. In the southwestern US, there has been a paradigm shift away from conventional forestry practices toward a new set of treatments that have a primary objective of reducing fuel loads. This has resulted in an increased emphasis on using non-commercial treatments in the region, and most of the current research in the southwest has focused on ponderosa pine dominated forests. An increased understanding of how these treatments affect vegetative communities in the higher elevation dry mixed conifer forests will allow managers to more effectively implement silvicultural treatments and develop new treatments in a multiple-use matrix.

Typically, commercial silvicultural treatments lead to increased herbaceous and midstory production, with the exception of an initial reduction in herbaceous cover post-harvest (Thysell and Carey, 2001). In the western US the majority of work has been done in ponderosa pine forests (Pase, 1958; McConnell and Smith, 1965; Clary and Ffolliott, 1966; McConnell and Smith, 1970; Thompson and Gartner, 1971; Clary, 1975; Uresk and Severson, 1989). Relatively little work has been done in the higher elevation mixed conifer forests and has typically focused on commercial treatments (Young et al., 1967; Wallmo et al., 1972; Dyrness, 1973; Patton, 1976). Little attention has been given to non-commercial (Scherer et al., 2000; Metlen et al., 2004). Those that have examined non-commercial treatments have shown herbaceous cover to remain the same or decrease 1–3 years post-treatment (Scherer et al., 2000; Metlen et al., 2004).

In ponderos pine and mixed conifer forests, commercial treatments generally result in an increase in herbaceous production and cover 1–2 years after harvest which may last for many years. In Arizona, estimated herbaceous production increased by 50 lbs acre^{-1} 2 years after harvest in mixed conifer sites harvested by selection cutting and overstory removal (Patton, 1976). However, understory cover has also been found to decrease the first year post-harvest in Douglas-fir stands in Washington (Thysell and Carey, 2001). Deer forage was 47% greater on clear cut strips than uncut areas 15 years after harvest on lodgepole pine and spruce-fir stands in Colorado (Wallmo et al., 1972). Studies examining non-commercial treatments in mixed conifer stands have shown herbaceous cover to remain the same or decrease 3 years post-harvest (Scherer et al., 2000; Metlen et al., 2004).

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While production is important ecologically, information on species richness and species composition help identify the usefulness of the increase depending on management objectives. For example, herbaceous production is useful when the management objective is to increase forage for ungulates. Clearcuting of old-growth Douglas-fir forests in Oregon lead to areas being dominated by a wide variety of both residual and invasive species (Dyrness, 1973). Species richness response to treatment varies, for example, it increased 1 and 3 years post-treatment in Washington (Thysell and Carey, 2001) and decreased 3 years post-treatment in Oregon (Metlen et al., 2004).

Shrub response to varying levels of tree removal differed among studies (Patton and McGinnes, 1964; Young et al., 1967; McConnell and Smith, 1970; Uresk and Severson, 1989). Shrub production peaked at intermediate levels of overstory crown cover, while current annual growth peaked slightly before this point in relation to canopy closure in ponderosa pine stands of the Black Hills (Uresk and Severson, 1989) and mixed conifer stands in Eastern Oregon (Young et al., 1967). Shrub production increased slightly on thinned ponderosa pine stands in Washington (McConnell and Smith, 1970).

The objectives of this study were to identify the effects of different silvicultural treatments on midstory and understory vegetative response in dry mixed conifer stands of the Sacramento Ranger District (Lincoln National Forest, New Mexico).

The three silvicultural treatments were non-commercial thin with a lop and pile slash treatment, non-commercial thin with a lop and scatter slash treatment, and commercial harvest up to 61-cm diameter at breast height (DBH). We hypothesized that: (1) herbaceous biomass, cover and species richness would be highest in commercial harvest treatments followed by non-commercial scatter, non-commercial pile, and untreated controls; (2) midstory density and cover would be highest in commercial harvest treatments followed by non-commercial scatter, non-commercial pile, and untreated controls; (3) herbaceous biomass, cover, and species richness would be greatest in areas that were logged most recently prior to current treatment application.

2. Methods

2.1. Study area

Three sites, Bailey Canyon (Bailey), Cox Canyon (Cox), and Sleepy Grass Campground (Sleepy) were located in the Lincoln National Forest, approximately 3.2–16 km from Cloudcroft, NM within the Sacramento Ranger District. Elevation ranged from 2560 to 2773 m. Average annual rainfall for Cloudcroft, NM is 704.3 mm with 50.1% falling in July–September (World Climate, 2006). Average maximum and minimum temperatures are 14.0 and 0.8 °C respectively (World Climate, 2006). Estimated overstory composition by BA for all site–treatments combined were Douglas-fir (*Psuedotsuga menziesii*) 71.6%, ponderosa pine 12.9%, southwestern white pine (*Pinus strobiformus*) 7.0%, white fir (*Abies concolor*) 6.5%, and aspen (*Populus tremuloides*) 2.0% (Mason, 2006). Overstory composition differed among site–treatment combinations, where the most notable difference was a higher proportion of *Pinus* spp. at Bailey and aspen at Sleepy (Mason, 2006).

Historic treatments and current treatments differed among the three study areas. The Bailey and Sleepy areas were similar in that neither had been commercially harvested in the last 60–100 years, while the Cox site was commercially harvested 20–30 years ago (Mickey Mowter, USFS, personal communication 2006). Bailey and Sleepy sites were relatively dense stands with little herbaceous production compared to the Cox study area which had little overstory regeneration since harvested 20–30 years ago and greater herbaceous production (Mason, 2006).

Treatments in 2003 at Cox and Bailey were a non-commercial thin with slash piled (pile) and a non-commercial thin with slash scattered (scatter). At Cox and Bailey slash remained on site for the entirety of the study. Sleepy was thinned non-commercially in 2002, where perimeter slash piles were burned and interior piles were left for fire wood collection. At the end of the growing season in 2004, Sleepy was commercially harvested where slash was piled at loading decks and removed. Each study area contained an untreated control. Non-commercial treatments were a thin-from-below prescription with a 22.9-cm diameter cap and a 4.9-m spacing requirement. Commercial treatments harvested trees greater than 22.9 cm DBH and less than 61.0-cm DBH. Commercial treatments had a target residual basil area (BA) of 18–23 $m^2\ ha^{-1}$ with an emphasis on removing conifers from within and immediately surrounding clumps of aspen where applicable. All treatments were done by hand crews using chainsaws. The commercial harvest used heavy equipment to skid felled trees to loading decks. Stand structure post-harvest was summarized by Mason et al. (2007).

Cattle were present at Cox and the control treatment at Sleepy, while elk and deer were at all sites. Elk population estimates for the Sacramento Mountains from 1998–2002 range from 3000 to 4000 animals over an area of 434,364 ha (NMDGF, 2006). Estimates of deer populations were not available.

The control treatment at Sleepy and all treatments in Cox were located in the Pumphouse Grazing Allotment, which has been grazed for >30 years by cattle from the middle of May until the middle of October (Rick Newmon, USFS, personal communication, 2005). The number of cattle on the allotment has been between 56 and 64 cattle for the last ~20 years, prior to that, the permit was for 146 cattle (Rick Newmon, USFS, personal communication, 2005). The pile (2004) and commercial (2005) treatments at Sleepy were part of the Pumphouse Grazing Allotment until the 1960s, after which they were no longer grazed by cattle (Anthony Madrid, USFS, personal communication 2006). Treatments at Bailey were located in both the La Luz Grazing Allotment and the James Canyon Grazing Allotment. Cattle grazing was discontinued in the La Luz Grazing Allotment in the 1950s and in the James Canyon Grazing Allotment in 1995 (Anthony Madrid, USFS, personal communication 2006).

2.2. Study design

Sites were selected based on historical treatments, recent treatments, slope, aspect, and cover type. Due to differences in historical and recent treatments among sites, we randomly selected three experimental units for each site–treatment combination (i.e. Bailey-pile $n = 3$; Cox-pile $n = 3$; etc.). Two permanent 100-m transects were systematically placed perpendicular to the contour in each of the experimental units (Mueller-Dombois and Ellenberg, 1974). All transects were placed at least 50 m from the stand boundary to avoid edge bias (Mueller-Dombois and Ellenberg, 1974). The second transect was systematically placed 50–100 m from the first transect. Data collection took place the summers of 2004 through 2007. Bailey was only sampled in 2004 and 2005. At Sleepy, the pile treatment was only sampled in 2004 (2 years post-treatment) and the commercial treatment was sampled for 3 years post-treatment.

2.3. Midstory

Midstory density (woody stems <11.4 cm DBH) was measured in 40 2 m × 5 m subplots along two 100-m transects per