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Can pine forest restoration promote a diverse and abundant understory and simultaneously resist nonnative invasion?

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ABSTRACT

An important goal of forest restoration is to increase native plant diversity and abundance. Thinning and burning treatments are a common method of reducing fire risk while simultaneously promoting understory production in ponderosa pine (*Pinus ponderosa*) forests. In this study we examine the magnitude and direction of understory plant community recovery after thinning and burning restoration treatments in a ponderosa pine forest. Our objective was to determine if the post-treatment community was a diverse, abundant, and persistent assemblage of native species or if ecological restoration treatments resulted in nonnative species invasion. This project was initiated at the Grand Canyon-Parashant National Monument, Arizona, USA in 1997. We established four replicated blocks that spanned a gradient of soil types. Each block contained a control and a treated unit. Treated units were thinned to emulate pre-1870 forest stand conditions and prescribed-burned to reintroduce fire to a system that has not burned since ~1870. We measured plant cover using the point-line intercept method and recorded species richness and composition on 0.05 ha belt transects. We examined the magnitude of treatment responses using Cohen's *d* effect size analysis. Changes in community composition were analyzed using nonmetric multidimensional scaling (NMS). Native plant species cover and richness increased in the thinned and burned areas compared to the controls. By the last year of the study, annual species comprised nearly 60% of the understory cover in the treatment units. Cheatgrass (*Bromus tectorum*), a nonnative annual grass, spread into large areas of the treated units and became the dominant understory species on the study site. The ecological restoration treatments did promote a more diverse and abundant understory community in ponderosa pine forests. The disturbances generated by such treatments also promoted an invasion by an undesirable nonnative species. Our results demonstrate the need to minimize disturbances generated by restoration treatments and argue for the need to proactively facilitate the recovery of native species after treatment.

1. Introduction

The diversity and abundance of native understory vegetation is an important measure of ecological integrity in ponderosa pine (*Pinus ponderosa*) forests. Over the past century, fire suppression, overgrazing, and poor logging practices have led to increased overstory density and reduced understory species abundance (i.e., aerial cover) and diversity (Bakker and Moore, 2007). The loss of species from a community can alter ecosystem functions, such as plant productivity, nutrient cycling, and trophic linkages, and may reduce community resistance to nonnative species invasion (Elton, 1958; Hooper and Vitousek, 1997; Tilman et al., 1997; McCann, 2000). Thus, a major management goal in these low-diversity forests is to restore the native diversity and abundance of herbaceous understory communities while simultaneously mitigating nonnative species establishment and spread. In this paper we evaluate whether reducing overstory biomass and canopy cover and reintroducing surface fires can achieve these goals.

Restoration treatments of tree removal and prescribed fire are ecological disturbances. Tree harvesting machinery and personnel often perturb the soil during thinning procedures and prescribed fire removes much of the understory aboveground biomass. While the disturbances are produced with the intention of enhancing the native vegetative community, undesired and detrimental nonnative species can also respond quickly to disturbance (Hobbs and Huenneke, 1992; Crawford et al., 2001; Griffis et al., 2001; Allen et al., 2002). Nonnative species have been shown to increase in coniferous forests treated with prescribed fire, particularly when coupled with tree thinning (Wienk et al., 2004; Fulé et al., 2005; Huisinga et al., 2005; Dodson and Fiedler, 2006; Youngblood et al., 2006; Collins et al., 2007). The risk of spread of nonnatives is a major concern and usually contrary to the goals of ecological restoration (Moore et al., 1999; Allen et al., 2002; D'Antonio and Meyerson, 2002).

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