Effect of Fire Severity and Hillslopes Gradient on Herbaceous Cover and Diversity

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Abstract

Anthropogenic activities have altered the structure of southwestern Ponderosa pine forests from open forest with diverse herbaceous understories to closed forests with more homogenous understories. The objectives of this study are to: (1) analyze how fire severity and hillslope gradient affects the herbaceous cover and diversity, (2) quantify post fire erosion herbaceous cover and diversity, and (3) understand the impacts on herbaceous regeneration after fire in a ponderosa pine forest in New Mexico. The effect of fire severity and hillslope gradient on the herbaceous cover and diversity will be determined by identifying herbaceous vegetation diversity and percent cover in 0.1 m2 quadrats. In addition, percent soil cover, rock cover, and ash cover were estimated. Four sites were selected based on fire severity and hillslope gradient with 2, 2 x 10 m replicate plots of each. Ten quadrats were sampled at the top of the hillslope, and 10 additional quadrats at 1 m increments down the hillslope for a total of 10 increments (10 m). Sampling was initiated 1 month after a summer wildfire, and will be sampled in the fall, spring, and summer. A control area (no burn) was also sampled. Initial data from one month post fire indicate that herbaceous diversity between the control and low severity plots were similar; herbaceous cover was higher in the control plot. The high severity plots had only *Populus tremloides* regeneration, therefore diversity and cover were lower than the low severity and control plots. Sampling will continue to monitor regeneration over time.

Introduction

Changes in land-use and management practices following Euro-American settlement have altered ponderosa pine (*Pinus ponderosa*) stand age-structure and density, composition, and ecological processes in the southwestern United States (Covington and Moore, 1994). Fire suppression, overgrazing, and timber harvest have changed these forests from the open stands typical of pre-settlement times to even-aged, high-density stands at increased risk of high intensity crown fires, which can lead to altered ecological processes outside the historic range of variability (Friederici, 2003). Ponderosa pine forests in the southwestern United States have historically been characterized by a low-severity, high-frequency fire regime that promoted uneven-aged, low-density, park-like stands within a matrix of grasses (Covington and Moore, 1994, Swetnam and Baisan, 1996, Fule et al., 1997 and Mast et al., 1999). Life-history characteristics of ponderosa pine were shaped by and thus well suited to the historical low-severity fire regime (Moore et al., 1999). The stand-replacing crown fires that have replaced high-frequency, low-severity fires have altered forest structure, function, and species composition in formerly low-density ponderosa pine forests (Fule et al., 1997, Moore et al., 1999, Covington, 2003 and Savage and Mast, 2005). Ultimately, changes in species composition and disturbance regime alter the entire ecosystem, change landscape patterns in nutrient and energy cycling, and affect plant and wildlife dynamics.

Purpose

The purpose of this study is to evaluate the revegetation following high and low severity fires, and on gentle and moderate slopes in southwestern *Pinus pondersoa* forests.

Study Site

The study was conducted in the Valles Caldera National Preserve, located in north-central New Mexico, in the Jemez Mountains (Figure 1A, B). In May, 2013 a wildfire burned a large part of the Preserve.

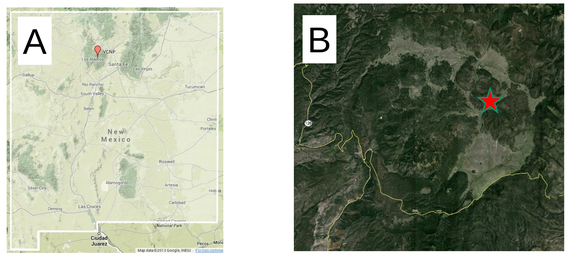

Figure 1. A) Map of the Valles Caldera National Preserve within New Mexico and B) topographical map of the caldera with a star indicating the study site location.

Methods

Two fire severities (high and low) were identified based on a fire severity map provided by the Valles Caldera Trust (Figure 2 and Figure 3). Within each fire severity, two hillslope gradients were selected (gentle and moderate slope). There were two replications of each treatment combination for a total of eight plots. Plot gradients were determined by measuring the change in height over the plot length using a hand-held distometer laser. Gentle slopes range from 0.11 to 0.13 m/m, while moderate gradients range from 0.13 to 0.31 m/m. Each treatment contains 10 soil plots (1 x 2 m), 20 vegetation plots (1 x 1 m), and one erosion plot (3 x 10 m). All plots were established from upslope to downslope so that changes could be measured as a function of position on the slope. There were two- 1 x 10 m strips established for both soil and vegetation sampling. The erosion plot was established in the center, with the strips on either side. Within each strip, 5 quadrats (1 x 2 m) were established for soil sampling and 10 quadrats (1 x 1 m) for vegetation sampling (see Figure 4). Within each 1 x 1 m vegetation quadrat, herbaceous vegetation cover was measured in 5-0.1 m^2 quadrats (Figure 4). In addition, soil, rock litter, ash, burnt organic matter, and manure cover were estimated.

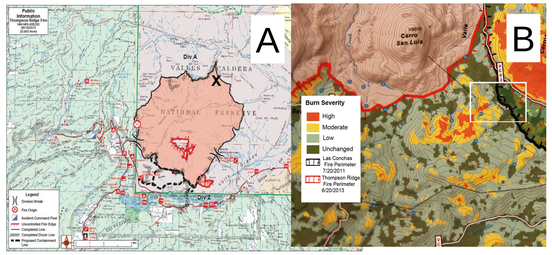

Figure. 2 A) Map of Thompson Ridge Fire outlined in the Valles Caldera National Preserve and B) fire severity map of Thompson Ridge fire. Study sites outlined in white box. Photo Credit Inciweb.org

Methods (continued)

Figure 3. Represented plots of A) low and B) high severity

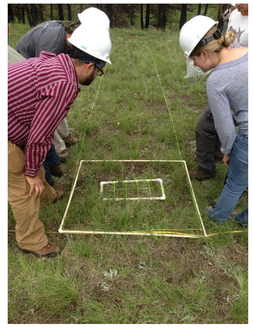

Figure 4. Quadrats used to estimate density of woody plants (1 m^2) and herbaceous cover (0.1 m^2).

Results

Table 1. Cover of herbaceous vegetation (greater than 10% /m^2), standing dead, litter, soil, rock, manure, burnt organic matter, ash, and species richness two months post fire in low burn severity ponderosa pine forests with a gentle and moderate slope, and a high burn severity ponderosa pine forest with a gentle and moderate slope

Variable	Low Severity		High Severity	
	Gentle Slope	Moderate Slope	Gentle Slope	Moderate Slope
Vegetation Cover (%)				
Grass species Poaceae species	11 ± 3	55 ± 9	-*	-
Wooly Cinquefoil *Potentilla hippiana*	11 ± 0	6 ± 0	0	0
Pussytoes *Antennaria rosulata*	5 ± 2	1 ± 1	0	0
Western yarrow *Achillea millefolium*	4 ± 1	2 ± 1	0	0
Common Dandelion *Taraxacum officinale*	3 ± 2	3 ± 2	0	0
Standing Dead (%)	7 ± 2	-*	0	0
Litter Cover (%)	28 ± 3	35 ± 20	2 ± 1	1 ± 0
Soil Cover (%)	6 ± 2	19 ± 11	18 ± 12	14 ± 6
Rock (%)	-*	1 ± 0	4 ± 2	3 ± 1
Manure (%)	-*	-*	0	0
Burnt Organic Matter	0	0	63 ± 5	82 ± 7
Ash	0	0	9 ± 8	0 ± 0
Species Richness (#)	22 ± 1	15 ± 2	2 ± 0	1 ± 1

**** < 0.05.***

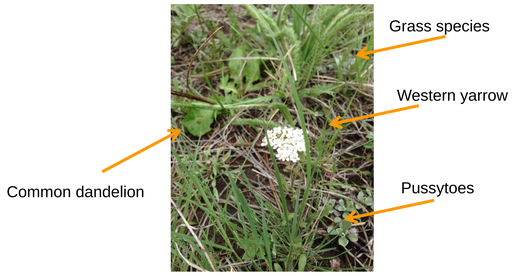

Figure 5. View of some of the plants with high percent covers.

Conclusions

- Species richness of herbaceous species was greater in the low severity burn areas
- Species richness of herbaceous species was greater on the gentle slopes when compared to the moderate slopes in the low severity burn areas.
- Grass species and woolly cinquefoil had the highest cover in the low severity/gentle slope areas.
- Grass species percent cover was ~10 times greater then the next highest species in the low severity/moderate slope areas.
- Soil cover was greater in the low severity/moderate slope areas.
- Ash was still present in the high severity/gentle slope, however no ash was present in the high severity/moderate slope.
- At the high severity sites, aspen roots were exposed and regenerating.

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