Analysis of the Seed Bank in a Southwestern Ponderosa Pine Forest

Monica Y. Juarez, Francisco Llarena, Andrew Sposato, Emily Jackson, Janis K. Bush and J. K. Haschenburger
The University of Texas at San Antonio, San Antonio TX, 78249

TREE

Abstract

Anthropogenic activities have altered 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 soil seed bank, (2) quantify post fire erosion and associated seed displacement, and (3) understand the impacts on regeneration after fire in a ponderosa pine forest in New Mexico. The effect of fire severity and hillslope gradient on the soil seed bank over time will be analyzed using soil core samples, and greenhouse germinating methods. Four sites were selected based on fire severity and hillslope gradient with four replicate soil core plots per site. Each 1 x 10 m soil core plot was divided into 32 sample sub-plots. For each field visit, 15 soil core samples (3 samples from every two meters down slope) will be taken from each soil plot. Samples will be analyzed every 2cm in depth for species and number of viable and unviable seeds. The soil samples will be stored at 5° C for a sufficient amount of time for cold stratification. After storage, the soil samples will be sieved using a 1 cm-wire screen to remove debris and rhizomes. Each soil sample will be spread over a layer of two cm deep sand in a 23 cm by 33 cm by 6 cm deep aluminum tray. Trays will be placed in a fiberglass greenhouse, watered as needed, and seedlings will be identified and counted.

Introduction

Human activities have greatly altered the historical structure and fire regime of southwestern Ponderosa pine forests. Their historical open forest structures with large trees and diverse herbaceous understories have transformed into forests that are denser with smaller, stressed trees and more homogenous understories. Historically, these ecosystems evolved with frequent moderate fires, which promoted forest health. However, current conditions have resulted in larger fuel loads and the enhanced presence of fuel ladders, which increases the risk for stand-replacing fires (Cooper 1960). There have been many studies conducted which focus on the restoration of these ecosystems to their natural conditions. However, the role of the seed bank in restoring understory plant life and diversity in these ecosystems is not well known (Carr 2012).

Purpose

The objectives of this study are to: (1) analyze how fire severity and hill slope gradient affects the soil seed bank over time, (2) to quantify post fire erosion and associated seed displacement, and (3) understand the impacts on regeneration of vegetation after fire in a ponderosa pine forest in New Mexico.

Methods

The study site is located in the Valles Caldera National Preserve in the heart of the Jemez Mountains in north-central New Mexico (Fig. 1).

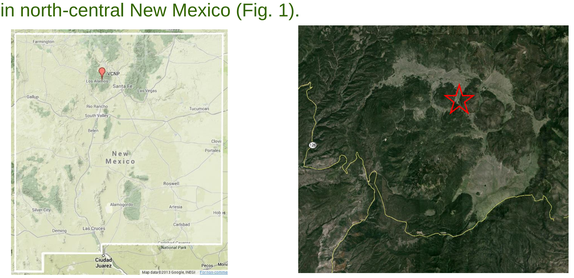

Figure 1. Left: Map of the Valles Caldera National Preserve within New Mexico. Right: Topographical map of the caldera with a star indicating the study site location.

On May 31, 2013, the Thompson ridge fire was initiated in the area due to a downed power line. The fire burned in a mosaic pattern of varying severities (Fig. 2) and was contained on July 23.

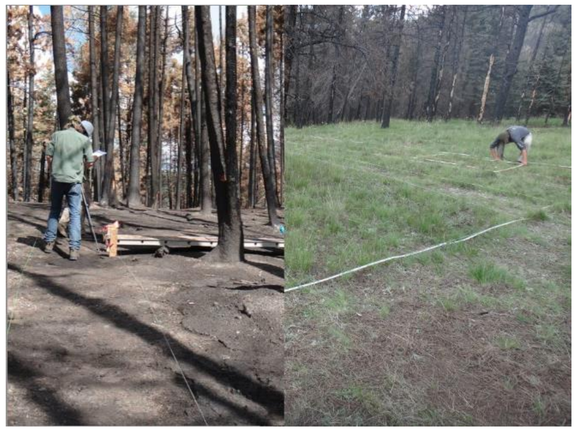

Fig 2. An example of a high burn severity site (Left) compared with a low burn severity site (Right).

To study the effects of fire severity and slope on the seed bank, 4 sites were selected based on fire severity (high or low) and hillslope gradient (steep or gentle) with 4 replicate seed bank plots per site. One control plot was selected in an un-burned area so that pre-fire conditions could be assessed. Plots were established between July 28 and August 6, 2013 and will be monitored over the next year.

On each field visit, three core sub-samples (fig. 3), will be taken every two meters down the plot to characterize the seed bank within that area of the plot.

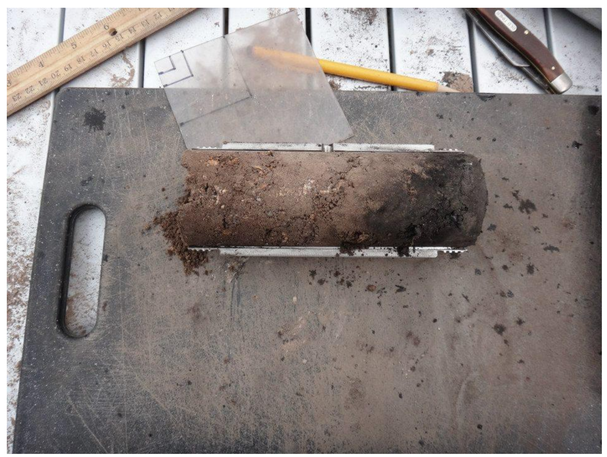

Figure 3. A soil core sub sample from a severely burnt site with the burnt soil surface on the right. The core is 15 cm long. The top 10 cm are divided into five 2 cm increments and the rest is discarded.

The top 10 cm of each sub-sample will be divided into 2 cm increments and then composited with the other samples for the specific plot area

In addition to the seed bank plots, two 3 x 10 m replicate erosion plots were designated per treatment with three sediment traps installed at the bottom of each plot (Fig 4). The sediment traps are being used to assess whether there are any relationships between seed characteristics such as density and shape and the amount of hillslope material collected.

Figure 4. A high severity erosion plot with three sediment traps measuring approximately 40 x 30 x 20 cm, installed downslope of the plot.

Next Steps

Seed bank composition will be documented over time by conducting a germination experiment on compostied samples. Soil samples will be stored at 5° C for a sufficient amount of time for cold stratification. After storage, the soil samples will be sieved using a 1 cm-wire screen to remove debris and rhizomes. Each soil sample will be spread over a layer of two cm deep sand in a 23 cm by 33 cm by 6 cm deep aluminum tray. Trays will be placed in a fiberglass greenhouse, watered as needed, and seedlings will be identified and counted. Based on field observations, the germination experiment will most likely show very little seed viability in the upper layers of soil for the severely burnt sites.

Material from the sediment traps will be treated in a similar manner so that possible relationships between seed characteristics and erosion can be examined to help explain how soil erosion impacts species colonization after fire.

References

Carr, C. A., Krueger, Wi. C., (2012). Northwest Science(3): 168-178.
Cooper, C. F. (1960). Ecological Monographs 30(2): 130-164.

Acknowledgements

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