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Spatial Patterns of Ponderosa Pine Regeneration in High-Severity Burn Patches

By Suzanne Owen, PhD student, School of Forestry, Northern Arizona University; Chemist Intern, Rocky Mountain Research Station

Introduction

Over the past three decades, wildfires in southwestern U.S. ponderosa pine (*Pinus ponderosa*) forests have increased in size and severity, leaving large, contiguous patches of tree mortality. Ponderosa pines evolved under fire regimes dominated by low- to moderate-severity wildfires. They are poorly adapted to regenerate in large patches of high-severity fire because they are not a sprouting species and do not have serotinous cones or long-lived soil seedbanks. Consequently, the lack of seed-producing trees in high-severity burn patches may prevent or significantly delay ponderosa pine regeneration. Previous studies have documented low ponderosa pine regeneration densities in large high-severity burn patches, but less is known about the spatial patterns of ponderosa pine regeneration and interactions with sprouting species near residual live forest edges or the interiors of high-severity burn patches.

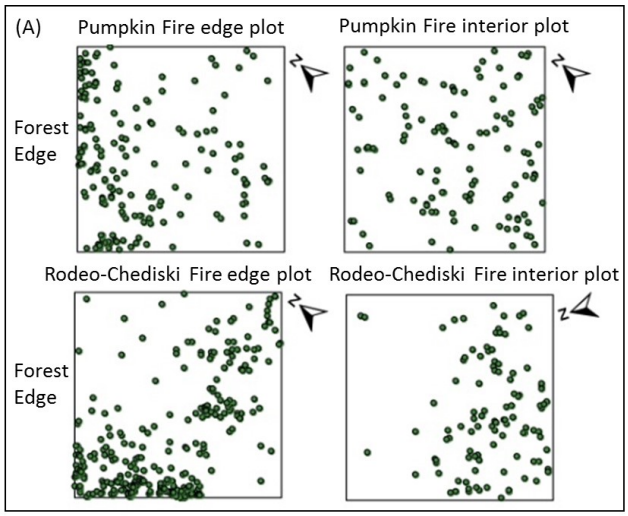

Figure 1. (A) Patterns of ponderosa pine regeneration (green circles) in an edge and interior plot from both wildfires and (B) regenerating ponderosa pine in a high-severity burn patch, 13 years after the 2000 Pumpkin Fire.

Methods

We established 10-acre plots in high-severity burn patches in two Arizona wildfires, the 2000 Pumpkin and 2002 Rodeo-Chediski fires, to determine if: 1) distance from forest edge influences the spatial patterns and density of regenerating trees, 2) interactions with resprouting trees affect the spatial patterns of ponderosa pine regeneration, and 3) distance from forest edge and species competition affect regenerating ponderosa pine height. Plots were located in high-severity burn patches (defined as 100 percent tree mortality). Three "edge plots" were established adjacent to residual live forest edges, and three "interior plots" were established greater than 650 feet from any residual live trees on each wildfire. We quantified the spatial location, species and height of all regenerating trees within each 10-acre plot and determined nearest-neighbor distances for all regenerating trees and distances from nearest potential seed-source trees.

Ecological Restoration Institute, P.O. Box 15017, Flagstaff, AZ 86011, 928.523.7182, FAX 928.523.0296, www.nau.edu/eri

Results

- Ponderosa pines were re-establishing in all of our study plots, however regeneration densities were lower farther from forest edges.
- Ponderosa pines seedlings were found in areas more than 980 feet from potential parent trees on all interior study plots.
- Regenerating ponderosa pines displayed patterns of small-scale spatial aggregation in all plots, except one edge and one interior plot on the Pumpkin Fire, which displayed random distributions.
- Dense re-sprouting trees dominated tree regeneration on the Rodeo-Chediski Fire, but did not influence the spatial location or height of regenerating ponderosa pine.
- Regenerating ponderosa pine height was positively correlated with neighboring ponderosa pine densities and height.

Implications

- Tree regeneration densities and species composition in high-severity burn patches are highly variable in different geographic locations.
- Regeneration patterns suggest both short- and long-distance dispersal may play important roles in ponderosa pine regeneration in high-severity burn patches.
- Ponderosa pine regeneration could be more strongly influenced by intraspecific facilitation than interspecific competition from dense sprouting species.
- Future forest spatial patterns and composition are still unclear, but at this stage of development, these heterogeneous patches, characterized by drought-tolerant sprouting species or low pine densities, could be more resilient to climate change and severe wildfires than the overly dense ponderosa pine forests that were present before the wildfires.
- Managers may want to use a "wait and see" approach before replanting in some areas to monitor natural regeneration over time.

Further Reading

Chambers, M.E., P.J. Fornwalt, S.L. Malone, and M.A. Battaglia. 2016. Patterns of conifer regeneration following high-severity wildfire in ponderosa pine-dominated forests of the Colorado Front Range. *Forest Ecology and Management,* 378: 57–67.

Haire, S.L., and K. McGarigal. 2010. Effects of landscape patterns of fire severity on regenerating ponderosa pine forests (*Pinus ponderosa*) in New Mexico and Arizona, USA. *Landscape Ecology* 25: 1055–1069.

Rother, M.T., and T.T. Veblen. 2016. Limited conifer regeneration following wildfires in dry ponderosa pine forests of the Colorado Front Range. *Ecosphere*, 7: 12.

This fact sheet summarizes information from the following publication:

Owen, S.M., C.H. Sieg, A.J. Sánchez Meador, P.Z. Fulé, J.M. Iniguez, L.S. Baggett, P.J. Fornwalt, and M.A. Battaglia. 2017. Spatial patterns of ponderosa pine regeneration in high-severity burn patches. *Forest Ecology and Management,* 405: 134-149. https://www.fs.usda.gov/treesearch/pubs/55012

Contact: Suzanne Owen, smowen@fs.fed.us

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