University of Idaho
College of Natural Resources

JOINT FIRE SCIENCE PROGRAM

Resilience and regeneration after wildfire in dry mixed-conifer forests of the US northern Rockies

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Influence of wildfire on seedling regeneration across environmental gradients

Recent increases in area burned in the western U.S. have raised concerns about the resilience of forests to large wildfires, particularly in dry mixed-conifer forests, where climate change and 20th-century land management have altered species composition, fuel loads, and fire regimes.

Of particular concern in these ecosystems is the possibility that large, stand-replacing wildfires will remove viable seed sources over large areas, significantly delaying post-fire forest recovery or converting forested areas into a qualitatively different vegetation type. Alternatively, however, the combination of variable fire affects and the diversity of species with different fire tolerances and adaptations could create a landscape that is highly resilient and regenerates rapidly after fire.

Research Objectives

- Document natural post-fire conifer seedling regeneration across the range of dry mixed-conifer forests in the U.S. northern Rockies.
- Quantify the relationships among post-fire seedling abundance and composition, wildfire patch metrics, and abiotic and biotic environmental drivers.
- Identify important mechanisms that drive patterns of forest recovery at large-scales and infer the resilience of dry mixed-conifer forests to future large fires.

Sampling Scheme

We sampled conifer regeneration in 21 large (> 400 ha) mixed-severity fire events that burned in 2000 or 2007 across central Idaho and western Montana (Fig. 1). We sampled 182 sites stratified across a gradient in burn severity, elevation, aspect, and latitude. At each site, we quantified stand, vegetation, and patch size characteristics.

Highlights:

- Distance to a live seed source is the overriding factor influencing post-fire seedling regeneration.
- There are fewer tree seedlings in high severity patches because these patches are further from live seed sources. Thus, the size of high severity patches is an important determinate of post-fire tree regeneration.
- Over 75% of the burned landscape is close enough to live seed sources to naturally regenerate.

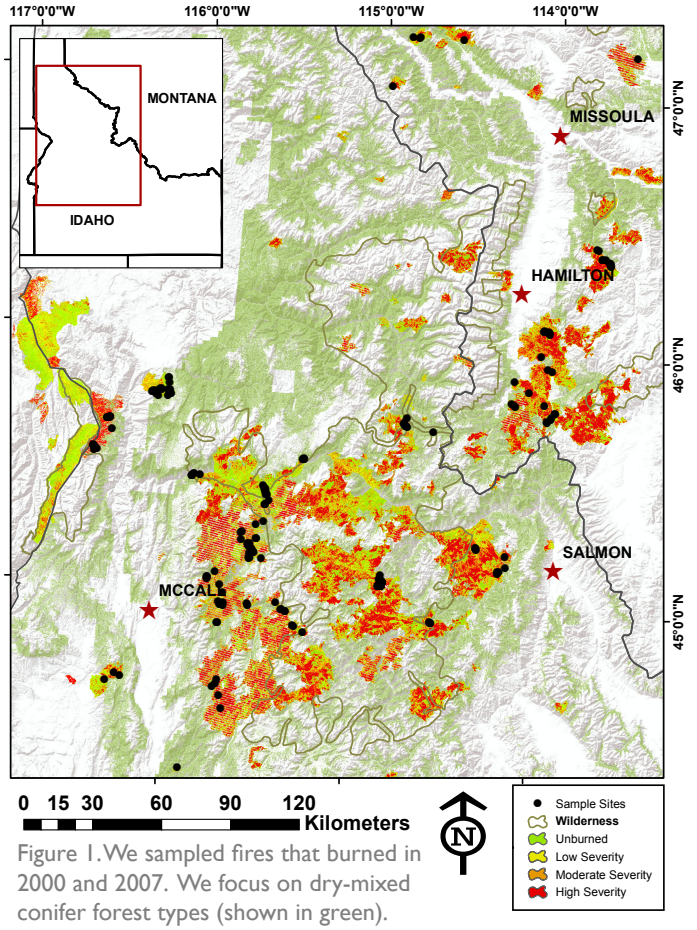

Figure 1. We sampled fires that burned in 2000 and 2007. We focus on dry-mixed conifer forest types (shown in green).

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Small burned patch dominated mostly by Douglas-fir on a north facing slope on the Payette National Forest, ID © Kerry Kemp

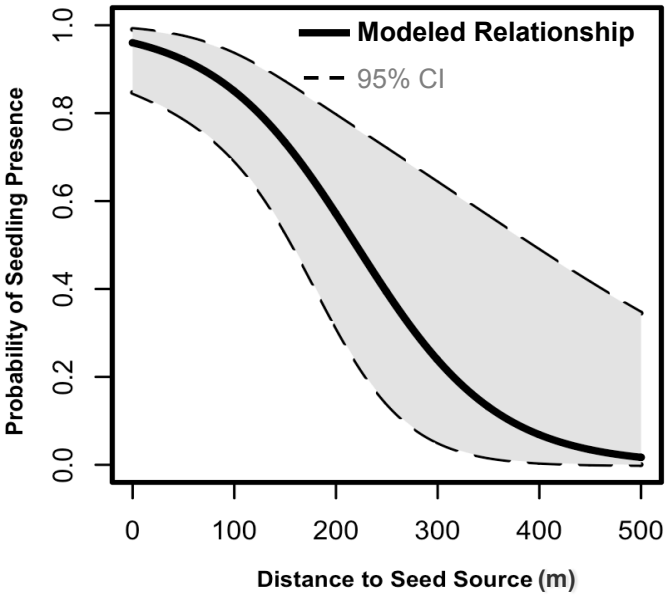

Figure 2. As distance to a live seed source increases, seedlings are less likely to establish. We measured over 10,000 seedlings of eight different species in 182 sites to develop this statistical model.

Findings

We used logistic and negative binomial regression models to predict the presence and abundance of seedlings post-fire as a function of different environmental and fire-related variables. We found that:

- Distance to a live seed source is the most important variable determining seedling presence and abundance in dry mixed conifer-forests. We identified a threshold of 95 m from a live seed source, beyond which, seedlings were unlikely to be present post-fire (Fig. 2).
- High severity patches tend to have higher tree mortality, and as a result residual live seeds trees are more distant than from either low or moderate severity patches (Fig. 3).
- In the northern Rockies, 85% of the area burned by high severity wildfire in 2000 was within 95 m of an edge of lower severity. Similarly, 75% of the 2007 high severity burned area was within 95 m of an edge.

Conclusions & Implications

Seedling regeneration was abundant across our study area. Sparse natural regeneration was observed primarily in large, high severity burned patches. However, different processes were important for regeneration of different species. Seed dispersal distance limited the regeneration of Douglas-fir, grand fir, and ponderosa pine, but not lodgepole pine. Germination of Douglas-fir and lodgepole pine was limited by environmental factors such as heat load and elevation.

Dry mixed-conifer forests in the northern Rockies will be resilient to mixed severity wildfires so long as the landscape remains dominated by relatively small patches resulting from heterogeneous burn patterns and forests do not re-burn before the regenerating trees reach maturity.

Current post-fire restoration should focus on large, high severity patches where natural tree regeneration is likely to be limited. With increases in area burned predicted for forests of the northern Rockies in the future, more area will burn severely. The size of these high severity patches and the relative proportions they occupy on the landscape will be important determinants of future forest recovery.

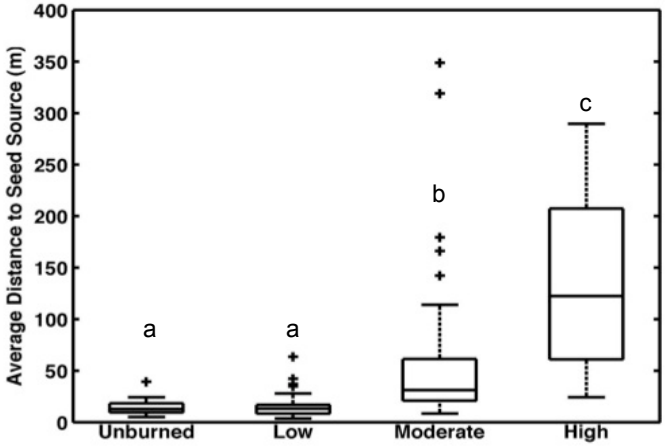

Figure 3. Plots burned with high burn severity are significantly further from live seed trees.

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