Postfire plant community dynamics in subalpine forests: the first 25 years after the 1988 Yellowstone fires

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Introduction

Recently burned forests are increasingly common in the West, but forest development after large wildfires is not well understood, especially in the context of variable burn severity, environmental heterogeneity, and changes in controlling mechanisms over time. We have studied plant communities in permanent plots since the 1988 Yellowstone fires. We address two questions.

Question #1

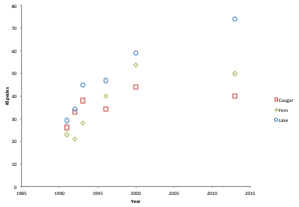
Are plant community composition and species richness converging or diverging across gradients in elevation, soils, fire severity, and post-fire lodgepole pine density?

Data set: 10-m^2 plots (n=600) clustered in three geographic areas (*below*); a large (10^3 ha), moderate (10^2 ha), and small (10^1 ha) patch in each area; sampled 1991, 1992, 1993, 1996, 2000, & 2013.

- **Cougar Creek**: 2150-2300m, infertile, high pine density
- **Fern Cascades**: 2270-2500 m, infertile, moderate density
- **Yellowstone Lake**: 2400-2700 m, fertile, low density

Results:

* Richness (total no. species recorded in a geographic area) was low in the most severely burned areas in 1991, but increased with time; greatest increase atfertile Yellowstone Lake area.



* In each area, small & moderate patches share many species with unburned forest, but large patches contain these species plus numerous unique species not seen in unburned forests.

more results for Question #1

Question #2

What are the major environmental controls on postfire species composition, and has the relative importance of controls changed over time?

Data set: 0.25-ha plots (n=72) distributed across the burned landscape, sampled 1999 & 2012.

Results:

* Multilevel models (MLM) reveal variables that influence overall community composition as well as occurrence of particular species in a plot:
  - -- ***Local substrate*** & ***climate*** significant in 1999 and 2012
  - -- ***Burn severity*** significant in 1999 but no longer significant in 2012
  - -- ***Lodgepole pine abundance*** significant in 1999 and 2012; became most important predictor in 2012.

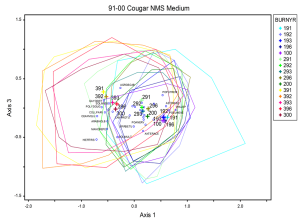
Post-fire lodgepole pine density varies across the burned landscape from <100 to >100,000 stems/ha, and influences local species composition

more results for Question #2

Question #1 Results (cont.)

* NMS ordination displays community composition. Initial composition was similar in low & moderate burn severity plots, but high-severity plots contained unique species, e.g., fire-stimulated annuals and soil seed banks. Composition of high, moderate, & low severity converged over time.

Key:
1st number is fire severity:
1=low
2=moderate
3=high
2nd & 3rd numbers are year:
91=1991 92=1992 etc.



Question #2 Results (cont.)

* Eleven species disappeared from the 72 plots between 1999 and 2012, including:
  - -- 4 shade-intolerant species (e.g., *Agoseris aurantiaca*)
  - -- 2 annual species (e.g., *Androsace septentrionalis*)
* Species for which lodgepole pine abundance had an especially negative influence in 2012 included:
  - -- 6 annual/biennial species *(e.g., Gayophytum diffusum)*
  - -- 6 shade-intolerant species *(e.g., Achnatherum occidentale)*
  - -- 1 N-fixer *(e.g., Lupinus argenteus)*

**** Photos of these representative species:***

Agoseris

Androsace

Gayophytum

Achnatherum

Lupinus

Overall Patterns & Trends

* Post-fire species richness has increased over time at both local and landscape scales.
* The three geographic areas (Cougar, Fern, and Lake) were each compositionally distinct in 1991, and have remained distinct.
* Substrate and climate (deterministic variables) have continued to influence community composition throughout the period of study.
* Burn severity (a contingent variable) significantly influenced initial community composition, but is no longer significant.
* Lodgepole pine abundance (another contingent variable) is increasingly important: shade-intolerant species are decreasing or dropping out where pine is abundant.

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