Patterns of post-fire diversity and regeneration in subalpine forests of the Sierra Nevada

Emily Brodie ¹, Hugh Safford ²
University of California, Davis¹ ; University of California, Davis and USDA Forest Service Region 5 ²

Introduction
Climate-fueled changes in snowpack and growing season are increasing sapling density and changing stand dynamics in subalpine forests of the Sierra Nevada. These changes will likely continue in coming years, and, combined with a trend in increasing size and upper elevation of fire in the Sierra Nevada, may contribute to larger and more severe fires in subalpine forests. Despite potential changes in high elevation fire behavior, there is no published literature documenting how subalpine understory communities and regenerating tree seedlings respond to fire severity in a Mediterranean climate. The goal of this study is to determine how fire severity affects understory diversity and tree regeneration in subalpine forests of the Sierra Nevada, California.

Research Questions
1. What is the relationship between understory plant species diversity and fire severity in high elevation forests?
2. How does fire severity affect tree regeneration in high elevation forests?

Methodology
We sampled 7 fires in subalpine forest ranging from 2 to 16 years post-fire (Figure 1). We defined subalpine forest first by elevation (above 2750m) and second by forest type. We used CALVEG spatial data to determine the extent of subalpine forest types in burned areas and made the preliminary fire severity classification using a remotely sensed fire severity index (dNBR). We stratified sampling plots initially by fire severity (Figure 2) and subsequently by aspect.

In each plot we took a complete census of plant richness, cover, and modal height, as well as structural measurements such as DBH and basal area. We counted and aged seedlings in a “regeneration plot” (Figure 3).

Fire severity is a measure of the impact of fire on an ecosystem (e.g., basal area mortality).

Fire severity classes used in study

<table>
<thead>
<tr>
<th>Fire severity class</th>
<th>Fire severity label</th>
<th>Percentage basal area mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Unburned</td>
<td>0-25</td>
</tr>
<tr>
<td>1</td>
<td>Low</td>
<td>25-50</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>50-75</td>
</tr>
<tr>
<td>3</td>
<td>Low-moderate</td>
<td>75-90</td>
</tr>
<tr>
<td>4</td>
<td>High-moderate</td>
<td>&gt;90</td>
</tr>
</tbody>
</table>

Fire Severity

Conclusions

Research Question 1

- Broadly speaking, high severity fire (>50% basal area mortality) increases understory diversity in subalpine forests of the Sierra Nevada, while low severity fire stimulates tree regeneration. In general, higher fire severity classes do not produce the same stimulating effects on tree regeneration when compared to unburned areas, though results are variable.

Research Question 2

- Baseline knowledge: this study generates a baseline understanding of how subalpine forests respond to fire.
- Fire management: while fires have generally been allowed to burn in wilderness areas and my research is unlikely to change management actions in the study area, it provides empirical data for understanding the repercussions of management actions.
- Future predictions: with median fire size and upper elevation increasing in the Sierra Nevada, this study will aid those trying to predict the effects on subalpine forest persistence, structure, diversity, and carbon balance.

Why is this important?

- Field work is not yet complete for this study and I hope that patterns become clearer with additional data. After the coming field season, I would like to ask questions such as:
  - How does the diversity-severity relationship at high elevations change over time and at relevant spatial scales?
  - Does understory plant life-form composition differ with fire and/or fire severity?
  - How does the regeneration-severity relationship change over time at high elevations? And even further afield:
    - How does the fire-severity-diversity relationship change across a major elevation and productivity gradient in the Sierra from yellow pine mixed conifer to subalpine?

References