LONG TERM EFFECTS OF FUEL TREATMENTS IN A PONDEROSA PINE FOREST POST-FIRE

JESSIE M. DODGE¹, EVA K. STRAND¹, ANDREW T. HUDAK², BENJAMIN C. BRIGHT²

¹ DEPARTMENT OF FOREST, RANGELAND, AND FIRE SCIENCES, UNIVERSITY OF IDAHO, MOSCOW, ID 83844
² FORESTRY SCIENCES LABORATORY, 1221 SOUTH MAIN STREET, ID 83843
INTRODUCTION

• Most historically dry ponderosa pine (*Pinus ponderosa*) forests are thought to have been fire resilient (Cooper 1960)

• Euro-American settlement:
  • Decrease ponderosa pine forest fire resistance
  • Increase in burn severity (Allen *et al.* 2002)

• Burn severity: amount of ecological change caused by fire (Morgan *et al.* 2001)
  • Commonly measured remotely
INTRODUCTION: Treatments

- Land managers implemented mechanical treatments (Fulé et al. 2012, Kaye et al. 2005)
  - Thinning

- Focus:
  - Increase in canopy base height
  - Break up horizontal canopy continuity (Agee and Skinner 2005)
OBJECTIVES

1) Analyze remotely sensed burn severity gradient relationship to ground measurements 1 and 9 years after the Egley Fire Complex

2) Compare post-fire overstory and understory components between
   1) Treatment status
   2) Burn Severity

3) Evaluate the changes over time
METHODS: Study Area

- July 6\textsuperscript{th}, 2007: Egley Fire Complex
- 70 paired plots (Harbert \textit{et al.} 2007)
  - 35 treated (T) and 35 untreated (U)
- differenced Normalized Burn Ratio (dNBR)
METHODS: Remote Sensing

Common way to measure burn severity:

- Normalized Burn Ratio (NBR) = \( \frac{RED - SWIR}{RED + SWIR} \)
- differenced NBR (dNBR) = NBR \textit{prefire} – NBR \textit{postfire}
- LandTrendr: Landsat-based Detection of Trends in Disturbance and Recovery
  - Implemented from 1984 to 2016 (Gorelick et al. 2017; Kennedy et al. 2018).
METHODS: Treatments

Harbert et al. (2007)

METHODS: Field Procedures

- Measured in summers of 2008 and 2016
- Overstory
  - Tree density
  - Tree canopy cover
- Understory
  - Surface cover
  - Functional groups
  - Fuel loadings
METHODS: Analysis

- Linear regressions: relationships between 2008 and 2016 NBR values and ground measurements:
  - Tree canopy, green, and char cover (%)
- Treatment status and burn severity were combined (TSEV) into 4 groups
- A Kruskal-Wallis test was used to test significance between TSEV groups
  - Dunn’s test for significant (α = 0.05) pairwise comparisons (R Core Team 2013)

<table>
<thead>
<tr>
<th>TSEV</th>
<th>Number of Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-low</td>
<td>30</td>
</tr>
<tr>
<td>T-high</td>
<td>5</td>
</tr>
<tr>
<td>U-low</td>
<td>11</td>
</tr>
<tr>
<td>U-high</td>
<td>24</td>
</tr>
</tbody>
</table>
RESULTS & DISCUSSION: LandTrendr Time Series
RESULTS & DISCUSSION:
Treatments

<table>
<thead>
<tr>
<th>Year</th>
<th>Untreated</th>
<th>Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td><img src="image1.png" alt="Untreated 2008" /></td>
<td><img src="image2.png" alt="Treated 2008" /></td>
</tr>
<tr>
<td>2016</td>
<td><img src="image3.png" alt="Untreated 2016" /></td>
<td><img src="image4.png" alt="Treated 2016" /></td>
</tr>
</tbody>
</table>
RESULTS & DISCUSSION: NBR vs Ground Measurements

$P < 0.001$, $R^2 = 0.137$

$P < 0.001$, $R^2 = 0.256$

$P < 0.001$, $R^2 = 0.151$
RESULTS & DISCUSSION:
Tree Density
RESULTS & DISCUSSION: Functional Groups

- Savage and Mast (2005)
- Our study: large patches of snowbrush ceanothus (*Ceanothus velutinus*)
  - No significant differences between TSEV in either year
RESULTS & DISCUSSION: Functional Groups

<table>
<thead>
<tr>
<th>Invasive</th>
<th>2016</th>
<th>P</th>
<th>A</th>
<th>T mean</th>
<th>T SE</th>
<th>U mean</th>
<th>U SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.041</td>
<td>0.033</td>
<td>1.7</td>
<td>0.815</td>
<td>3.131</td>
<td>0.138</td>
</tr>
</tbody>
</table>

**Understory Functional Groups**

A

B

C

D

![Bar chart showing invasive cover and forb cover for different years and treatment groups](chart-image)
RESULTS & DISCUSSION: Fuel Loading
MANAGEMENT IMPLICATIONS

- Pre-fire fuel treatments were effective at reducing burn severity
- LandTrendr time series captured disturbance and post-fire vegetation recovery
- Burn severity affected tree canopy cover and tree density more than treatment
- Treatments passively affected percent invasive cover
- Lower total fuel loads can still be detected in pre-fire treated areas 9 years post-fire
ACKNOWLEDGEMENTS

Forest Service Rocky Mountain Research Station
- John Byrne

University of Idaho
- Darcy Hammond
- Sean McNeal
- Eli Berman
- Deborah Blanscet
- Maritza Henrandez

USDA ARS
- Beth Newingham

This project was funded on the Joint Fire Science Program grant # 14-1-02-27 and the USDA Forest Service RMRS (# 17-JV-11221637-132)
QUESTIONS
REFERENCES


Fulé, P. Z., J. E. Crouse, J. P. Roccaforte, E. L. Kalies. 2012. Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine dominated forests help restore natural fire behavior? Forest Ecology and Management 269: 68-81


RESULTS: Tree Basal Area
RESULTS: Sapling Density

A

B

C

D

Sapling Density

2008 **

2016 *

2008 **

2016 *

Dead Sapling Density (stems/ha) Live Sapling Density (stems/ha)

T-low T-high U-low U-high

A A C B C

A A C C

A B A B

A A B B, C
RESULTS: Surface Cover

A. 2008**

B. 2008*

C. 2008**

D. 2016*

E. 2016

F. 2016**