Factors that Control Non-native Plant Species within Shaded Fuelbreaks at Whiskeytown National Recreation Area

Jennifer Gibson, Ecologist
Windy Bunn, Biological Science Technician
Whiskeytown NRA
National Park Service

Plant Geography of the Klamath Region

Mitchell's (1976) airmass boundaries
- Winter
- Summer

Oregon
California
Klamath
Sierran
Great Basin

EXPERIENCE YOUR AMERICA
National Park Service
• Provide areas where containment of wildfires is more feasible (e.g., firing operations).
• Slow the rate of spread of fires.
• Provide safe egress and access for firefighters and public by reducing fire intensity.
• Provide for prescribed burn unit boundaries.
National Park Service
Introduction and spread of non-native mountain bikers?
Conduit for invasion of high priority non-native and invasive plants?
Non-native annual grasses…
Greater than 25% of Whiskeytown’s flora is composed of non-native plant species.

- Scotch Broom
- French Broom
- Tree of Heaven
- Himalayan Blackberry
- Yellow Star Thistle
- Bull Thistle
- Mullein
Research Questions:

1. Do shaded fuelbreaks play a role in the introduction and spread of non-native plant species?

2. What thinning practices and structural characteristics minimize this spread into low-elevation plant communities?
Educate and inform resource and fire managers as to what thinning practices and prescriptions minimize the introduction and spread of non-native plant species.
   - few invasive plants.


3. Undesirable (“The Ugly”) - representing the least desirable conditions.
   - established non-native plants.
Fuelbreaks Sampled in 2001:

- Buck (new - cut & burned)
- Kennedy (new - cut & chipped)
- Lower Mule (old - cut & burned)
- Lower Mule Control
- Orofino (old - cut & burned)
- Orofino Control
- PG&E (old - cut & burned, bull dozed)
Fuelbreaks Sampled in 2002:

- Buck (collected in 2001)
- Orofino (collected in 2001)
- PGE (collected in 2001)
- Shasta Divide (very old - cut & burned)
- Sunshine - (old - cut & burned)
- Whiskey - (new - cut and chipped)
Methods

- 5 transects, randomly located along a 1-1.5 miles section
- Each transect was 30 meters long.
- Drawn out in a random degree bearing - within the fuelbreak.
- 5 one-square meter plots were randomly located along the transect.
Slope and aspect
Percent cover of substrate
Percent cover of species (Daubenmire Values)
Depth of substrate
Height of the tallest Grass, Herb, Shrub, and Tree
Canopy Cover at 5 feet (spherical densiometer)
A Canonical Correlation was used to determine which microhabitat characteristics of these fuelbreaks were related to the percent cover of non-native plant species.

<table>
<thead>
<tr>
<th>Canonical Root 1</th>
<th>R(exotic*environmental) = 0.477</th>
<th>P&lt;0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exotic Plant Variables</strong></td>
<td><strong>Loadings</strong></td>
<td><strong>Microhabitat Variables</strong></td>
</tr>
<tr>
<td>Percent Cover of Exotic Grass species</td>
<td>0.885</td>
<td>Canopy Cover</td>
</tr>
<tr>
<td>Percent Cover of Exotic Herbaceous species</td>
<td>0.943</td>
<td>Bare Ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Litter Depth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent Cover of Litter</td>
</tr>
</tbody>
</table>
Take home message:

**Canopy Cover, Litter Cover and Litter Depth** are important factors that control non-native grasses and herbaceous species within the fuelbreaks.
But, how do we translate this information into specific prescription targets for management?

• Condition Rating
• Principal Components Analysis
Condition Rating = \frac{\% \text{ cover of non-native species}}{\% \text{ cover of native} + \% \text{ cover of non-native species}} \times 100
The Condition Rating of Shaded Fuelbreaks

Condition Rating

Desirable
Marginal
Undesirable

Orofino Control
Buck 2002
PG&E 2002
Whiskey
Sunshine
Lower Mule Control
Kennedy
Orofino
Shasta
Lower Mule
Used a Principal Components Analysis (PCA) to characterize the fuelbreaks in terms of the percent cover of native and non-native plant species and such microhabitat characteristics as **canopy cover, slope, aspect and substrate.**
PCA Factor Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canopy Cover</td>
<td>-0.689</td>
<td>0.382</td>
</tr>
<tr>
<td>Bare Ground</td>
<td>0.597</td>
<td>0.131</td>
</tr>
<tr>
<td>Percent Cover of Litter</td>
<td>-0.644</td>
<td>0.111</td>
</tr>
<tr>
<td>Litter Depth</td>
<td>-0.577</td>
<td>-0.129</td>
</tr>
<tr>
<td>Percent Cover of Exotic Grasses</td>
<td>0.719</td>
<td>0.109</td>
</tr>
<tr>
<td>Percent Cover of Exotic Herbaceous species</td>
<td>0.635</td>
<td>0.187</td>
</tr>
<tr>
<td>Percent Cover of Native Grasses</td>
<td>0.081</td>
<td>0.899</td>
</tr>
<tr>
<td>Percent Cover of Native Herbaceous species</td>
<td>0.609</td>
<td>0.255</td>
</tr>
<tr>
<td><strong>Percent Variance Explained by Factor</strong></td>
<td><strong>35.67</strong></td>
<td><strong>13.87</strong></td>
</tr>
</tbody>
</table>
Mean Factor 1 Scores from the Principal Components Analysis on the Condition of Shaded Fuelbreaks

Desirable | Marginal | Undesirable

-1 | 0 | 1.5

Mean Factor 1 Scores

-0.5 | 0 | 1

-1 | 0 | 0.5

OrofinoC | Buck02 | Kennedy | LMule01 | Whiskey | Orofino02 | Sunshine | PG&E02 | Shasta
A One-Way Analysis of Variance on the PCA Factor 1 scores characterizing non-native plants on the fuelbreaks determined that there was a significant difference (P<0.001) between fuelbreaks.

Contrasts:
- Roadside fuelbreaks vs. ridgeline fuelbreaks
- Old fuelbreaks vs. new fuelbreaks
- Control plots vs. plots within the fuelbreak

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum-of-Squares</th>
<th>df</th>
<th>Mean-Square</th>
<th>F-Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuelbreak</td>
<td>113</td>
<td>9</td>
<td>12.638</td>
<td>17.575</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Roadsides vs. Ridgelines</td>
<td>4</td>
<td>1</td>
<td>4.237</td>
<td>5.892</td>
<td>0.016</td>
</tr>
<tr>
<td>Old vs. New</td>
<td>20</td>
<td>1</td>
<td>20.331</td>
<td>28.276</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Control vs. Treatment</td>
<td>4</td>
<td>1</td>
<td>4.857</td>
<td>6.755</td>
<td>0.010</td>
</tr>
<tr>
<td>Error</td>
<td>165</td>
<td>230</td>
<td>0.719</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Contrasts:

- **Ridgeline fuelbreaks are less desirable** than roadside fuelbreaks.
- **Old fuelbreaks are less desirable** than new fuelbreaks.
- **Control plots are much more desirable** than plots in the fuelbreak.
<table>
<thead>
<tr>
<th>Desirable</th>
<th>Marginal</th>
<th>Undesirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA</td>
<td>Condition Rating</td>
<td>PCA</td>
</tr>
<tr>
<td>Orofino Control</td>
<td>Orofino Control</td>
<td>Kennedy</td>
</tr>
<tr>
<td>Lower Mule Control</td>
<td>Buck_02</td>
<td>Lower Mule</td>
</tr>
<tr>
<td>Buck_02</td>
<td>Whiskey</td>
<td>Sunshine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Mule Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kennedy</td>
</tr>
<tr>
<td>Fuelbreak</td>
<td>Highest Cover (Native)</td>
<td>Highest Cover (Non-native)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Buck_2001</td>
<td>Toxicodendron diversilobum</td>
<td>Vulpia bromoides</td>
</tr>
<tr>
<td>Buck_2002</td>
<td>Heteromeles arbutifolia</td>
<td>Gnaphalium luteo-album</td>
</tr>
<tr>
<td>Kennedy_2001</td>
<td>Ceanothus lemmoneii</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Lower Mule Control_2001</td>
<td>Heteromeles arbutifolia</td>
<td>Hypochaeris radicata</td>
</tr>
<tr>
<td>Lower Mule_2001</td>
<td>Heteromeles arbutifolia</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Orofino Control_2001</td>
<td>Styrax officinalis</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Orofino_2001</td>
<td>Styrax officinalis</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Orofino_2002</td>
<td>Lotus micranthus</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>PG&amp;E_2001</td>
<td>Aristolochia californica</td>
<td>Bromus madritensis</td>
</tr>
<tr>
<td>PG&amp;E_2002</td>
<td>Heteromeles arbutifolia</td>
<td>Gastridium ventricosum</td>
</tr>
<tr>
<td>Shasta_2002</td>
<td>Ceanothus lemmoneii</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Sunshine_2002</td>
<td>Toxicodendron diversilobum</td>
<td>Aira caryophyllea</td>
</tr>
<tr>
<td>Whiskey_2002</td>
<td>Heteromeles arbutifolia</td>
<td>Vulpia bromoides</td>
</tr>
</tbody>
</table>
• Of the shaded fuelbreaks sampled, approximately 23% of the grass and herbaceous species were non-native.

• No infestations of the park’s most invasive exotics were found.

• However, surveys have found star thistle, Tree of Heaven, Scotch Broom, and etc. on isolated fuelbreaks.
What’s this all mean?
The Canonical Correlation demonstrated that non-native plants were inversely related to canopy cover, the percent cover of litter and litter depth.

The Principal Components Analysis and Condition Class Rating identified desirable, marginal, and undesirable fuelbreaks.

So, data collected from the desirable fuelbreaks became the guidelines for construction.
Desirable
Buck Fuelbreak
Average Canopy Cover =70%
Marginal
Lower Mule Fuelbreak
Average Canopy Cover = 55%
Undesirable
Shasta Fuelbreak
Average Canopy Cover = 7%
PGE Lines – Marginal?
Average Canopy Cover = 11%
High Percent Cover of Bareground
Very little plant cover.
Hardly any litter.
Review of the Research Questions:

1. Do shaded fuelbreaks play a role in the introduction and spread of non-native plant species?

2. What thinning practices and structural characteristics minimize this spread into low-elevation plant communities?
• The 2001 and 2002 Redwoods Fire Effects Crews
  • Robin Wills, National Park Service
  • Dr. Shannon Bros, San Jose State University
  • Rob Klinger, UC Davis
  • Daniel Sarr, Klamath Network I&M Coordinator