Sudden Oak Death - Caused Changes to Surface Fuels Loadings and Potential Fire Behavior in Douglas-fir-Tanoak forests

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There is a strong public perception that *P. ramorum* killed trees significantly contribute to fuel loadings and increase potential fire behavior.
Risk models

Meentemeyer et al., 2004

Tanoak
Surface fuels are dead fuels found in the duff, litter, sticks, branches, fallen trees, stumps. They contribute to fire behavior by:
◦ carrying the fire
◦ affecting flame lengths
◦ influencing intensity
◦ affecting duration of burn

Aerial fuels are located in the forest canopy. They are shorter lived than surface fuels. They affect behavior by:
◦ contributing to spotting
◦ ember production
◦ torching
◦ crown fires
◦ sheltering the stand from wind
Study Objectives

• How long do surface fuels persist in Douglas-fir/tanoak forests?

• What is the long-term fuels forecast for these forests?

How long does this process take?
Our study

• The goal: to compare surface fuels in SOD-infested with uninfested forests over different time horizons in 3 north coast counties with SOD.

• Complication: SOD has been present in the various counties for varying lengths of time.

• Solution: use herbicide-treated tanoak stands as a surrogate for the effects of SOD.
## Locations

<table>
<thead>
<tr>
<th>Stage</th>
<th>Sonoma</th>
<th>Mendocino</th>
<th>S. Humboldt</th>
<th>N. Humboldt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden Oak Death</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>2-5 years</td>
<td>×</td>
<td>×</td>
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<tr>
<td>5-8 years</td>
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<tr>
<td>8-12 years</td>
<td>×</td>
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<tr>
<td>Herbicide Treatment</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>2-5 years</td>
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<td>5-8 years</td>
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<tr>
<td>8-12 years</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Control</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

5 replicates each
Methods

Surface Fuel Variables
1 hr (<1/4 inch)
10 hr (1/4 – 1 inch)
100 hr (1-3 inch)
1000 hr (CWD)
Duff and litter depth
Fuelbed depth

Douglas-fir type stands, south facing aspect

- No riparian vegetation
- 1/10 acre (0.04 ha) circular plots were randomly established in each stand condition
- All trees inventoried by species, diameter, height
- 3 Brown’s surface fuel (1974) transects per plot
Results

Basal area of dead tanoak increased sharply with *P. ramorum* infection but decreased in the mid-stage. Notice continuing wave of infection by late stage. Basal area of dead tanoak increased sharply with herbicide treatment and then declined as trees failed.

1.0 ft²/ac = 0.23m²/ha
Surface fuels and fuelbed depths decreased at first, then increased slowly over time in stands infected by *P. ramorum*. Surface fuels increased over time in all herbicide treatments. Fuelbed depth decreased in late stage as fine fuels broke down.
Example Plots

A: Control (N. Humboldt)
B: SOD 2-5 years (Mendocino)
C: SOD 5-8 years (Sonoma)
D: SOD 8-12 years (Sonoma)
E: Herbicide 2-5 years (Humboldt)
F: Herbicide 5-8 years (N. Humboldt)
G. Herbicide 8-12 years (Mendocino)
Stage versus Phase

**Stage**
- Early (2-5 years)
- Mid (5-8 years)
- Late (8+ years)

**Phase**
- Aerial (majority of fuels in crown)
- Surface (majority of fuels on the ground)
Fire Behavior Analysis

• The amount of surface fuels observed in the four regions for each condition constituted a “custom fuel model” for that condition

• We entered these fuel models into BehavePlus 5.0.1 to simulate predicted fire behavior
  
  • STEP 1: Wind (3mph), topographic conditions (Slope held constant at 45%); a range of 1-hour dead fuel moistures; **how do custom fuels models compare to standard fuel models?**

  • STEP 2: Wind speeds were varied for a suppression safety analysis; **what resources are needed to attack a fire in these fuel conditions under a variety of wind speeds?**
Predicted Rate of Spread by Fuels Category ("Aerial"/"Surface")

![Graph showing predicted rate of spread by fuels category. The graph plots the surface rate of spread against 1-hour fuel moisture (in %) for different fuels, including Control, SOD surface, SOD aerial, Herbicide surface, Herbicide aerial, Fuel Model SB1, Fuel Model SB2, Fuel Model 11, and Fuel Model 12. The lines show a decrease in surface rate of spread as fuel moisture increases.]
Predicted Flame Lengths by Fuels Category ("Aerial"/"Surface")

- Control
- SOD surface
- SOD aerial
- Herbicide surface
- Herbicide aerial
- Fuel Model SB1
- Fuel Model SB2
- Fuel Model 11
- Fuel Model 12
<table>
<thead>
<tr>
<th>Condition</th>
<th>Litter + FWD (tons/ac)</th>
<th>Fuel Bed Depth (ft)</th>
<th>Rate of Spread (ft/min)</th>
<th>Mid Flame Wind Speed (mi/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERIAL SOD</td>
<td>5.7</td>
<td>0.7</td>
<td>7.7</td>
<td>0</td>
</tr>
<tr>
<td>CONTROL</td>
<td>7.3</td>
<td>0.9</td>
<td>8.5</td>
<td>0</td>
</tr>
<tr>
<td>SURFACE SOD</td>
<td>7.7</td>
<td>1.5</td>
<td>14.1</td>
<td>0</td>
</tr>
<tr>
<td>AERIAL HERB</td>
<td>9.2</td>
<td>1.8</td>
<td>16.7</td>
<td>0</td>
</tr>
<tr>
<td>SURFACE HERB</td>
<td>13.1</td>
<td>2.2</td>
<td>14.6</td>
<td>0</td>
</tr>
</tbody>
</table>

**Interpretation:** Two type one handcrews required for grey conditions, indirect attack only for black conditions (flame lengths > 8 feet)
The dynamics of surface fuel accumulations after SOD are long-term (at least 8-12 years post-infection for significant accumulation), but the fuels do pile up and will probably cause changes in surface fire behavior.
There is a shorter-term risk from dead leaves remaining in killed trees for 1-3 years with critically low foliar moisture content (Kuljian and Varner 2010).
Tanoak fuels take longer to break down than often thought (large log piles still present and sound in some plots 12 years after treatment); could affect fire severity.
Both predicted fire behavior and predicted fire effects should be considered on the landscape for planning purposes. Even if fire severity ends up being low, ramped-up fire behavior will inspire a different choice of tactics for suppression, and this choice will have consequences.
The effects of herbicide treatment may approximate the most extreme effects of SOD. However, SOD is chronic, long-term, and unpredictable, while herbicide treatment is a one-time pulse of material that shows up in targeted, discrete areas that are accessible for fire suppression.
The “aerial”/“surface” fuel distinction provides a relatively reliable, quick, and easy way to assess possible hazards and determine appropriate firefighter response from surface fuels on either SOD or herbicide-treated plots.