Surface fuel loadings in mulching treatments in Colorado coniferous forests

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Fire Exclusion

Photo: Gary Chancey, USFS
Wildland / Urban Interface
Interface Areas of High Wildfire Risk in Colorado

Red Zone Population:
- 748,350 (1990 Census)
- 979,851 (2000 Census)

Homes in Red Zone:
- 370,000 (1990 Census)
- 474,000 (2000 Census)

Red Zone Acres:
- 6,300,000 (2000)

Map Created September 2004
Colorado State Forest Service
Mulching Treatments

Surface and ladder fuels cut into small chunks or chips
Mulching Treatments

Wood biomass is left on site

Compact layer of many small pieces
Objective
Quantify changes to forest floor

- Fuel loadings
- Fuel size distribution
## Tree density reduction

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Untreated Basal Area (m²/ha)</th>
<th>Mulched Basal Area (m²/ha)</th>
<th>%</th>
<th>Untreated TPH</th>
<th>Mulched TPH</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinyon-Juniper</td>
<td>22</td>
<td>12</td>
<td>47</td>
<td>1247</td>
<td>392</td>
<td>69</td>
</tr>
<tr>
<td>Ponderosa pine / Douglas-fir</td>
<td>27</td>
<td>9.5</td>
<td>65</td>
<td>2258</td>
<td>202</td>
<td>91</td>
</tr>
<tr>
<td>Lodgepole pine</td>
<td>38</td>
<td>10.5</td>
<td>73</td>
<td>2783</td>
<td>472</td>
<td>83</td>
</tr>
</tbody>
</table>

- TPH: Total Petroleum Hydrocarbons
Sampling

- Sites 2 to 4 years post-treatment

- Paired study areas
  - Untreated and Mulched areas

- 3 50-m transects per study area

- 25 1-m² quadrants per transect
Sampling: Fuel load estimates

- At each study site 9-m² quadrants established
- Measured total fuel depth at 5 points in quadrant
- Estimated %cover of each fuel size class
Pinyon Pine/Juniper

Ros Wu
Mulching in Pinyon Pine/Juniper: Changes to fuel loads

- No difference in needle litter fuel load

- 520% increase for fuels <2.54 cm

- 205% increase for fuels 2.54 to 7.61 cm

- 208% increase for Total woody debris
  - Untreated: 8 Mg/ha⁻¹
  - Mulched: 26 Mg/ha⁻¹
## Mulching in Pinyon Pine/Juniper: % of Total Fuel Load

<table>
<thead>
<tr>
<th>Fuel size (cm)</th>
<th>Untreated</th>
<th>Mulched</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 0.6</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>(1 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.6 to 2.54</td>
<td>19</td>
<td>45</td>
</tr>
<tr>
<td>(10 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.54 to 7.62</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>(100 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;7.62 cm</td>
<td>50</td>
<td>13</td>
</tr>
<tr>
<td>(1000 hr)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ponderosa pine / Douglas-fir
Mulching in Ponderosa Pine:
Changes to fuel loads

- 50% increase in needle litter fuel load

- 560% increase for fuels <2.54 cm

- 415% increase for fuels 2.54 to 7.61 cm

- 257% increase for Total woody debris
  - Untreated: 11 Mg/ha⁻¹
  - Mulched: 39 Mg/ha⁻¹
## Mulching in Ponderosa pine / Douglas-fir: % of Total Woody Fuel Load

<table>
<thead>
<tr>
<th>Fuel size (cm)</th>
<th>Untreated</th>
<th>Mulched</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 0.6</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>(1 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.6 to 2.54</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>(10 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.54 to 7.62</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>(100 hr)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;7.62 cm</td>
<td>77</td>
<td>14</td>
</tr>
<tr>
<td>(1000 hr)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ponderosa pine/Douglas-fir

Mulch depth (cm)
Lodgepole Pine
Mulching in Lodgepole Pine: Changes to fuel loads

- No difference in needle litter fuel load
- 2295% increase for fuels <2.54 cm
- Similar fuel loads for fuels >2.54 cm
- 463% increase for Total woody debris
  - Untreated: 9 Mg/ha\(^{-1}\)
  - Mulched: 50 Mg/ha\(^{-1}\)
Mulching in Lodgepole pine: % of Total Woody Fuel Load

<table>
<thead>
<tr>
<th>Fuel size (cm)</th>
<th>Untreated</th>
<th>Mulched</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 0.6 (1 hr)</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>0.6 to 2.54 (10 hr)</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td>2.54 to 7.62 (100 hr)</td>
<td>49</td>
<td>10</td>
</tr>
<tr>
<td>&gt;7.62 cm (1000 hr)</td>
<td>32</td>
<td>11</td>
</tr>
</tbody>
</table>
## Mulching changes fuelbed characteristics

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Untreated Litter:Fine Woody Fuels</th>
<th>Mulched Litter:Fine Woody Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinyon Pine/ Juniper</td>
<td>5.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Ponderosa/ Douglas Fir</td>
<td>11.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Lodgepole</td>
<td>11.5</td>
<td>0.61</td>
</tr>
</tbody>
</table>
Summary

- Mulching treatment redistributed the stand biomass from the vertical to the horizontal
Summary

- Total surface woody fuel loads increased 208% to 463%
  - Lodgepole pine > Ponderosa pine > Pinyon pine

- Largest contributor to surface fuel loading was found in the smaller sized fuel classes instead of the coarse woody debris
Change in fuelbed characteristics due to mulched will change surface fire behavior:
- reduced rate of spread, shorter flame lengths, more smoldering, and possibly increased soil heating.
Mulch depth varied across ecosystems and sites

- Pinyon-Juniper: majority within 0.5 to 3 cm
- Ponderosa pine/Douglas-fir and Lodgepole pine: majority 1 to 7 cm
Acknowledgements

➢ Joint Fire Science

➢ Steve Culver, Lara Duran, Todd Gardiner, Kristin Garrison, Dan Huisjen, Patrick McCoy, Pat McLaughlin, Ken Reed, Kirsta Scherff, Matt Schulz, Kathy Seiple, Diana Selby, John Smeins, Scott Wagner, Brenda Wasielewski, Julie Watkins, Dan Weber, Denise White, Ros Wu, Bill Wyatt

➢ Field assistance

➢ Brett Wolk, Akasha Faist, Natalia Canova, Tony Harp, Jake Davidson, Jen Allgood, Jason Blair, Lance Asherin, Paula Fornwalt, Jenny Ventker
Questions?
2005 Workshop

- Attendees: Managers and scientists
- Discussed experiences and concerns about mulching treatments
- Developed a list of high priority research needs
- Joint Fire Science Proposal
Mulching in Pinyon Pine/Juniper: Shifts in forest floor cover

- Decrease in litter/duff cover
- Decrease in soil cover
- Increase in woody debris <2.54 cm
Mulching in Ponderosa Pine: Shift in forest floor cover

- Decrease in litter/duff cover
- Increase in woody debris <7.61 cm
- Largest increase in <2.54 cm woody debris
Mulching in Lodgepole Pine: Shift in forest floor cover

- Decrease in litter/duff cover
- Increase in woody debris <7.61 cm
- Largest increase in <2.54 cm woody debris
- Similar trends in Ponderosa