Airborne laser scanner-assisted estimation of prescribed fire fuel consumption

Nicholas Skowronski, Albert Simeoni, Kenneth Clark, Michael Gallagher, Robert Kremens, Ruddy Mell, and Eric Mueller
Effect and Effectiveness

Effect - What is the physical effect ($\Delta$) of a fuel treatment operation on 3-D Fuels?

Effectiveness - How does this change affect fire behavior?

Eric Mueller: Field Experiments and Modeling for the Assessment of Fuel Treatment Effectiveness in Reducing Wildfire Intensity and Spread Rates; 2:00-2:20; UG 326/327
Effect and Effectiveness

Effect- What is the physical effect (Δ) of a fuel treatment operation on 3-D Fuels?
   - This talk

Effectiveness- How does this change affect fire behavior?
   - Eric Mueller: Field Experiments and Modeling for the Assessment of Fuel Treatment Effectiveness in Reducing Wildfire Intensity and Spread Rates:
     2:00- 2:20 ---- UG-326/327
Spatial heterogeneity following treatment
Allometrically estimated CBD from Airborne Scanning Lidar

From: Skowronska et al. 2011
Destructive Harvest to Terrestrial LiDAR

From: Clark et al. 2013
## Destructive Harvest to Terrestrial LiDAR

<table>
<thead>
<tr>
<th>Fuel Class</th>
<th>Equation</th>
<th>$r^2$</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Fuels*</td>
<td>$y = 2.012x + 0.009$</td>
<td>0.94</td>
<td>901.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Needles$_{live}$</td>
<td>$y = 0.998x + 0.013$</td>
<td>0.89</td>
<td>451.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Needles$_{dead}$</td>
<td>$y = 0.008x - 0.001$</td>
<td>0.36</td>
<td>31.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1-hr$_{live}$</td>
<td>$y = 0.426x + 0.007$</td>
<td>0.87</td>
<td>363.6</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1-hr$_{dead}$</td>
<td>$y = 0.255x - 0.001$</td>
<td>0.93</td>
<td>727.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>10-hr$_{live}$</td>
<td>$y = 0.662x + 0.001$</td>
<td>0.82</td>
<td>257.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>10-hr$_{dead}$</td>
<td>$y = 0.326x - 0.009$</td>
<td>0.92</td>
<td>613.4</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>100-hr$_{live}$</td>
<td>$y = 0.930x + 0.056$</td>
<td>0.53</td>
<td>62.1</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>100-hr$_{dead}$</td>
<td>$y = 0.248x + 0.009$</td>
<td>0.56</td>
<td>70.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>1000-hr$_{live}$</td>
<td>$y = 0.056x + 0.016$</td>
<td>0.08</td>
<td>4.5</td>
<td>0.0382</td>
</tr>
<tr>
<td>1000-hr$_{dead}$</td>
<td>$y = 0.042x + 0.001$</td>
<td>0.08</td>
<td>4.5</td>
<td>0.0370</td>
</tr>
<tr>
<td>Reproductiveall</td>
<td>$y = 0.355x + 0.012$</td>
<td>0.63</td>
<td>93.5</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

From: Clark et al. 2013
Approach: Treatment effects on canopy fuels

- Concurrent LiDAR (Airborne and Terrestrial) and field campaigns
- 2 burn seasons of 25 field sampled burns and 40+ unsampled
- Airborne LiDAR
  - 776 square mile initial acquisition (Fall ‘12)
  - 2 post-treatment collections of 200 square miles (Spring ‘13 and ‘14).
- Estimation and Analysis
  - Space for time using approx. 50 years of burn history
  - Pre- and Post- acquisitions for approx. 25 treatments.
Pre and Post Canopy Bulk Density

Canopy Bulk Density (Kg m\(^{-3}\))

Height (m)

Post
Pre
Relative Change

Relative CBD Change (% kg m$^{-3}$)

Height (m)
Eric Mueller: Field Experiments and Modeling for the Assessment of Fuel Treatment Effectiveness in Reducing Wildfire Intensity and Spread Rates: 2:00 - 2:20 UG-326/327
Future Work

• 25 Treatment Blocks with field estimates
• 40 Rxb blocks over the 2 years
• Several mechanical operations
• Space for time with a 50 year burn history
Acknowledgements

This work is funded by Joint Fire Science Project #12-1-03-11: Evaluation and optimization of fuel treatment effectiveness with an integrated field/modeling approach.

The authors thank the NJ Division of Forestry and the FERA team of the USDA FS PNW Research Station.