Tree mortality in Oregon forests: importance and trends

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Forest Health in Oregon: State of the State 2020
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Roadmap

• Why tree mortality matters?

• Tree mortality across Oregon: an inventory perspective

• Landscape patterns of tree mortality: a satellite perspective

• Conclusions
Significance of tree mortality

• Forest support timber, water, recreation, carbon storage, wildlife, etc.

• Mortality (i.e., tree death) is a part of how forests function
Mortality and stand development

Total volume

Annual components of change
Tree mortality agent examples

“Mortality spiral”

Franklin et al. 1987

Drought

Image: USFS FHP

Insect

Image: USFS

Harvesting

Image: USFS

Mechanical

Image: Greg Cohn

Fire

Image: USFS

Disease

Image: USFS
Tree mortality and forest landscapes
The strategic inventory of Oregon’s forests
The power of the FIA plot grid:

- Representative sample
- Consistent protocols
- Multiple data attributes
- Permanent plots
- Plot confidentiality
Implications of a 10-yr annual cycle

“estimate of average annual mortality by species and ownership, 2001-2007 to 2011-2017”

Crews also estimate mortality year, enabling analyses by year, but it takes ~3-4 years to have enough data to say something reliable about a particular year.
### The big picture for Oregon

**Acres of forestland: 29,362,968**

<table>
<thead>
<tr>
<th></th>
<th>N trees (million)</th>
<th>Volume (million ft³)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Live</strong></td>
<td>9,733</td>
<td>97,702</td>
<td></td>
</tr>
<tr>
<td><strong>Mortality / yr</strong></td>
<td>140</td>
<td>621</td>
<td>1.4%</td>
</tr>
<tr>
<td><strong>Cut / yr</strong></td>
<td>89</td>
<td>901</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

**Mortality**

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overstory / yr</strong></td>
<td>0.9%</td>
</tr>
<tr>
<td><strong>Understory / yr</strong></td>
<td>1.9%</td>
</tr>
</tbody>
</table>

**Net growth / yr**

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,024</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
Mortality and ownership

Volume/yr (million ft³)

NFS
othpub Owner
private

Cut
Mortality
Growth
Net change
### How prevalent is disturbance?

<table>
<thead>
<tr>
<th>Disturbance</th>
<th>Area (1000 ac)</th>
<th>SE</th>
<th>Percent</th>
<th>Percent/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut</td>
<td>3,392.2</td>
<td>139.6</td>
<td>11.6%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Fire</td>
<td>177.7</td>
<td>32.0</td>
<td>0.6%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Cut + Fire</td>
<td>1,122.2</td>
<td>80.9</td>
<td>3.8%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Insect or Disease</td>
<td>4,012.7</td>
<td>135.9</td>
<td>13.7%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Weather + Other</td>
<td>928.8</td>
<td>78.9</td>
<td>3.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>None</td>
<td>19,729.4</td>
<td>236.1</td>
<td>67.2%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29,363.0</td>
<td>171.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1%/yr
Timing and cause of mortality
Species and disturbance agents

Annual Mortality Rates (% of live volume)

<table>
<thead>
<tr>
<th></th>
<th>Pacific silver fir</th>
<th>lodgepole pine</th>
<th>Douglas-fir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvested</td>
<td>0.03%</td>
<td>0.57%</td>
<td>1.18%</td>
</tr>
<tr>
<td>Other Agents</td>
<td>1.07%</td>
<td>2.39%</td>
<td>0.38%</td>
</tr>
</tbody>
</table>

PACIFIC SILVER FIR (ABIES AMABILIS)
- Fire: 9%
- Insect or Disease: 58%
- Other: 33%

LODGEPOLE PINE (PINUS CONTORTA)
- Fire: 6%
- Insect or Disease: 85%
- Other: 9%

DOUGLAS-FIR (PSEUDOTSUGA MENZIESII)
- Fire: 26%
- Insect or Disease: 32%
- Other: 42%
Getting a satellite perspective
Satellite imagery and forest change: LandTrendr helps pixels tell a story.
LandTrendr: Each pixel has a story

LandTrendr performs a temporal segmentation of Landsat multispectral data, producing

- **Stable forest**
  - Fast, high magnitude disturbance
  - Minor forest recovery

- **Insects** (slow)

- **Fire** (fast)

Cloud-computing and LandTrendr

- Building systems (e.g., within GEE or AWS) to automate and globalize
- Facilitate analysis, summarization, and dissemination of map data
Landscape Change Monitoring System (LCMS) Products

LCMS Products Suite

1986 – current

- Year of Detection
- Duration
- Magnitude
- Agent
- Recovery
LCMS – USFS Bioregional Assessment for Northwest Forests area
Harvesting: public vs. private
Wildfires over time

Monitoring Trends in Burn Severity (mtbs.gov)

2003
Pine beetle west of Mt. Bachelor

1998

LCMS (Satellite)  USFS Aerial Detection Survey
Satellites highlight long-term changes in tree mortality
Conclusions

• There are many perspectives on tree mortality.

• Many agents are responsible for mortality, indicating no single process can explain patterns.

• Tree mortality in future Oregon forests could change substantially.
Thank you!

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• Zhiqiang Yang

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