Wood degradation in standing lodgepole and hybrid lodgepole-jack pine killed by mountain pine beetle

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Background

• “Shelf-life” = Post-mortality rate of decay and degradation of wood quality and quantity variables

• Rate of change of stand structure

• Essential for strategic planning
Research Objectives

• Quantify the relationship between time since death and measures of wood quality and quantity, in trees killed by mountain pine beetle.
  – Regression models

• Quantify the influence of site factors in wood deterioration

• Determine rates of tree fall.
Other “shelf-life” factors

• Markets
• Cost of raw material
• Operating costs
• Manufacturing technology
• Log inventories

- Biophysically-based
Multi-phased approach

• Synthesis report
  – Literature review, interviews from Caribou Plateau outbreak
  – Report available (CFS, WP 2005-14)

• Phase I - BC
  – 0-5 years post-mortality (SBSdk and SBSmc3)

• Phase II - BC
  – 6-10 years post-mortality (SBSdk)
  – Phase I and II report available (CFS, WP 2008-30, Wood and Fiber Science 43:130-142)

• Phase III - Alberta
  – hybrid lodgepole/jack pine – boreal mixed wood
  – lodgepole
Study Area – Phase I and II - BC
Study Areas - Alberta

- 2010 samples
- 2011 samples
Variables

Response variables
- Moisture content \((hw/sw)\)
- Wood density \((hw/sw)\)
- Penetration depth of blue stain fungi
- Number, depth of checks
- Penetration depth of saprot
- Wood borer damage

Predictor variables
- Date of Mortality
  - Time since death
- Tree size \((dbh)\)
- Site
  - Subzone, soil moisture regime
- Height along the stem
- Stand density
Time Since Death – External Indicators, local information

Four Categories

1. Red, bright needles, needles retained
2. Old Red, some needle loss
3. Early Grey, needle and some twig loss
4. Old Grey, all needles gone, most fine twigs gone

Photo by Lorraine Maclauchlan
1. Stand-level surveys

- Space – time distribution of mortality
- Fall rate
- Stand and tree attributes
- Select trees for destructive sampling
2. Tree Level

SBSdk (1-4)
SBSmc (3,4)

3 Soil Moisture Regimes
3 Diameter Classes
4 TSD Categories

~ 600 sample trees
phase I and II
187 sample trees
Alberta
Field Measurements

- Followed MOFR procedures for volume and decay studies (12 cookies (4 in Alberta))
- Each cookie: diameter, bluestain, number and depth of checks, saprot, woodborers
- Moisture content and specific gravity (fresh weight discs 1, 2, 4, 8)
Mortality dates via crossdating

- Collect cores from live trees on sensitive sites
- Prepare cores, measure rings
- Standardize to remove age-related growth trend => master chronology
- “Pattern match” dead trees to live chronology
Years to Tree Fall

1. Stand level surveys - % down at time of surveying
2. Adjacent tree scar dates (BC only)
   - 30 pairs, phase I, II only
   - Date of death from fallen tree
   - Date of fall from scarred tree
## Results – Stand Level

<table>
<thead>
<tr>
<th>BEC</th>
<th>TSD (years)</th>
<th># plots</th>
<th>Average stems/ ha</th>
<th>% PI</th>
<th>% Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBSdk</td>
<td>0-5</td>
<td>102</td>
<td>980-1225</td>
<td>68-90</td>
<td>&lt;1%</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>15</td>
<td>500-1450</td>
<td>60-100</td>
<td>28% (range = 0-60%)</td>
</tr>
<tr>
<td>SBSmc3</td>
<td>0-5</td>
<td>81</td>
<td>1000-1350</td>
<td>84-94</td>
<td>0</td>
</tr>
<tr>
<td>Foothills + mixed wood</td>
<td>0-4</td>
<td>17</td>
<td>840-2867</td>
<td>4-65</td>
<td>0-4%</td>
</tr>
<tr>
<td>Upper, Lower Foothills</td>
<td>1-7</td>
<td>30</td>
<td>252-500</td>
<td>75, 69</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
Progression of mortality in a stand by diameter

SBS dk
Stand group 1

SBS mc3
Stand group 3
Sapwood moisture content grouped by year of mortality

**dk**

**mc**

*Alberta-mixed wood*
Heartwood moisture content grouped by year of mortality

Alberta
Moisture content, grouped by BEC unit.
Alberta – bluestain depth

**Mixed wood**

- Depth (cm) vs. Years since death

**Foothills**

- Depth (cm) vs. Years since death
Percent of trees with 1 or more checks – by disc height

mc

Years since death

Percent

dk

Years since death

Percent

Alberta
Number and depth of checks
BC samples
Number and depth of checks

Alberta samples
DBH significantly related to number of checks and depth of checks, BC data.

Alberta data showed significant relationship only with check depth.
Condition of bark and effect on checking

1 = tight
2 = loose
3 = missing
Percent down, 6-10 YSD, SBS
Conclusions

• External indicators of tsd = inaccurate by 4-5 years, especially with smaller trees.
• Mortality in a stand can take place over 5+ years. Pattern of mortality may vary between BC and Alberta
  – BC: early attacks = large (preceded by the small and weak)
  – More recent attacks = remaining small trees
• Only .25% of beetle-killed trees had fallen within the first 5 years, but rates of fall increased substantially after 5 years.
Conclusions continued

- Biogeoclimatic unit and soil moisture regime did not predict decay and degrade in BC, but may be important with wider ranges of smr.
- Most change in dependent variables occurred in the first 1-2 years.
- Checks develop first and are worst in the middle sections of trees.
- Response variables changed with height on the tree.
- Tree size (dbh or merchantable volume) is a good predictor of decay and degrade (BC).
0-6 months, green wood characteristics

0-2 years
- Rapid checking increase
- Some saprot development

2-8 years
- Period of stability in wood
- Quality
- Most trees remain standing

8+ years
- Trees begin to fall
- Trees that remain standing develop rot and woodborers at base

0  Years post mortality  10