Bark Beetle Activity in Southern Rockies Forests

Chuck Rhoades, Rob Hubbard & Kelly Elder

M. Battaglia, P. Fornwalt, B. Collins, K. Pelz

U.S. Forest Service, Rocky Mountain Research Station

Mountain Pine Beetle Information Exchange Forum
Foothills Research Institute
23 April 2014
Talk Overview

- Southern Rockies Context
- Overview of Outbreak
- General Patterns

![Map of the Southern Rockies](image)

<table>
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<tbody>
<tr>
<td>Annual Average Temperature (°F)</td>
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Colorado Forest Types

Colorado

<table>
<thead>
<tr>
<th>Forest Type</th>
<th>Area (km²)</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Spruce-fir</td>
<td>18,584</td>
<td>19%</td>
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<tr>
<td>Lodgepole</td>
<td>6,060</td>
<td>7%</td>
</tr>
<tr>
<td>Mixed Conifer</td>
<td>7,272</td>
<td>10%</td>
</tr>
<tr>
<td>Ponderosa</td>
<td>8,080</td>
<td>8%</td>
</tr>
<tr>
<td>PJ, Aspen, Oak,</td>
<td>~40,000</td>
<td>44%</td>
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<tr>
<td>Riparian</td>
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</table>

* 68% are on Federal Land
Lodgepole Pine
(Pinus contorta var. latifolia)

Lodgepole pine 0.61 million ha
(7 % of CO forest land)

Lodgepole Regional Climate Vulnerability
Moderate Risk Factors:
Near southern range limit
Elevation Range Shift: ~ 300 m
Connectivity less in S Rockies than N
Ponderosa Pine

(*Pinus ponderosa*)

Ponderosa pine forests and woodlands occupy ~0.8 million ha (8 % of CO forestland).

**Low Regional Climate Vulnerability**
- Well north of southern range limit
- Elevation range shifts possible
- Connectivity across large scales may be limited by grasslands
Spruce-Fir (*Picea engelmannii/Abies lasiocarpa*)

**Southern Limit**
Southern Colorado spruce-fir ecosystems are ~ 200 km from the southern limit. Smaller, more fragmented patches not typical at higher latitudes.

**Elevation Shift (< 300 m)**
Potential for upward elevation shifts, though microsite conditions, geomorphic and soil limitations, reduced snowpack, and less moisture availability may inhibit establishment.

**Connectivity**
Large tracts of lower elevation land isolate these ecosystems and can constrain latitudinal range shifts, but may not necessarily limit shifts within the subalpine zone.
Observed Changes in S. Rockies Climate

**TEMPERATURE**

**Increased Annual Average Temperature**  1.1°C over the past 30 yrs

Warming observed in most parts of the state

**Daily Minimum Temperatures have Warmed More than Daily Maxima**

Increases in all seasons, largest in summer, followed by fall, spring, winter

**Less Frequent Severe Cold Waves**

**PRECIPITATION/WATER**

**No Long-Term Trends in Annual Precipitation, but ...**

**Below Average Snowpack since 2000**

**1-4 Week Earlier Snowmelt & Peak Runoff:** lower SWE, warming spring temperatures, enhanced solar absorption from dust-on-snow

**More Frequent Soil Moisture Drought (PDSI):** warming & below-average precip

Climate Change in Colorado 2014. Western Water Assessment, Univ of CO (Draft V 3)
Colorado Mountain Pine Beetle Event

Current Outbreak started late 1990s
Big Years 2004 – 2011
(> 160,000 ha / yr)
Peaked in 2008 (466,000 ha)
1.4 million cumulative hectares
(since ‘96)
(0.6 + 0.7 + 0.8 million ha of LPP, MC, Pipo)
Continental Patterns

British Columbia
Cumulative MPB: 18.1 million ha
Big years > 5 million ha / yr
Peak: 10 million ha / yr (2007)
Total Province Area: 94 million ha

Montana
Big years > 0.5 million / yr
Peak: 1.5 million ha / yr (2009)
Total State Area: 38 million ha

Colorado
Cumulative MPB: 1.4 million ha
Peak: <0.5 million ha/yr
Total State Area: 27 million ha

Rafé et al. 2008
Colorado – Spatiotemporal Patterns

Earliest activity: distinct epicenters up to 100 km apart
Drier, lower sites

Zones merged over time
Wetter, higher sites

Multiple locations
regional > local factors

Lodgepole differs from ponderosa

Host Progression

- 71% lodgepole; 26% ponderosa
- Increase in Ponderosa over time
Regional Climate & Weather Factors

Triggering Droughts
2001-2002: One of the most severe in 500 yrs

General Warming
Warming since 1900, steep increase in last 50 yrs

High Minimum Temps
Outbreak coincides to 15 yrs with generally > average Oct, Jan, Mar min temps

Regional Patterns

MPB activity synchronous over broad areas
> MPBs dispersal distance

Warming & drought create favorable conditions
Beetle enhanced vs Tree inhibited

Initial conditions no needed to sustain outbreak
Host depletion ended event

### Basal Area Losses in S. Rockies Lodgepole

<table>
<thead>
<tr>
<th>%</th>
<th>Description</th>
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<tbody>
<tr>
<td>74%</td>
<td>MPB salvage areas (Collins et al. 2012)</td>
</tr>
<tr>
<td>64%</td>
<td>Rocky Mtn Nat’l Park – Multiple pine types (Diskin et al. 2011)</td>
</tr>
<tr>
<td>60%</td>
<td>N. Colo Landsat analysis (Meddens &amp; Hicke 2014)</td>
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<tr>
<td>56%</td>
<td>N. Colo initial 7 yrs of outbreak (Klutsch et al. 2009)</td>
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<tr>
<td>46%</td>
<td>1980s outbreak; lodgepole &amp; pine, spruce-fir (Pelz and Smith 2012)</td>
</tr>
<tr>
<td>40%</td>
<td>High elevation mixed pine, spruce-fir (Rhoades et al. unpub)</td>
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**Colo/Wyo border Landsat Image**  
3-4 years per grid cell (900 m$^2$ cell)  
20% of grid cell / yr  
60% mortality loss

**Meddens & Hicke. 2014.** FEM (in press).
Spruce Beetle - *(Dendroctonus rufipennis)*

Spruce-fir 1.9 million ha (19% CO forestland)

Started around 2000

460,000 ha since 1996 (~200k ha in WY)

160,792 ha in 2013 (> ½ are new areas)

Entire drainages in 1 year
Western US Bark Beetle Activity

<table>
<thead>
<tr>
<th>Region</th>
<th>Affected Area (ha)</th>
<th>Affected Area (ac)</th>
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<tbody>
<tr>
<td>W. Canada</td>
<td>19</td>
<td>47</td>
</tr>
<tr>
<td>W. US</td>
<td>17</td>
<td>43</td>
</tr>
<tr>
<td>Intermountain</td>
<td>9.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Colorado</td>
<td>2.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Montana</td>
<td>2.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Idaho</td>
<td>2.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Wyoming</td>
<td>1.5</td>
<td>3.6</td>
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All Hosts including:
MPB, Spruce beetle, Ips spp.
Doug-fir beetle, Fir engraver

Colorado
10 million ha of forest
6 million ha of conifer
4 million ha of high elevation conifer
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Western US Insect & Disease Risk

9.4 million ac (14%)
6.2 million ac (9%)
5.9 million ac (11%)
3.5 million ac (7%)
13.3 million Ac (25%)
7.9 million Ac (12%)
2013 Summary of forest health conditions in British Columbia. – http://www.for.gov.bc.ca/ftp/HFP/external/Ipublish/Aerial_Overview/2013/Aerial%20overview%202013%20March%2024.pdf
Over time outbreak spread from lower to higher elevations large, susceptible stands to small trees.