Trends and drivers of carbon storage in westside forests of Oregon and Washington

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Forest carbon pools and fluxes

Sources of confusion

• Stocks vs. fluxes
• Leakage and substitution
• Permanent vs. temporary emissions
• Future decay pool
• Carbon debt

Harvested wood products
While their owners sleep, nervous little dogs prepare for their day.

Gary Larsen Far Side cartoon
Stocks at one point in time: W. Oregon

<table>
<thead>
<tr>
<th>Component</th>
<th>%total</th>
<th>% non-soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live trees</td>
<td>48</td>
<td>72</td>
</tr>
<tr>
<td>Snags</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Down wood</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Under. Veg</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Forest floor</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Soil</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>HWP</td>
<td>4?</td>
<td>6?</td>
</tr>
</tbody>
</table>
Stock change avoids most of the fuss

Example: change over 10 years, moderate fire event

Net change: +10

Carbon density (Mg/ha)

- Live trees
- Snags
- Down wood
- Under. Veg
- Forest floor
- Soil

Time 1

Time 2

+2
+7
+7
0
-4
-2

Net change: +10
The strategic inventory of Washington’s forests:

Forest Inventory and Analysis (FIA)
Measuring a nice forest
Measuring a real forest
The power of the FIA plot grid:

- Representative sample
- Consistent protocols
- Multiple data attributes
- Permanent plots
- Plot confidentiality
The FIA Plot Footprint and Measurements

Measurements to estimate carbon stocks
- Trees: DBH, HT, SPP, Defect, DecayClass
- Understory veg: SPP, Cover
- Down wood: DIA, SPP, DecayClass
- Forest floor: Litter + Duff Depths

KEY

- 6.8 ft radius microplot (seedlings, live+dead trees 1-5” DBH)
- 24.0 ft subplot (live+dead trees>5” DBH, understory vegetation)
- 58.9 ft macroplot (live+dead trees>24” E, >30” W)
- Woody materials transects: 2 x 24’ per subplot (>=0.25” DIA, forest floor depth)

* Prior measurements include:
- Soil cores
- Longer CWD transects
- Large trees on hectare (2.4 ac)
- Lichen communities
- Plant diversity
Then we calculate carbon..

"I think you should be more explicit here in Step Two."
Improving our foundation

Cap and trade

National carbon monitoring system

Tree biomass equations

Carbon tax or credits

Primary problems: Scope of inference, extrapolation beyond original data, few spp, little belowground
What are we finding?
Mortality and stand development

Total volume

Annual components of change
Live and dead accumulate with age

Undisturbed productive stands
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>3,477.6</td>
<td>152.4</td>
<td>11.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Fire</td>
<td>1,026.1</td>
<td>81.4</td>
<td>3.5%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Cut + Fire</td>
<td>161.1</td>
<td>33.9</td>
<td>0.6%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Insect or Disease</td>
<td>4,100.5</td>
<td>148.3</td>
<td>14.0%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Weather</td>
<td>524.0</td>
<td>62.9</td>
<td>1.8%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Incidental Cut</td>
<td>373.7</td>
<td>56.3</td>
<td>1.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td>None</td>
<td>19,532.4</td>
<td>254.0</td>
<td>66.9%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29,195.5</td>
<td>182.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.0%/yr
Many fires are not severe
Area by fire severity class, OR+WA NFS

~50% of area burned resulted in >60% overstory mortality
Most of the carbon is still there

Flux by pool and disturbance type, OR+WA NFS

For. Ecol. Manage. 328:167
There's still a lot of growing going on

Net change in live trees by disturbance, OR

![Graph showing net change in live trees by disturbance, OR]
Teasing out temporal signals
Timing and cause of mortality

![Graph showing volume (million ft³) vs. mortality year with categories for other, insect + disease, and fire.](image-url)
Summary

- Strategic inventories track carbon pools and flux at landscape to regional scales
- Inventories inform causes and timing of flux
- Tree mortality is not an emission; dead wood tends to accumulate
- Many fires are not severe and the overall effect on emissions has been minor
- Live tree growth has been the dominant force of C flux in PNW, largely due to reduced harvest
- Detailed forest carbon reports for OR+WA in 2019
Thank you!