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Carbon and Fire Risk:
Alternative Treatments and the Probability of Fire

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A non-profit corporation formed by 15 research institutions to conduct cradle to grave environmental studies of wood products

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Background

The CORRIM report estimated the carbon storage contribution from three pools linked to the forest:

1. In the Forest pool
2. In wood products pool (net of energy used and biofuel produced)
3. Avoided fossil intensive product pool

A major conclusion was that the highest leverage use of wood is in long lived products that substitute for fossil intensive products.

A second conclusion was the shortest and most intensive rotations that produce long lived products stores the most carbon.
Life Cycle Assessment of Wood Products & Buildings

- Sun
- O₂
- CO₂
- Air Emissions
- Management & Harvest
- Production
- Construction
- Water & Land Emissions
Life Cycle Inventories: measure all inputs & outputs

“Cradle”

Forest Resources & Harvesting
PNW and SE

Processing of Structural Materials
PNW and SE
- Lumber
- Plywood
- Glulam
- LVL
- I-joists
- OSB (SE only)

“Gate-to-Gate”

Construction of Virtual Residential Buildings to Code
- Minneapolis wood and steel designs
- Atlanta wood and concrete designs

“Grave”

Materials

Energy

Water

Products

Co-products

Emissions

Effluents

Solid Waste

Disposal or Recycle

Use and Maintenance
Carbon in PNW Forest Pools
80-Year Rotation with Two Thinnings
Carbon in Product Pools
Processing Energy and Displacement
Summary Performance Indices
Atlanta House vs. Above-grade Wall

Concrete vs. Wood Design (%)

- Embodied Energy
  - House: 16%
  - Above-grade Wall: 38%
- Global Warming
  - House: 31%
  - Above-grade Wall: 80%
- Air Emissions
  - House: 23%
  - Above-grade Wall: 46%
- Water Emissions
  - House: 0%
  - Above-grade Wall: 0%
- Solid Waste
  - House: 51%
  - Above-grade Wall: 164%
Forest, Product and Substitution Pools

Forest, Product, Emissions, Displacement & Substitution Carbon by Component

Metric Tons Per Hectare

Year

Forest with Products

Forest with Substitution

Stem
Root
Crown
Litter
Dead
Chips
Lumber
HarvEmis
ManufEmis
Displacement
Substitution
Carbon in Forests, Products and Concrete Frame Substitutes

[Bar chart showing carbon content over different rotation lengths in years for various time intervals (0-45, 0-80, 0-120, 0-165 years). The chart compares metric tons per hectare of forest, products, emissions, and displacement, with substitution.]
Problem

- This raises several interesting questions for carbon strategy in the Inland West.
  - What is the impact of fire which eliminates the opportunity to produce products and also impedes regeneration and productivity.
  - Should the Inland West produce long lived product or biofuels?

- Knowing the carbon impact after a range of fire risk reduction treatments (NA, BA45, 9&Under, 12&Up, & Wildfire) is not sufficient.

- We need to know the expected value of carbon which depends upon the probability of fire as a function of the treatment.

- We also need to know the likelihood of producing long lived engineered products vs. biofuel.
Methods applied to Okanogan FIA data

- Average per acre metric tons of carbon were calculated for each 5-year time period from 1995 to 2030 for NoAction(NA), BA45, 9&Under, 12&Up, and Wildfire treatments.

- Fire risks were estimated using the FVS Fire and Fuel Extension (FFE model) and categorized as Hi, Moderate or Low risk.

- Probability of fire was computed/calibrated at 17% per 5 year period to result in 15% unburned refugia after 50 years based on prior studies.

- 17% of the acres at high risk were burned each period, 8% at moderate risk and 0 % for low risk.

- Composite carbon totals through time were calculated as a percentage of acres treated and whether unburned or burned.

- All treatments occurred in 2000 or were phased in; Fire occurred each time period.
Assumptions

- Low risk acres don’t burn (or low intensity fire)
- High and Moderate risk acres can only burn once in the period
- After a fire on High and Moderate risk acres the carbon remaining is estimated from post-fire residual stands:
  - higher in the north (Okanogan)
  - lower in the south (Fremont)
- Regeneration is assumed and may be excessive (many burned stands may actually be ready for a second burn)
- Snags are decayed (no salvage)
Acres in Low Risk Class - no fire
Acres burned each period: Okanogan with Regeneration

Percent of Landscape Burned Each Time Per

Increase in high risk acres
Acres unburned:
Okanogan with Regeneration

Percent Unburned

Percent

Year

Percent
**ALL Carbon:**
Okanogan with Regeneration

![Graph showing carbon emissions over time in Okanogan with regeneration. The graph includes data for different age classes, with labels for MT/Acre and years from 1995 to 2050.](image-url)
12 & Over:
20% of Initially High and Moderate groups treated during each of first 5 periods (2000 – 2020)
9 & Under:
20% of Initially High and Moderate groups treated during each of first 5 periods (2000 – 2020)
BA45:
20% of Initially High and Moderate groups treated during each of first 5 periods (2000 – 2020)
Treatments phased in over 25 years

<table>
<thead>
<tr>
<th></th>
<th>Treatments:</th>
<th>Fire</th>
<th>9&quot;-</th>
<th>12&quot;+</th>
<th>45sfBA</th>
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</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>mil. Tonnes</td>
<td>23.9</td>
<td>26.8</td>
<td>33.1</td>
<td>31.4</td>
</tr>
<tr>
<td>Burn</td>
<td>000's acres</td>
<td>557</td>
<td>471</td>
<td>562</td>
<td>377</td>
</tr>
<tr>
<td>Harvest</td>
<td>mil bft</td>
<td>0</td>
<td>495</td>
<td>5084</td>
<td>3213</td>
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</tbody>
</table>
### Treatment Costs and Revenues

<table>
<thead>
<tr>
<th>$mils</th>
<th>Treatments:</th>
<th>Fire</th>
<th>9&quot;-</th>
<th>12&quot;+</th>
<th>45sfBA</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Carbon Value @$2/T</td>
<td>$48</td>
<td>$54</td>
<td>$66</td>
<td>$63</td>
</tr>
<tr>
<td></td>
<td>Rel Carbon Rev</td>
<td>$0</td>
<td>$6</td>
<td>$18</td>
<td>$15</td>
</tr>
<tr>
<td></td>
<td>Fire Dept Cost@$2000/acre</td>
<td>$1,114</td>
<td>$942</td>
<td>$1,124</td>
<td>$754</td>
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<tr>
<td></td>
<td>Harvest Value@$200/mbf</td>
<td>$0</td>
<td>-$30</td>
<td>$1,017</td>
<td>$573</td>
</tr>
<tr>
<td></td>
<td>removal of non-mkt mat'l</td>
<td>$300/acre</td>
<td></td>
<td></td>
<td>$150/acre</td>
</tr>
<tr>
<td></td>
<td>Net Rev-Cost</td>
<td>-$1,114</td>
<td>-$978</td>
<td>-$126</td>
<td>-$196</td>
</tr>
</tbody>
</table>
Conclusions

• Fire risk reduction treatments do increase carbon stored
  • 12 tonnes/acre but the accounting is complex

• Treatment response time reduces benefits (limits reduction in acres burned & delays product carbon)

• 9”&under barely reduces fire risk or cost

• 12+&over produces highest net revenue but maintains high fire risk
  • Other non-mkt values (avoided costs) would reduce benefit

• 45sfBA almost as good with fire fighting cost included
  • Better with other non-mkt benefits included
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  – USFS/FPL, 10 companies & 8 institutions funded Phase I

• PNW & SE product manufactures surveyed

• USDA/CSREES National Research Initiative competitive grants program

• EPA & Special grants for carbon links
The Details

CORRIM:  www.CORRIM.ORG

Athena:  www.athenaSMI.ca

LMS:  http://LMS.cfr.washington.edu

USLCI database:  www.nrel.gov/lci