WASHINGTON STATE FOREST SECTOR AND THE CARBON CYCLE

An overview of the Washington's production forests and how they fit into the global carbon cycle
Overview

◦ Washington Forest Sector and its role in global production

◦ How does forest sector impact carbon cycle
  ◦ In woods
  ◦ Fossil fuel

◦ How can we measure
  ◦ HWP accounting
  ◦ Substitution
  ◦ Overview of in forest trends

◦ Future trends
U.S. a Global Supplier of Wood- 8% of global forest area. Supplies 28% timber used for industrial products

Source: USDA. 2014. Forest Resources Facts and Trends
U.S. Largest Producer Sawnwood and Industrial Roundwood

Source: FAO. 2015.
Washington: Global Producer and a Good Place to Grow Trees

Second largest producer of sawtimber in US

Has highest percentage of forestland in the highest site index of any state in the Continental US

<table>
<thead>
<tr>
<th>State</th>
<th>2015</th>
<th>% of US Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oregon</td>
<td>5,222</td>
<td>17%</td>
</tr>
<tr>
<td>Washington</td>
<td>3,745</td>
<td>12%</td>
</tr>
<tr>
<td>Georgia</td>
<td>2,454</td>
<td>8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Selected States</th>
<th>Total Forest Area (1000 acres)</th>
<th>Productivity Class &gt;120’ (1000 acres)</th>
<th>% Forest Area in Highest Productivity Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington</td>
<td>22,174</td>
<td>8328</td>
<td>38%</td>
</tr>
<tr>
<td>Mississippi</td>
<td>19,380</td>
<td>6593</td>
<td>34%</td>
</tr>
<tr>
<td>Oregon</td>
<td>29,653</td>
<td>9266</td>
<td>31%</td>
</tr>
<tr>
<td>Louisiana</td>
<td>14,984</td>
<td>4664</td>
<td>31%</td>
</tr>
</tbody>
</table>

MMBF – Forest Economic Advisors 2014 (OFRI Forest Facts 2017-218)
Washington State a Good Place to Manufacture Forest Products

Low Emissions Relative to Other Parts of the County

Why? Very low GHG emissions intensity in electricity grid due to abundance of hydropower.
Forest Sector Carbon Cycle

**Atmosphere**

- **LAND**
  - Plant More Trees
  - Enhance C sink
  - Increase Carbon Density/Stocks in Existing Forests
  - Increase wood product Pool C storage
  - Reduce deforestation/degradation

**FOSSIL FUEL**

- Use biomass for energy, replacing fossil fuel
- Use wood products in construction and materials, avoiding fossil fuel emissions in manufacturing products with higher embodied emissions
- Reduce fossil fuel emissions

Adapted from FAO 2016. Forestry for a Low Carbon Future. Table 1 - key forest mitigation options
Harvested Wood Product Carbon Accounting

Annual Data Requirements
1. Harvest statistics
2. Product production
3. Product exports and imports

Coefficients
1. Factors to convert product units to carbon
2. Distribution of products to end uses
3. Use life of products in end uses
4. Portion of discarded wood to dumps vs SWDS vs burning
5. Portion of wood in permanent vs temporary storage in SWDS
6. Decay rates in dumps & SWDS

Figure 3. A schematic of calculations to quantify HWP storage and emissions. These calculations quantify HWP products in use, products in SWDS, emissions with energy capture, and emissions without energy capture using the IPCC/EPA approach.
## USFS statistics - Distribution of Primary Products to Their End-Uses (From Smith et al 2006)

<table>
<thead>
<tr>
<th></th>
<th>Half Life</th>
<th>Softwood lumber</th>
<th>Hardwood lumber</th>
<th>OSB</th>
<th>Plywood</th>
<th>Non-Structural Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Home</td>
<td>100 years (after 1980); 80 years (pre 1980)</td>
<td>33.2%</td>
<td>3.9%</td>
<td>57.8%</td>
<td>33.4%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Multi-family home</td>
<td>70</td>
<td>3.1%</td>
<td>0.4%</td>
<td>4.7%</td>
<td>3.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Commercial Buildings</td>
<td>67</td>
<td>7.9%</td>
<td>2.8%</td>
<td>7.1%</td>
<td>9.0%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Other Products</td>
<td>20</td>
<td>23.3%</td>
<td>24.3%</td>
<td>13.1%</td>
<td>17.1%</td>
<td>32.4%</td>
</tr>
<tr>
<td>Repair and Furniture</td>
<td>30</td>
<td>28%</td>
<td>32.2%</td>
<td>17.2%</td>
<td>33.9%</td>
<td>46.8%</td>
</tr>
<tr>
<td>Shipping</td>
<td>6</td>
<td>4.5%</td>
<td>36.4%</td>
<td>0.1%</td>
<td>3.3%</td>
<td>0.6%</td>
</tr>
</tbody>
</table>
Harvested Wood Products: Methodology

Source: USDA presentation “HWP in the U.S. National GHG Inventory: Methodology and Accounting”; Heath and others, 1996; Skog and Nicholson, 1998

Disposition of Carbon in Harvested Wood - U.S. Average

<table>
<thead>
<tr>
<th>Percent</th>
<th>Products</th>
<th>Landfills</th>
<th>Energy</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Years since harvest

Removals

Emissions

Legend:
- Green: Products
- Yellow: Landfills
- Blue: Energy
- Red: Emissions
# Two Ways to Report HWP Carbon

## EPA/IPCC Country Level Reporting

<table>
<thead>
<tr>
<th>Year After Production</th>
<th>Softwood Lumber</th>
<th>Hardwood Lumber</th>
<th>Plywood</th>
<th>OSB</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0.973</td>
<td>0.938</td>
<td>0.976</td>
<td>0.983</td>
<td>0.845</td>
</tr>
<tr>
<td>2</td>
<td>0.947</td>
<td>0.882</td>
<td>0.952</td>
<td>0.967</td>
<td>0.713</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.633</td>
<td>0.375</td>
<td>0.662</td>
<td>0.749</td>
<td>0.009</td>
</tr>
<tr>
<td>49</td>
<td>0.407</td>
<td>0.166</td>
<td>0.432</td>
<td>0.546</td>
<td>0.000</td>
</tr>
<tr>
<td>77</td>
<td>0.301</td>
<td>0.098</td>
<td>0.318</td>
<td>0.431</td>
<td>0.000</td>
</tr>
<tr>
<td>100</td>
<td>0.234</td>
<td>0.064</td>
<td>0.245</td>
<td>0.349</td>
<td>0.000</td>
</tr>
<tr>
<td>Ave</td>
<td>0.463</td>
<td>0.250</td>
<td>0.484</td>
<td>0.582</td>
<td>0.058</td>
</tr>
</tbody>
</table>

## Table

<table>
<thead>
<tr>
<th>Amount Placed in use</th>
<th>1900</th>
<th>1901</th>
<th>1902</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>10.2</td>
<td>9.2</td>
<td>9.1</td>
<td>9.0</td>
<td>...</td>
</tr>
<tr>
<td>1901</td>
<td>10.7</td>
<td>9.6</td>
<td>9.5</td>
<td>...</td>
<td>3.7</td>
</tr>
<tr>
<td>1902</td>
<td>11.2</td>
<td>...</td>
<td>10.1</td>
<td>9.5</td>
<td>3.9</td>
</tr>
<tr>
<td>x</td>
<td>...</td>
<td>x</td>
<td>x</td>
<td>24.4</td>
<td>24.2</td>
</tr>
<tr>
<td>2001</td>
<td>26.7</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>24.7</td>
</tr>
<tr>
<td>2002</td>
<td>27.3</td>
<td>...</td>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9.2</td>
<td>18.8</td>
<td>28.7</td>
<td>896.1</td>
<td>913.4</td>
</tr>
</tbody>
</table>

### Change in carbon

17.3

Source: USDA presentation “HWP in the U.S. National GHG Inventory: Methodology and Accounting”; Heath and others, 1996; Skog and Nicholson, 1998
Avoided Emissions - Comparing the embodied emissions associated with manufacturing a wood product versus an alternative product that provides the same function.

- Reduce fossil fuel emissions
- Use biomass for energy, replacing fossil fuel
- Use wood products in construction and materials, avoiding fossil fuel emissions in manufacturing products with higher embodied emissions
Avoided Emissions - Substitution

- Average 1 ton of wood avoids the addition of 2.1 tons of carbon (or 7.7 tons of CO2) to the atmosphere.

- The use of wood-based materials avoid emissions of 483 million tons CO2e annually, via substitution effects. (FAO, 2016)

- In Sweden, on average about 470 Kg carbon dioxide emissions are avoided for each cubic meter of biomass harvested. (Lundmark et al. 2014)
Washington State Forest Sector Carbon Cycle

ATMOSPHERE

Enhance C sink

Reduce emissions from forest

Increase wood product Pool C storage

Reduce deforestation/degradation

Use biomass for energy, replacing fossil fuel

Use wood products in construction and materials, avoiding fossil fuel emissions in manufacturing products with higher embodied emissions

LAND

FOSSIL FUEL

Plant More Trees

Increase Carbon Density/Stocks in Existing Forests

Increase wood product Pool C storage

Reduce deforestation/degradation

Reduce fossil fuel emissions

Adapted from FAO 2016. Forestry for a Low Carbon Future. Table 1 - key forest mitigation options
National Forest Land Volume Has Increased since Low Point in 1977. Other public lands higher than 1950, after drop in mid-1990s. Private land has remained roughly the same.
Long-term C storage from Harvested Wood Products

100 year average carbon storage in Products and Landfills from Private and State Lands in WA

- Private Yearly Ave 100 yr climate benefit
- Landfill 100 yr
- State Product 100 yr
- State Landfill 100 yr
Land-use Change in Washington State

Figure 7—Western Washington net change in area from resource classes (forest land, mixed forest/agriculture, or intensive agriculture) to developed classes (low-density residential or urban) from 1976 to 2006.

Carbon Implications of Land-Use Change

**Figure 1.** Estimates of tons of carbon stored per acre for urban forests of varying tree cover. Estimates are given for 4 different diameter distributions (Type 1-3 and Average - see Table 1).

<table>
<thead>
<tr>
<th>Acres Lost 1976-2006</th>
<th>Average Carbon Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest to Low Density</td>
<td>419,678</td>
</tr>
<tr>
<td>Forest to Urban</td>
<td>59,646</td>
</tr>
<tr>
<td>Forest to mixed forest/ag</td>
<td>6,935</td>
</tr>
<tr>
<td>Forest to intensive ag</td>
<td>1,761</td>
</tr>
<tr>
<td>Forest to other</td>
<td>5,074</td>
</tr>
<tr>
<td>Average</td>
<td>32 tC/acre</td>
</tr>
</tbody>
</table>

Average Carbon Storage for WA state Forestland = 55.4 C/acre. Washington’s Forest Resources, 2002-2006; Five Year Forest Inventory and Analysis Report. ONW-GTR-800 April 2010. Table 23
* Wildfire estimates highly variable depending on methodology. FIA data may under-estimate because re-measurements are 10 years apart (so there is growth)

WEIS uses input from satellite imagery to calculate burn area and fuel loading to get total emissions. No data after 2010. Model may over-estimate emissions.

Per acre calculations difficult to apply because acreage burn response highly variable.

Estimates range from ~.8 MT CO2e/yr to 4 MT CO2e/yr based on different approaches.

*Years 2000-2015 from MTBS Project.
Years 2016-2017 from NIFC
Carbon Implications of Forest Product Demand

Demand for wood influences production (less demand, less production, less harvest)

Demand for wood also influences supply (more harvest, more supply)

Figure 2.—New U.S. home construction and western states timber harvest and lumber production, 1959-2010.

Keegan et al 2012

US Forest Growth, Removals, Mortality and Inventory 1952-2012 (million cubic ft)

USFS 2014
## Putting it all together

<table>
<thead>
<tr>
<th>Carbon Stocks</th>
<th>Inputs/Outputs</th>
</tr>
</thead>
</table>
| **Private Land** | • Inventory (carbon stock) largely stable over last 70 years (increased in last 20)  
• Long-term carbon benefit of HWP in products averaged 1.6 MMT CO2e for each year over last 20 years (3.2 when include landfill carbon storage) | • Growth has increased  
• 447,000 forest acres lost to conversion over last 20 years. Average carbon loss = 2.6 MMT CO2e |
| **National Forest** | • Inventory (carbon stock) has increased since low point in 1977 (highest point in 2008)  
• HWP carbon benefit has decreased due to reduction in harvest. | • Mortality has increased  
• Wildfires have burned an average of 250,000 acres land/yr. Estimates of CO2e emissions vary wildly. |
| **State** | • Inventory stable (slightly higher than 1950)- had sharp drop in mid-1990s.  
• Long-term benefits of HWP in products average 0.36 MMT CO2e each year (0.7 when include landfill) over last 20 years, about 20% of private land production but still meaningful contributor. | |
Future Projections of US Forests

Main Take-Aways from RPA Assessment

Forest Inventory Volumes Expected to Peak between 2030 and 2040 and then will start to decline

Decline due to following drivers
- Decline in forest area due to development. (note- how much forest loss varies depending on population and GDP as well as value of forest land (i.e. forest product price). Projections vary between loss 16 million and 30 million acres forest nationwide
- Disturbances influenced by climate change (higher levels of tree mortality due to insect and drought; increase in the number and size of wildfires)
- Trees getting older

Markets will provide economic rationale for sustainable forests and good forestry practices
“Enhancing the flow of timber revenues helps to sustain forest management and provides an economic rationale for policies favoring sustainable forests and good forestry practices. If future technology development and wood demands provide enhanced timber revenues, then historic experience suggests that forests and forest management will thrive. If the value of timber declines, however, through low-value use, limited demand, or insufficient forest product technology development, the future sustainability of forests will be compromised.”
From 2010 RPA Assessment
Main Take-aways from Washington Forest Sector

- Washington is a great place to grow trees
- Washington is a great place to have forests
- Focus on keeping and improving healthy resilient forests
- Use wood products instead of more fossil intensive materials
- Sustainably produce wood products - be efficient at all levels
Any Questions?