Introduction to the Wood Carbon Seminars
Speaker Background

- Kate Simonen
  - Current position:
    - Associate Professor of Architecture, College of Built Environments, University of Washington
    - Department Chair, effective June 2020
    - Director, Carbon Leadership Forum
  - Credentials:
    - M.S. Structural Engineering, M.Arch Architecture
    - Licensed Architect, Structural Engineer, Civil Engineer
  - Key experiences
    - Author *Life Cycle Assessment: Pocket Handbook*
    - Over 15 years professional experience
    - Past ten years focused on integrating LCA and practice
Buildings and the Climate Crisis

Building’s Climate Impact

Global CO₂ Emission by Sector

- Industry: 30%
- Transportation: 22%
- Building Materials and Construction: 11%
- Building Operations: 28%
- Other: 9%


Total Building Material Impacts?

- Building Operations: 28%
- Non-Building Mfg: ~22% (32%–10%)
- Building Materials (core & shell): 11%
- Other Building Material Mfg: ~10%
- Other: 6%
- Transport: 23%

Adapted from 2019 Global Status Report, Global Alliance for Building and Construction (GABC) and Architecture 2030.

- The building and construction sector has a vital role to play in eliminating carbon, as it is responsible for at least 39% of global carbon emissions.
Operating and **Embodied** Carbon

**Embodied Carbon**
- Manufacture, transport and installation of construction materials

**Operational Carbon**
- Building Energy Consumption

Total Carbon = Embodied Carbon + Operational Carbon

\[ TC = EC + OC \]
Embodied Carbon Estimates

MATERIAL QUANTITY ESTIMATE

EMBODIED CARBON PER UNIT MATERIAL

BUILDING EMBODIED CARBON (EC) ESTIMATE
Busy, Busy Town and What Do People Do All Day? By Richard Scarry
Wood Carbon Seminars – Preliminary survey

- 82 respondents
Wood Carbon Seminars - Preliminary survey

- Total score by topic
Speaker Background

- **Cynthia West**
  - Current position:
    - Director, Office of Sustainability & Climate
    - U.S. Forest Service
    - Washington, DC…
  - Credentials:
    - B.S. Forest Management
    - MBA, Marketing & Management
    - PhD, Wood Science
    - Sustainability Profession Certification, CSE
  - Key experiences
    - Research Administration for 26 years
    - Forest Products Market & Economics Research for 10 years
    - Faculty for 12 years
    - Industrial Forestry for 5 years
    - Sustainability Professional for 5 years
Credits for content:

Duncan McKinley
Alexa Dugan
Aurora Cutler
Jessica Halofsky
How do we explain the role of forests and forest products in relation to GHG emissions?
U.S. Forests and Wood Products carbon sinks are equivalent to 12%–19% of Fossil-Fuel Emissions

From SOCCR Report: http://www.climatescience.gov

First, why are people interested?

Summary:
1. Concerned about carbon emissions and effects on climate
2. Interest in using management to sequester carbon (i.e. Mitigation) and reduce carbon loss where appropriate (i.e. Adaptation)

Further reading:

Understanding the relationship of forests, forest management & use, forest products is like an elephant....

Sometimes you make the wrong conclusions when you don’t look at the whole...
Challenges: Competing views

Differing perspectives on how to conceptualize the forest system is the greatest source of confusion and conflict!
How most people view the forest system...

Deforestation and forest management activities (harvests, thinning, prescribed fires) release carbon to the atmosphere.

Growing forests and tree planting (afforestation/reforestation) take up and store carbon from the atmosphere.
But, we know there is A LOT more to the story...
Forests are dynamic biological systems capable of regenerating unless there is a major interruption.
The Natural Boom & Bust Cycle of Forest Carbon

Carbon uptake & storage (growth)
Carbon release (fire)
Below-ground carbon storage (in roots & soil) is about 50% of forest carbon
Carbon uptake & storage (re-growth)
Carbon release (decomposition) & storage in dead trees
The closed loop of FOREST CARBON in the ATMOSPHERE

Wood products can store carbon and can substitute for emission-intensive products such as concrete & steel.

Growing forests remove carbon from the atmosphere.

Fires & decomposition following disturbance events release carbon into the atmosphere.

Bioenergy from forest biomass can substitute for fossil fuel energy.

Fossil fuel use is an OPEN SYSTEM where CO₂ remains in the atmosphere.
Carbon stocks in forests are always in flux due to variations in age, disturbance, and environmental factors. Detecting patterns and trends requires taking a broad view in both space and time.
The larger the landscape considered, the more accurate the representation of the forest and the more stable the carbon seems.
To look at the complete picture of forest carbon:

Look across an appropriate ecological time scale

Include a complete accounting of all carbon pools in the closed biogenic carbon cycle
The importance of keeping forests as forests

Carbon & Land Use Changes

Even if a forest is disturbed or harvested, carbon is exchanged in a CLOSED SYSTEM as long as it remains forest.

Conversion of forests to non-forest land uses is an OPEN SYSTEM where CO₂ remains in the atmosphere.
The United States lost 60% of its pre-European forest carbon stocks during settlement and into the industrial revolution.

About 40% of the carbon lost during the industrial revolution has been recovered via re-growth.

Wood-based 1915 Fossil fuel-based
Keeping Forests as Forests is the major concern with respect to carbon

- Carbon cycle does not close, effectively making the impact of biogenic emissions the same as fossil fuels
- Development, conversion to agricultural or other use. Important for U.S., not just tropics
  - 2000-2005 gross deforestation rate in U.S. was 600,000 ha/yr, but about 1,000,000 ha/yr of non-forested land reverted to forest during this same time.
  - Globally, deforestation releases 1,400-2,000 million tonnes of C per year
  - 156,000 million tonnes of C have been released globally due to land use change (1850-1998)
Loss of forest land is primary driver of forest carbon loss in the future

Projections of U.S. carbon stock changes, including transfers associated with land-use change

**Net sequestration**: forest carbon stock change minus land-use carbon transfers
What happens to carbon with no regeneration?
Main concern for NFS lands

Example: Hayman Fire, Colorado, 2002

Prefire: Total = 16 kg C m$^{-2}$

100 years postfire: Total = 8 kg C m$^{-2}$
Lost = 8 kg C m$^{-2}$
When we think of a renewable resource, the first thing that usually pops in our heads is the solar panels on our neighbor’s roof or perhaps the wind turbine that rises from the mountains. vanity does a share of human need in our idea of a renewable resource.

But the cycle of planting, growth, and harvesting makes a natural renewable resource and this is something we, at the USDA Forest Service, would love everyone to know. This is because while trees grow in the forest, they take carbon dioxide from the atmosphere in their trunks, branches, leaves, twigs, and soil.

So, when these trees are sustainably harvested, wood continues to store carbon in the thousands of products we can make (e.g., furniture, paper products) to burn in energy generation. Times they are a-changing regarding the
The story of “This Old House”
Thank You
Additional slides
Forestland Ownership:
Carbon in Harvested Wood Products

- Baseline report
- Regional scale
- Cut & sold reports
- Net increase in recent years – C sink
- Monte Carlo uncertainty
  - Model uncertainty
  - Commodity proportions
  - Product decay rates

Figure 5. R4
Manufacturing and the Forest Products Industry
Speaker Background

- Kent Wheiler
  - Associate Professor, University of Washington, School of Environmental and Forest Sciences
  - Director, Center for International Trade in Forest Products
    - Ph.D. in Marketing, University of Texas at Austin
    - 33 years forestry industry experience, including 26 years with Weyerhaeuser Company
    - Career focus has been predominantly market development and plantation operations
    - Lived and worked in Tokyo for six years, Shanghai four years, and Dubai one year
    - Managed timber and bamboo plantations in China, Indonesia, Ghana, South Africa and Nicaragua
“Peace is a natural effect of trade.”
—Charles de Montesquieu
We believe that using sustainably sourced wood is good for the environment and for humanity

The Center for International Trade in Forest Products.
Forest Certification

- Programme for the Endorsement of Forest Certification (PEFC)
  - Umbrella organization that endorses ~50 national forest certification systems developed through multi-stakeholder processes and tailored to local priorities and conditions.
  - For example, in the U.S. – The Sustainable Forestry Initiative (SFI)

- Forest Stewardship Council (FSC)
  - In the U.S., many small private forestland owners manage sustainably and are also strictly regulated, but do not certify their forests simply due to economic considerations.
PEFC CHAIN OF CUSTODY CERTIFICATION

CERTIFIED FOREST

CERTIFIED LOGS

CERTIFIED DISTRIBUTION

CERTIFIED MERCHANT

CERTIFIED SAWMILL

Wood Carbon Seminars, Kent Wheiler
Here’s How American Uses Its Land (Merrill and Leatherby 2018)

Volume of roundwood harvested, by region, 2016

Industry is Located Where the Trees Are

- Most wood products produced in the U.S. depend on private timber.

- Private timber owners manage their land on a variety of objectives, but those prioritizing industrial production prefer:
  - Climate conditions conducive to growth
  - Geography conducive to low cost harvesting
  - A variety of potential buyers within an economic haul distance

Wood Products Taxonomy

Logs

Saw
Lumber
- Softwood, Hardwood
- Green, Dry
- Rough, Surfaced
- Machine Stress Rated (MSR)

Peel/Slice
- Glulam
- Cross Laminated Timber
- Finger Jointed
- Edge Glued
- Pressure Treated
- Heat Treated

Veneer
- Plywood
- Laminated Veneer Lumber

Chip/ Flake/ Grind
- Pulp -- Paper, Packaging, Sanitary Products
- Oriented Strand Board
- Particleboard
- Medium Density Fiberboard (MDF)
- Hardboard
- Pellets
- Energy
- Etc.

Production Waste

For example:

Composites

I-Beams
Combination of a lumber or LVL flange with plywood or OSB web
Wood Products Taxonomy

Logs
- Saw
  - Lumber
- Peel/Slice
  - Veneer
- Chip/Flake/Grind
  - Production Waste
  - Production Waste

**Slicing**

![Slicing Diagram](http://www.metz-furniere.de/uberfurng.htm)

**Peeling**

![Peeling Diagram](http://www.metz-furniere.de/uberfurng.htm)

**Sawing**

![Sawing Diagram](https://cdn.newsapi.com.au)
Wood Products Taxonomy

- Logs
- Peel/Slice
- Veneer
- Production Waste
  - Plywood
  - Laminated Veneer Lumber

Veneer

Plywood

Laminated Veneer Lumber
Wood Products Taxonomy

- Logs
- Chip/Flake/Grind
- Waste
- Pulp -- Paper, Packaging, Sanitary Products
- Oriented Strand Board
- Particleboard
- Medium Density Fiberboard (MDF)
- Hardboard
- Pellets
- Energy
- Etc.

Oriented Strand Board (OSB)

Particleboard (low density fiberboard)

Medium Density Fiberboard (MDF)

Wood Pellets
Wood Products Taxonomy

Logs

Saw

Lumber

Softwood

Dry

Surfaced

Plywood

Composites

I-Beams

Combination of a lumber or LVL flange with plywood or OSB web
- The forest products industry is the largest producer and user of energy from biomass of any industrial sector.
- The creation and use of biomass energy in wood products mills is integral to the manufacture of lumber, wood panels and engineered wood products.
- Using forest and mill residuals for power reduces reliance on fossil fuels and the accompanying greenhouse gas emissions.

Wood Utilization

- Lumber processing yields have improved tremendously, from 35-39% in the 1940s to more than 52% today.
- Wood science technology has developed many innovative products to use sawmill and veneer mill waste; now accounting for 36% of the log.
- Waste that cannot be used as a raw material for other products is burned to provide heat for kilns and boilers, and electricity for operations.
- The entire log is utilized.

90.0% of U.S. softwood lumber imports are from Canada; amounting to 49.7% of Canada’s total production.

Another 7.4% of imports are from Europe, Chile, and New Zealand… countries with good forestry practices and a high proportion of certified, sustainable suppliers.

54% of U.S. softwood lumber production is in the South; 41% in the West.
U.S. Oriented Strand Board (OSB) and Softwood Plywood in 2018
Billion Square Feet 3/8”
Source: APA, The Engineered Wood Association

- U.S. softwood plywood imports:
  - Brazil: 34%
  - China: 30%
  - Chile: 20%
  - Canada: 14%
  - Other: 2%

- 82% of U.S. OSB and 62% of U.S. plywood production is in the South

- 99.2% of U.S. OSB imports are from Canada; amounting to 73.7% of Canada’s total production.
U.S. Softwood Lumber Consumption by End Use in 2018
Source: Western Wood Products Association

- Residential Construction: 32.6%
- Repair & Remodel: 38.8%
- Non-Residential Construction: 9.0%
- Industrial & Other: 19.6%

Half-Life for Products by End Use

<table>
<thead>
<tr>
<th>End Use or Product</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Single-Family Home</td>
<td>100</td>
</tr>
<tr>
<td>New Multi-Family Apartment Building</td>
<td>70</td>
</tr>
<tr>
<td>Residential Repair &amp; Remodel</td>
<td>30</td>
</tr>
<tr>
<td>Furniture</td>
<td>30</td>
</tr>
<tr>
<td>Paper</td>
<td>3</td>
</tr>
</tbody>
</table>

- The Southern Region accounts for half of U.S. housing starts.
- Ten years after the housing crash of 2007-2009, we are not yet back to the same level of construction.
- Canadian owned-capacity has recently migrated to the U.S. South.

**New Housing Starts by Region**

<table>
<thead>
<tr>
<th>Total Regional Starts*</th>
<th>Total NE</th>
<th>133,000</th>
<th>8.3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total MW</td>
<td>254,000</td>
<td>15.8%</td>
<td></td>
</tr>
<tr>
<td>Total S</td>
<td>810,000</td>
<td>50.4%</td>
<td></td>
</tr>
<tr>
<td>Total W</td>
<td>411,000</td>
<td>25.6%</td>
<td></td>
</tr>
</tbody>
</table>

SAAR; in thousands

NE = Northeast, MW = Midwest, S = South, W = West
US DOC does not report 2 to 4 multi-family starts directly, this is an estimation (Total starts – (SF + ≥ 5 MF starts)).

Thank you!
Slides for Discussion Session
Wood Carbon Seminars
Cynthia West
April 30, 2020
US Forests Net Carbon Flux Over Time

Southeastern plantation forests and biodiversity

Species Richness in US Forests

Acres of planted trees by county


Articles:
Loehle et al (2009) Achieving conservation goals in managed forests of the Southeastern Coastal Plain *Environmental Management*
Components of the Nation’s Forest Sink
EPA 2020 GHG Inventory (2018 data)

Total Net Sink = 752.9 MMTCO2e/yr
Land Use Conversion
Nation's Forest Sink
EPA 2020 GHG Inventory (2017 data)
Million metric tonnes CO2e/year

TO FOREST LAND USE

Carbon Sink

- Cropland
- Grassland
- Other lands
- Settlements
- Wetlands

Total Net Source = 16.7
MMTCO2e/yr

FROM FOREST LAND USE

Carbon Source

<table>
<thead>
<tr>
<th>Land Use</th>
<th>From Forests</th>
<th>To Forests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland</td>
<td>48.7</td>
<td>-46.3</td>
</tr>
<tr>
<td>Grassland</td>
<td>15.9</td>
<td>-9.7</td>
</tr>
<tr>
<td>Other lands</td>
<td>-14.9</td>
<td>-14.9</td>
</tr>
<tr>
<td>Settlements</td>
<td>62.9</td>
<td>-38.9</td>
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<tr>
<td>Wetlands</td>
<td>-0.9</td>
<td>-0.9</td>
</tr>
</tbody>
</table>

Source: USEPA 2017/FS data
Components of North Carolina’s Forest Sink
EPA 2020 GHG Inventory (2018 data)

Million metric tonnes CO2e/year

Total Net Sink = -43.23 MMTCO2e/yr

<table>
<thead>
<tr>
<th>Carbon Source</th>
<th>Carbon Sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodlands</td>
<td>Harvested Wood Products</td>
</tr>
<tr>
<td>Non-CO2</td>
<td>Urban Trees</td>
</tr>
<tr>
<td>Conversion From Forest</td>
<td>Conversion to Forest</td>
</tr>
<tr>
<td>Non-CO2 Woodlands</td>
<td>Forest Land</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>CO2e/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodlands</td>
<td>0</td>
</tr>
<tr>
<td>Non-CO2</td>
<td>0</td>
</tr>
<tr>
<td>Conversion From Forest</td>
<td>5.5</td>
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<tr>
<td>Conversion to Forest</td>
<td>-4.2</td>
</tr>
<tr>
<td>Urban Trees</td>
<td>-8.2</td>
</tr>
<tr>
<td>Harvested Wood Products</td>
<td>-5.93</td>
</tr>
<tr>
<td>Forest Land</td>
<td>-30.4</td>
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</table>

Source: USEPA 2017/FS data, EPA 2020 GHG Inventory (2018 data)
Land Use Conversion
North Carolina’s Forest Sink
EPA 2020 GHG Inventory (2017 data)

Million metric tonnes CO2e/year

Total Net Source = 1.3 MMTCO2e/yr

<table>
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<th>Component</th>
<th>From Forests</th>
<th>Other lands</th>
<th>Settlements</th>
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<tr>
<td>Cropland</td>
<td>2.5</td>
<td>0</td>
<td>1.3</td>
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<tr>
<td>Other lands</td>
<td>-1.7</td>
<td>-0.2</td>
<td>-2.2</td>
</tr>
<tr>
<td>Settlements</td>
<td>1.3</td>
<td>-2.2</td>
<td>1.3</td>
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</table>

From Forests

TO FOREST LAND USE

Carbon Sink

From Forest Land Use

Million metric tonnes CO2e/year

Cropland

Other lands

Settlements

Carbon Source

North Carolina’s Forest Sink

Million metric tonnes CO2e/year

Cropland

Other lands

Settlements

Table:

<table>
<thead>
<tr>
<th>Component</th>
<th>From Forests</th>
<th>Other lands</th>
<th>Settlements</th>
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<tr>
<td>Cropland</td>
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<td>1.3</td>
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<tr>
<td>Other lands</td>
<td>-1.7</td>
<td>-0.2</td>
<td>-2.2</td>
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<tr>
<td>Settlements</td>
<td>1.3</td>
<td>-2.2</td>
<td>1.3</td>
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</table>
Disturbances in regional context: management dominated

Effect of Different Disturbances, 1990-2011, on Carbon Storage in the Southern Region

- Fire: 24%
- Harvest: 67%
- Insect: 5%
- Wind: 4%

Healey et al. in review

14 National forests

(5a)

- Abiotic
- Insects
- Harvest
- Fire

Percentage of forest disturbed

Year

1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011
Components of Montana’s Forest Sink
EPA 2020 GHG Inventory (2018 data)

Total Net Source = 12.17 MMTCO2e/yr

- Forest Land
- Harvested Wood Products
- Urban Trees
- Conversion From Forest
- Conversion to Forest
- Non-CO2
- Woodlands

EPA 2020 GHG Inventory (2018 data)

<table>
<thead>
<tr>
<th>Component</th>
<th>Emissions</th>
<th>Woodlands</th>
<th>Non-CO2</th>
<th>Conversion From Forest</th>
<th>Conversion to Forest</th>
<th>Urban Trees</th>
<th>Harvested Wood Products</th>
<th>Forest Land</th>
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<td>0</td>
<td>3.9</td>
<td>0.2</td>
<td>-1.7</td>
<td>-0.1</td>
<td>-0.63</td>
<td>10.5</td>
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</table>
Total Net Sink = -1.5 MMTCO2e/yr

Montana’s Forest Sink

EPA 2020 GHG Inventory (2017 data)

Million metric tonnes CO2e/year

Carbon Source

Carbon Sink

Land Use Conversion

<table>
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<th>Carbon Source</th>
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<td>Other lands From Forests</td>
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<td>Cropland To Forests</td>
<td>Settlements To Forests</td>
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Components of **Colorado’s Forest Sink**

EPA 2020 GHG Inventory (2018 data)

Total Net Source = 10.39 MMTCO2e/yr

<table>
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<th>Carbon Source</th>
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<td>Woodlands</td>
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<td>Non-CO2</td>
<td>Harvested Wood Products</td>
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<td>Conversion From Forest</td>
<td>Conversion to Forest</td>
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<td>Urban Trees</td>
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<table>
<thead>
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<th>Component</th>
<th>Emissions (MMTCO2e/yr)</th>
</tr>
</thead>
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<tr>
<td>Woodlands</td>
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</tr>
<tr>
<td>Non-CO2</td>
<td>0.1</td>
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<td>Conversion From Forest</td>
<td>0.6</td>
</tr>
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<td>Conversion to Forest</td>
<td>-1</td>
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<td>Urban Trees</td>
<td>-0.4</td>
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<tr>
<td>Harvested Wood Products</td>
<td>-0.61</td>
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<tr>
<td>Forest Land</td>
<td>11.1</td>
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</table>
Land Use Conversion

**Colorado’s Forest Sink**

EPA 2020 GHG Inventory (2017 data)

Million metric tonnes CO2e/year

**Total Net Sink = -0.45 MMTCO2e/yr**

<table>
<thead>
<tr>
<th></th>
<th>Cropland</th>
<th>Grassland</th>
<th>Other lands</th>
<th>Settlements</th>
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</thead>
<tbody>
<tr>
<td><strong>From Forests</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>To Forests</strong></td>
<td>0</td>
<td>-0.4</td>
<td>-0.6</td>
<td>0</td>
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</table>
Disturbances in regional context: natural disturbance dominated

Effect of Different Disturbances, 1990-2011, on Carbon Storage in the Intermountain Region

12 National forests

Healey et al. in review

Graph showing percentage of forest disturbed by Abiotic, Insects, Harvest, and Fire from 1991 to 2011.
Narrow view of the forest system

Concerned with emissions on shorter time scales and limited geographical extent

Source/sink trends main way to view impacts of management activates

Considers narrower range of activities that influence carbon positively

E.g., timber harvesting would have an immediate negative impact.
Concerned with emissions on longer time scales and broader geographical extent
- Impacts of management activates are considered more holistically – closer to what the atmosphere actually “sees.”
- Considers broader range of activities that influence carbon positively

E.g., timber harvesting would have a positive impact right away.

McKinley et al. 2011
Carbon neutrality and its connection to the substitution effects of forest products

(5/21/2020 version)

Reid Miner, Retired NCASI

Some of the following material was developed by the author while an employee of NCASI. The material is used here with the permission of NCASI.
Carbon neutrality of forest products

• “Carbon neutrality” implies net zero emissions of biogenic carbon from the product system
• No agreement on the definition or calculations (as you will see)
• Best to avoid the term and refer instead to the net emissions of biogenic carbon
• Carbon neutrality does not consider substitution effects and is focused only on biogenic emissions (e.g., CO$_2$ from biomass)
We will describe 4 general approaches to the calculations: These are not comprehensive but are intended to capture some of the key elements of the debate about how to characterize biogenic carbon fluxes

- Approach 1: CO₂ is removed from the atmosphere before harvesting while the tree is growing
- Approach 2: CO₂ is removed from the atmosphere after harvest by the trees that replace the tree that was harvested
- Approach 3: CO₂ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the landscape
- Approach 4: Any of the previous approaches adjusted to account for foregone sequestration
Emissions of biogenic C = net flow across system boundaries
Approach 1: CO$_2$ is removed from atmosphere by the growing tree before it is harvested

Start accounting when tree starts to grow

Note: If all carbon in the tree is returned to the atmosphere, emissions of biogenic CO$_2$ = zero (neutral?)
Approach 1: CO$_2$ is removed from atmosphere by the growing tree before it is harvested

Start accounting when tree starts to grow

Approach 1 is a common LCA method: System boundary is consistent with cradle to grave (life cycle) assessment
Approach 1: CO$_2$ is removed from atmosphere by the growing tree before it is harvested

Start accounting when tree starts to grow

Note: With this approach wood obtained via deforestation can be determined to be “neutral”. Constraints can be placed on the use of Approach 1 to help prevent this.
Approach 2: CO₂ is removed from atmosphere by a growing tree that replaces the tree that was harvested.

Note: If the new tree grows to same size as harvested tree, biogenic CO₂ = zero (neutral?)
Approach 2: CO₂ is removed from atmosphere by a growing tree that replaces the tree that was harvested.

Bio-C

Harvest → Product Manufacture → Product Use → Product End-of-Life

New tree grows

C from Atmosphere

Start accounting at harvest

Note: Biogenic CO₂ emissions depend on time selected, growth rate of new tree, etc.
Approach 2: CO$_2$ is removed from atmosphere by a growing tree that replaces the tree that was harvested.

Also Note: System boundaries include a new tree that is not connected by flows of material or energy to our product.
Approach 2: CO$_2$ is removed from atmosphere by a growing tree that replaces the tree that was harvested.

On the other hand, this approach directly captures the impacts of deforestation.
Approach 3: CO$_2$ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.
Approach 3: CO₂ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.

Note: If carbon from atmosphere across the supply area = Bio-C emissions, then emissions of biogenic C = zero.
Approach 3: CO$_2$ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.

Also Note: If carbon stocks in the supply area are stable, emissions of biogenic C = zero.
Approach 3: CO$_2$ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.

In addition: If deforestation occurs in the supply area, this approach captures the effect because carbon stocks go down.
Approach 3: CO$_2$ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.
Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3

Approach 3

System Boundary

Ongoing Net C removals from atmosphere over period of interest

Ongoing biogenic C emissions to the atmosphere over period of interest

Entire long-term supply area → Ongoing Harvest → Ongoing Product Manufacture → Ongoing Product Use → Ongoing End-of-Life
Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3.

Approach 3

System Boundary

Ongoing Net C removals from atmosphere over period of interest

Entire long-term supply area

Ongoing Harvest

Ongoing Product Manufacture

Ongoing Product Use

Ongoing End-of-Life

Ongoing biogenic C emissions to the atmosphere over period of interest

Alternative Scenario

Entire long-term supply area without ongoing harvest
Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3.
Ongoing Net C removals from atmosphere over period of interest

Entire long-term supply area

Ongoing Harvest

Ongoing Product Manufacture

Ongoing Product Use

Ongoing End-of-Life

Ongoing biogenic C emissions to the atmosphere over period of interest

To be accurate, one should model the alternative scenario supply area to account for differences in natural disturbances and landowner responses, including potential loss of forest land and impacts of changed management.
Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3

Difference between these scenarios represents the biogenic C consequence of substituting the wood-based product

Ongoing Net C removals from atmosphere over period of interest

Entire long-term supply area

Ongoing Harvest

Ongoing Product Manufacture

Ongoing Product Use

Ongoing End-of-Life

Ongoing biogenic C emissions to the atmosphere over period of interest

This introduces considerable uncertainties and the results are heavily dependent on assumptions. This also clearly introduces processes and carbon that are outside of our system boundaries and not connected by flows of mass or energy to our product.
So the answer to the question is…… it depends

- The traditional LCA approach (Approach 1) results in biogenic carbon being “neutral” in most circumstances
  - but can miss deforestation unless constraints are added
- The landscape or supply area approach (Approach 3) is best aligned with wood procurement practices
  - Where supply area carbon stocks are stable over time, biogenic carbon is “neutral”.
  - It includes the effects of deforestation, although the impact depends on the scale used to define the supply area
  - It may be difficult to isolate the C uptake due to our product
- Other approaches are highly dependent on assumptions
  - They can yield useful insights for some circumstances but should be used with a clear understanding of the limitations
  - Often include hypothetical alternative scenarios
And never forget landowner response

- Common assumption: The only response of landowners to increased demand is increased harvesting
  - and there is a perception that this causes deforestation
- But the empirical evidence and modeling studies of the U.S. indicate that demand for wood...
  - **Increases** forested area
  - Encourages more productive forest management

---

For forest areas, we identified the rise in timber net returns as the most important factor driving the increase in forest areas between 1982 and 1997. (Lubowski, et al. 2008)*

“...forest land [area] responds positively to increases in pine stumpage prices and negatively to increases in timber production costs. (Hardie, et al. 2000 **)

**Responsiveness of Rural and Urban Land Uses to Land Rent Determinants in the U.S. South, Land Economics
Landowner response and carbon

• Landowner responses have important carbon implications

• In general, increased demand for sustainably produced wood leads to lower forest carbon stocks in the short term with stocks recovering in the longer term
  • This recovery may take stocks to higher levels than existed before demand increased
  • The recovery trajectory varies by location and market

“In all cases [for the US South], … higher prices yield somewhat higher levels of carbon stored in forests when compared to the low-price futures.” (US Forest Service, Wear et al. 2013. Forecasts of Forest Conditions in U.S. Regions Under Future Scenarios)
Landowner Response: One Example

Results for pine non-sawtimber from one study of increased demand for pellets*

Other examples will look different depending on the specifics.

Substitution effects vs. carbon neutrality

- Substitution effects include much more than an analysis of biogenic GHG emissions
- A bio-based fuel or product can have significant substitution benefits even if the life cycle emissions of biogenic carbon from the bio-based product system are greater than zero (i.e., not “neutral”)

Substitution effects vary depending on the products being considered.
Thank you
How LCA Handles Wood

James Salazar
Coldstream Consulting

May 7, 2020
Outline of Presentation

- LCA and EPD Methodology for Biogenic Carbon
- Biogenic Carbon in LCA and EPDs
LCA and EPD Methodology for Biogenic Carbon
Life Cycle of a Construction Product

Emissions to Air, Land, and Water

Primary Resources
LCA Calculation

Activity Data

<table>
<thead>
<tr>
<th>LCI Data</th>
<th>Characterization Factors</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 kg CO₂</td>
<td>*1 = 100 kg CO₂eq</td>
<td></td>
</tr>
<tr>
<td>1 kg CH₄</td>
<td>*25 = 25 kg CO₂eq</td>
<td></td>
</tr>
<tr>
<td>0.1 kg N₂O</td>
<td>*298 = 29.8 kg CO₂eq</td>
<td></td>
</tr>
</tbody>
</table>

Total Global Warming Potential is 154.8 kg CO₂eq
LCA Results

- Global warming
- Acidification
- Eutrophication
- Ozone depletion
- Smog
- Fossil fuel consumption
EPD Process

Perform LCA based on PCR  
Compile LCA in EPD Format  
Verification by EPD Program  
Registration and Publication
Standards Governing Wood Product EPDs

ISO standards
- ISO 14040
- ISO 14044
- ISO 21930

Regional Data Development for Forest Resources and Wood Manufacturing processes

LCI

LCIA
Impact Assessment based on TRACI Criteria for all impacts required under the PCR and EPD (US EPA)

LCA
Summarization and Integration of LCIA data consistent with ISO, PCR and EPD requirements

PCR
North American Wood PCR (ULE 2019)

EPD
Synthesis and aggregation of national product data e.g. North American Softwood Lumber EPD (2013, 2020)

Wood Carbon Seminars, James Salazar
8
Biogenic Carbon Accounting in Wood EPDs
ISO 21930: Section 7.2.7

- Biogenic C enters system: Global warming factor -1 kg CO2e/kg CO2
  - Virgin wood
  - Recycled wood
  - Biofuel

- Biogenic C leaves system: Global warming factor +1 kg CO2e/kg CO2
  - Combustion emissions
  - Sold biofuel
  - Sold coproducts

-1 kg CO2e/kg CO2 only when “wood originates from sustainably managed forests”
“Sustainably Managed Forests” for Biogenic C
ISO 21930: Section 7.2.11

- Option 1: Certified Wood Products
  - Canadian Standards Association - CSA
  - Forest Stewardship Council - FSC
  - Sustainable Forestry Initiative - SFI

- Option 2: National Reporting per UNFCC
  - United Nations Framework Convention on Climate Change - National Inventory Reports
  - Stable or Increasing Forest Stocks
"Sustainably Managed Forests" for Biogenic C
ISO 21930: Section 7.2.11

- Option 1: Certified Wood Products
  - Canadian Standards Association - CSA
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  - Sustainable Forestry Initiative - SFI

- Option 2: National Reporting per UNFCC
  - United Nations Framework Convention on Climate Change - National Inventory Reports
  - Stable or Increasing Forest Stocks
### Table 6-1: Net CO₂ Flux from Land Use, Land-Use Change, and Forestry (MMT CO₂ Eq.)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Forest Land Remaining Forest Land</td>
<td>(733.9)</td>
<td>(678.6)</td>
<td>(618.8)</td>
<td>(676.1)</td>
<td>(657.9)</td>
<td>(647.7)</td>
<td>(663.2)</td>
</tr>
<tr>
<td>Changes in Forest Carbon Stocks&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(733.9)</td>
<td>(678.6)</td>
<td>(618.8)</td>
<td>(676.1)</td>
<td>(657.9)</td>
<td>(647.7)</td>
<td>(663.2)</td>
</tr>
<tr>
<td>Land Converted to Forest Land</td>
<td>(109.4)</td>
<td>(110.2)</td>
<td>(110.5)</td>
<td>(110.6)</td>
<td>(110.6)</td>
<td>(110.6)</td>
<td>(110.6)</td>
</tr>
<tr>
<td>Changes in Forest Carbon Stocks&lt;sup&gt;b&lt;/sup&gt;</td>
<td>(109.4)</td>
<td>(110.2)</td>
<td>(110.5)</td>
<td>(110.6)</td>
<td>(110.6)</td>
<td>(110.6)</td>
<td>(110.6)</td>
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<tr>
<td>Cropland Remaining Cropland</td>
<td>(23.2)</td>
<td>(29.0)</td>
<td>(12.2)</td>
<td>(12.8)</td>
<td>(22.7)</td>
<td>(22.3)</td>
<td>(16.6)</td>
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<tr>
<td>Changes in Mineral and Organic Soil Carbon Stocks</td>
<td>(23.2)</td>
<td>(29.0)</td>
<td>(12.2)</td>
<td>(12.8)</td>
<td>(22.7)</td>
<td>(22.3)</td>
<td>(16.6)</td>
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<tr>
<td>LULUCF Carbon Stock Change</td>
<td>(860.7)</td>
<td>(831.0)</td>
<td>(739.6)</td>
<td>(802.9)</td>
<td>(801.7)</td>
<td>(790.0)</td>
<td>(799.6)</td>
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</tbody>
</table>
## Table 6-1 LULUCF Sector Net GHG Flux Estimates, Selected Years

<table>
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<th></th>
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<tbody>
<tr>
<td><strong>Land Use, Land-Use Change and Forestry TOTAL</strong></td>
<td>-60 000</td>
<td>-13 000</td>
<td>-25 000</td>
<td>-25 000</td>
<td>-18 000</td>
<td>-19 000</td>
<td>-16 000</td>
<td>-13 000</td>
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<tr>
<td>a. <strong>Forest Land</strong></td>
<td>-200 000</td>
<td>-150 000</td>
<td>-150 000</td>
<td>-150 000</td>
<td>-140 000</td>
<td>-140 000</td>
<td>-140 000</td>
<td>-140 000</td>
</tr>
<tr>
<td>Forest Land remaining Forest Land</td>
<td>-200 000</td>
<td>-140 000</td>
<td>-150 000</td>
<td>-150 000</td>
<td>-140 000</td>
<td>-140 000</td>
<td>-140 000</td>
<td>-140 000</td>
</tr>
<tr>
<td>Land converted to Forest Land</td>
<td>-1 100</td>
<td>-950</td>
<td>-590</td>
<td>-540</td>
<td>-500</td>
<td>-440</td>
<td>-390</td>
<td>-330</td>
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<tr>
<td>b. <strong>Cropland</strong></td>
<td>8 100</td>
<td>-11 000</td>
<td>-10 000</td>
<td>-9 500</td>
<td>-8 600</td>
<td>-7 700</td>
<td>-6 800</td>
<td>-6 200</td>
</tr>
<tr>
<td>Cropland remaining Cropland</td>
<td>-1 300</td>
<td>-15 000</td>
<td>-13 000</td>
<td>-12 000</td>
<td>-11 000</td>
<td>-10 000</td>
<td>-9 700</td>
<td>-8 800</td>
</tr>
<tr>
<td>Land converted to Cropland</td>
<td>9 500</td>
<td>3 900</td>
<td>2 700</td>
<td>2 800</td>
<td>2 700</td>
<td>2 800</td>
<td>2 900</td>
<td>2 700</td>
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<tr>
<td>c. <strong>Grassland</strong></td>
<td>0.6</td>
<td>0.9</td>
<td>1.9</td>
<td>0.8</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Grassland remaining Grassland</td>
<td>0.6</td>
<td>0.9</td>
<td>1.9</td>
<td>0.8</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Land converted to Grassland</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>d. <strong>Wetlands</strong></td>
<td>5 300</td>
<td>3 100</td>
<td>3 100</td>
<td>3 100</td>
<td>2 900</td>
<td>2 900</td>
<td>3 000</td>
<td>2 600</td>
</tr>
<tr>
<td>Wetlands remaining Wetlands</td>
<td>1 500</td>
<td>2 600</td>
<td>2 400</td>
<td>2 400</td>
<td>2 500</td>
<td>2 600</td>
<td>2 600</td>
<td>2 400</td>
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<tr>
<td>Land converted to Wetlands</td>
<td>3 800</td>
<td>480</td>
<td>670</td>
<td>710</td>
<td>410</td>
<td>330</td>
<td>350</td>
<td>210</td>
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<tr>
<td>e. <strong>Settlements</strong></td>
<td>2 100</td>
<td>2 100</td>
<td>2 300</td>
<td>2 300</td>
<td>2 200</td>
<td>2 100</td>
<td>1 900</td>
<td>1 800</td>
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<tr>
<td>Settlements remaining Settlements</td>
<td>-3 900</td>
<td>-4 100</td>
<td>-4 100</td>
<td>-4 100</td>
<td>-4 100</td>
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<td>6 400</td>
<td>6 400</td>
<td>6 200</td>
<td>6 000</td>
<td>5 900</td>
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<tr>
<td>f. <strong>Other Land</strong></td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
<td>NE, NO</td>
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<tr>
<td>g. <strong>Harvested Wood Products</strong></td>
<td>130 000</td>
<td>140 000</td>
<td>130 000</td>
<td>130 000</td>
<td>130 000</td>
<td>130 000</td>
<td>130 000</td>
<td>130 000</td>
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<tr>
<td>Forest Conversion</td>
<td>21 000</td>
<td>16 000</td>
<td>15 000</td>
<td>15 000</td>
<td>15 000</td>
<td>15 000</td>
<td>14 000</td>
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<tr>
<td>Indirect CO₂</td>
<td>790</td>
<td>820</td>
<td>630</td>
<td>560</td>
<td>570</td>
<td>530</td>
<td>510</td>
<td>490</td>
</tr>
<tr>
<td>Natural Disturbances</td>
<td>-22 000</td>
<td>46 000</td>
<td>43 000</td>
<td>160 000</td>
<td>240 000</td>
<td>120 000</td>
<td>220 000</td>
<td>250 000</td>
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</tbody>
</table>
Approach 3: CO$_2$ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area.
Biogenic Carbon Accounting per ISO 21930

Biogenic Carbon Emissions

- A1: biomass combustion and sold coproducts
- A3: product losses
- A5: of replaced products
- B1-B5: recycled biomaterials
- C3: landfill and combusted biomaterials
- C4: substituted biomaterials
- D: substituted biomaterials

Biogenic Carbon Removals

- A1: bio-based packaging
- A3: product losses
- A5: of replaced products

Wood Carbon Seminars, James Salazar
Biogenic Carbon in LCA & EPD
Cradle-to-Gate Biogenic Carbon Accounting
Cradle-to-Gate Wood Product System

System Boundary

A1 Extraction and upstream production
- Cradle to gate log production

A2 Transport to facility
- Log delivery to facility

A3 Manufacturing
- Sawmilling
- Drying
- Planing
- Packaging

Resource Inputs
( Energy, Water, Materials, etc.)

Emissions to air, water, and soil
Cradle-to-Gate Biogenic Carbon Accounting

**Biogenic Carbon Emissions**
- Biomass combustion and sold coproducts
- A3 of product losses
- A3 of replaced products
- Recycled biomaterials
- Landfilled and combusted biomaterials

**Biogenic Carbon Removals**
- Biogenic C enters product system
- Bio-based packaging
- A1 of product losses
- A1 of replaced products
- Substituted biomaterials

**Processes**
- Raw Material Production
- Product Manufacture
- Construction
- Building Use
- Waste Processing
- Waste Disposal
- Benefits Outside Building

Wood Carbon Seminars, James Salazar
Cradle-to-Gate Biogenic Carbon Accounting

**Biogenic Carbon Emissions**
- A3 of product losses
- A3 of replaced products
- Recycled biomaterials
- Landfilled and combusted biomaterials

**Biogenic Carbon Removals**
- A1 of product losses
- A1 of replaced products

**Raw Material Production**
- Biomass combustion and sold coproducts
- Biogenic centers product system

**Product Manufacture**
- Bio-based packaging

**Construction**

**Building Use**

**Waste Processing**

**Waste Disposal**

**Benefits Outside Building**
- Substituted biomaterials
Cradle-to-Gate Biogenic Carbon Accounting

Biogenic Carbon Emissions
- Biomass combustion and sold coproducts
- A3 of product losses
- A3 of replaced products
- Recycled biomaterials
- Landfilled and combusted biomaterials

Biogenic Carbon Removals
- Biogenic C enters product system
- Bio-based packaging
- A1 of product losses
- A1 of replaced products

Cradle-to-Gate Biogenic Carbon Accounting

- Coproducts: 1025 kg + Combustion: 185 kg
- Biogenic Carbon Emissions:
  - A3 of product losses
  - A3 of replaced products
- Primary Product: 843 kg

- Raw Material Production
- Product Manufacture
- A5
- B1-B5
- Waste Processing
- Waste Disposal
- D

- Logs: 2052 kg
- Biogenic Carbon Removals

(substituted biomaterials)
# Cradle-to-Gate Biogenic Carbon Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Total</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A5</th>
<th>C3/C4</th>
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<tbody>
<tr>
<td>Biogenic Carbon Removal from Product</td>
<td>(2,052.87)</td>
<td>(2,052.87)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Biogenic Carbon Emission from Product</td>
<td>1,868.67</td>
<td>0.00</td>
<td>0.00</td>
<td>1,025.02</td>
<td>0.00</td>
<td>843.66</td>
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<tr>
<td>Biogenic Carbon Removal from Packaging</td>
<td>1.35</td>
<td>0.00</td>
<td>0.00</td>
<td>1.35</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Biogenic Carbon Emission from Packaging</td>
<td>0.75</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.75</td>
<td>0.00</td>
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<tr>
<td>Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production</td>
<td>184.80</td>
<td>0.00</td>
<td>0.00</td>
<td>184.80</td>
<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

Zero Net Biogenic Carbon Sequestration in Cradle-to-Gate LCA
A Deeper Dive into Wood Product LCA Forest Resource Accounting

CLF Wood Seminar Series
May 7, 2020
by
Elaine O’Neil, PhD
Director of Science and Sustainability, CORRIM

Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products
Well Established International Framework and Hierarchy

Regional Data Development

Regional Data Development for Forest Resources and Wood Manufacturing processes

ISO standards

Summarization and Integration of LCI and LCIA consistent with ISO, PCR and EPD requirements

ISO 14040
ISO 14044
ISO 21930

PCR

North American Wood PCR (ULE 2019)

Synthesis and aggregation of national product data e.g. North American Softwood Lumber EPD (2013, 2020)

LCI

Impact Assessment based on TRACI Criteria for all impacts required under the PCR and EPD (US EPA)

LCIA

LCA

EPD

Consortium for Research on Renewable Industrial Materials

A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products
Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products

Stand Level Carbon Sequestration
PNW Commercial Softwoods

Years since forest establishment

Carbon in t/ha

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

PNW Commercial Softwood Management
Scale Matters

Graphic representation of the spatial and temporal dynamics of C storage for a typical PNW forest managed on 45-year rotations presented as: the growth and harvest cycles of one forest stand (in turquoise), an average per ha for 10 forest stands harvested in sequential intervals (in teal), and an average for 100 stands harvested sustainably as part of a “normal” forest (in brown). Adapted from McKinley et al. 2011 and Janowiak et al. 2017.

Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products
Major wood producing regions

bark beetles and fire – mostly National Forests driving the trend

Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products.
• 60 year old PNW Douglas-fir ready for harvest

• This is the result of intensive forest management that happens to be SFI certified, under a spotted owl management plan, and still part of the company’s active harvesting program.
Consortium for Research on Renewable Industrial Materials

A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products
Forest Growth with Management

Forest Growth without Management

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Stand Level Carbon Sequestration
Natural Regeneration vs Managed Forests

PNW Commercial Softwood Management
PNW No Management/Natural Regen

Management Matters
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SE region productivity increase
Silvicultural developments over 8 decades that have led to increased pine plantation productivity, heightened C uptake and storage, and shortened time to harvest in the US SE. Adapted from Fox et al. 2004.
SE Region Forest Carbon Stocks and Cumulative Harvest

Image courtesy of Reid Miner, NCASI, 2014

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Management Matters

Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products

## EPD “Nutritional” Label
### Wood Product

<table>
<thead>
<tr>
<th>LCA Impact Assessment</th>
<th>Total</th>
<th>Forestry Operations</th>
<th>Wood Product Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>143</td>
<td>11</td>
<td>132</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>1.60</td>
<td>0.15</td>
<td>1.45</td>
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<tr>
<td>Eutrophication</td>
<td>0.06</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Smog</td>
<td>25</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Total Energy</td>
<td>7,425</td>
<td>165</td>
<td>7,260</td>
</tr>
<tr>
<td>Non-Renewable Resources</td>
<td>6</td>
<td>0.01</td>
<td>6</td>
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<tr>
<td>Renewable Resources</td>
<td>640</td>
<td>0.00</td>
<td>640</td>
</tr>
<tr>
<td>Water Use</td>
<td>1,061</td>
<td>11</td>
<td>1,050</td>
</tr>
</tbody>
</table>

Ingredients: Carbon

Puettmann et al 2018

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<table>
<thead>
<tr>
<th></th>
<th>Reference Unit</th>
<th>Herbicide Treatment only</th>
<th>Herbicide plus Pile and Burn Treatment</th>
<th>*Broadcast Burn Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard TRACI methodology for the treatment of biogenic carbon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Emissions</td>
<td>kg CO₂ eq/m³</td>
<td>10.74</td>
<td>18.14</td>
<td>23.16</td>
</tr>
<tr>
<td>co₂ sequestered per m³ log</td>
<td>kg CO₂ eq/m³</td>
<td>960.37</td>
<td>960.37</td>
<td>960.37</td>
</tr>
<tr>
<td>Net sequestration</td>
<td>kg CO₂ eq/m³</td>
<td>-949.63</td>
<td>-942.23</td>
<td>-937.21</td>
</tr>
</tbody>
</table>

| **Modified TRACI methodology that includes biogenic carbon emissions** |                |                          |                                        |                           |
| Production Emissions | kg CO₂ eq/m³   | 10.74                    | 141.31                                 | 315.83                    |
| co₂ sequestered per m³ log plus residues | kg CO₂ eq/m³ | 1615                     | 1615                                   | 1615                      |
| Net sequestration    | kg CO₂ eq/m³   | -1604.25                 | -1473.69                               | -1299.17                  |

Thank You

For More Information

www.corrim.org

Elaine Oneil, PhD
Director of Science and Sustainability
elaine@corrim.org

Consortium for Research on Renewable Industrial Materials
A non-profit corporation formed by 20 research institutions to conduct cradle to grave environmental studies of wood products
Certification and Chain-of-Custody

Forest Carbon and Climate Program
Department of Forestry
MICHIGAN STATE UNIVERSITY
Speaker Background

- Lauren Cooper
  - Current position:
    - MSU Forest Carbon and Climate Program, Director
  - Credentials:
    - PhD in progress in Forestry, Human Dimensions, and Carbon
    - MS. Natural Resource Policy and Planning (UMich)
    - M. of Urban Planning, Sustainable
  - Key experiences
    - Steering committee member Forest-Climate Working Group
    - Consulting with NOAA, the World Bank, Trees for the Future
    - International work in Latin America
Presentation Outline

Introducing Certification
Forest Management Certification
Fiber sourcing and Chain of Custody
Certification: Alignment with Climate Change
Introducing Certification

Certified sustainable forestry and forest products
A Spectrum of Forest Benefits

**Timber Products**
- Selection Cutting
  - Relatively high biodiversity
  - Medium carbon storage on land
  - Medium but consistent carbon sequestration rates
  - Full range of ecosystem services
  - Mix of timber and non-timber forest products

**Sequestration**
- Selection Cutting
  - Relatively high biodiversity
  - Medium carbon storage on land
  - Medium but consistent carbon sequestration rates
  - Full range of ecosystem services
  - Mix of timber and non-timber forest products

**Non-timber + Recreational Uses**
- Selection Cutting
  - Relatively high biodiversity
  - Medium carbon storage on land
  - Medium but consistent carbon sequestration rates
  - Full range of ecosystem services
  - Mix of timber and non-timber forest products

**Biodiversity**
- Selection Cutting
  - Relatively high biodiversity
  - Medium carbon storage on land
  - Medium but consistent carbon sequestration rates
  - Full range of ecosystem services
  - Mix of timber and non-timber forest products

**Carbon Storage In Forest Pools**
- Selection Cutting
  - Relatively high biodiversity
  - Medium carbon storage on land
  - Medium but consistent carbon sequestration rates
  - Full range of ecosystem services
  - Mix of timber and non-timber forest products

**Plantation**
- Less biodiversity
- Lower carbon storage on land
- Likely higher carbon sequestration rates
- High forest products production
- Could be targeted for high-risk (e.g., fire prone)

**Selection Cutting**
- Relatively high biodiversity
- Medium carbon storage on land
- Medium but consistent carbon sequestration rates
- Full range of ecosystem services
- Mix of timber and non-timber forest products

**Old growth**
- High overall biodiversity
- Highest carbon storage on in forest ecosystem pools
- Possibly lower sequestration rates
- Very limited timber products
- Could be targeted for low-risk areas
- Recreation, habitat, etc.
Climate-Smart Forestry (CSF)

• Targeted approach/strategy to increase climate benefits from forests and the forest sector
• Respects and embraces other needs related to forests
• Three pillars:
  1. Reducing and/or removing greenhouse gas emissions to mitigate climate change
  2. Adapting forest management to build resilient forests
  3. Active forest management aiming to sustainably increase productivity and provide all benefits that forests can provide

Forest Certification = Climate-Smart Forestry

(European Forest Institute)
What is Certification?

Forest certification: a mechanism for forest management, monitoring, tracing, and labeling of timber, wood and pulp products and non-timber forest products, where the quality of forest management is judged against a series of agreed standards. (WWF, 2018)

Important terms

Standard – the requirements against which certification assessments are made

Certification – the confirmation that the forest and its management conforms to a particular standard
  • Assessed by third party, who reviews documentation, observes the forest, interviews management and employees, and uses evidence from third parties
  • Trained assessors following ISO practices

Accredidation – the mechanism for ensuring that the organizations that undertake certifications are competent and produce credible results
Comparing Management

Short-term Thinking
- Easiest route into forest
- Emphasis on extraction and high financial return
- Not necessarily based on research, training, or best practices
- Damage to, and resulting mortality of, remaining trees
- Limited consideration of soil, water, and habitat impacts

Long-term Thinking
- Certification solidifies these practices in standards
- Research and data-informed decision-making
- Required considerations of waterways, sensitive areas, habitat
- Minimizing damage
- Move beyond legal minimums in many areas
- Examples of practices:
  - Reduced Impact Logging (in tropics)
  - Best Management Practices

Note: Possible to pursue best practices without certification, but certification encourages additional adoption

Image: [https://hydrodictyon.eeb.uconn.edu/people/willig/Research/Brazil/Brazil.html](https://hydrodictyon.eeb.uconn.edu/people/willig/Research/Brazil/Brazil.html)
Certification provides:

- Facilitates climate-smart forestry/forestry BMPs
  - Technical guidance and support to working forests
  - Communication network of best practices
  - Education and engagement for deployment of improved practices
- Forest certification is based on principles that promote sustainable forest management
- A range of benefits in its guidance
  - Carbon benefits are just one such benefit
- Assurances to a range of stakeholders including investors and donors, governments, shareholders and employees, and purchasers
Certification Bodies

- Sustainable Forestry Initiative (SFI)
  - Housed under Programme for the Endorsement of Forest Certification (PEFC)
- Forest Stewardship Council (FSC)
- American Tree Farm
  - Under PEFC

Forest management certification
Basics of forest management certification

• How to become ‘Certified’?
  • A forest owner must follow set guidance
  • Inventory, implementation of BMPs, monitoring

• Auditing by third-party verifiers

• Loggers required to complete training

• BMPs for that state are required

• Many of these have implications for carbon storage

• Additional activities
  • Community and outreach
  • Research
Best Management Practices (BMPs)

• Guidelines to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources
• National core BMPs in 11 categories
• Not required in all states, certification bring more actors into alignment where they are not required
• Example topics and requirements:
  • Cleaning up fuel spills
  • Minimizing ruts left by heavy equipment
  • Installing properly sized culverts and bridges that allow fish passage
  • Minimizing soil disturbance
  • Water quality considerations
  • Biodiversity and Wildlife Habitat
  • Forests with Exceptional Conservation Value
  • Reducing forest impacts during harvest
• Michigan example: BMPs not required, certification boosts adoption

Sources: USFS, State of MI
Fiber sourcing and Chain of Custody
Fiber Sourcing and Chain of Custody Certification

• Chain of Custody
  • Refers to the entire path of **certified** products from forests through to the supply chain

• Fiber sourcing
  • Refers to **uncertified** wood entering the mill for processing
  • Emphasis on legal, responsible sources if not certified

Source: [https://greenblue.org/module-2-the-role-of-forest-certification/](https://greenblue.org/module-2-the-role-of-forest-certification/)
Chain of Custody (CoC)

- CoC traces certified materials through the supply chain
  - Verifies that certified material is identified or kept separate from non-certified material
- Allows for communication about certified forest products
- Direct data and linkages forest to product
- CoC picks up after Forest Management Certification

FSC, 2020
Responsible Fiber Sourcing/Controlled Wood

- Fiber sourcing refers to the wood entering the mill for processing, which may or not be from certified
  - Emphasis on “legal and responsible”

- SFI
  - Requires BMPs for the wood
  - Using trained loggers
  - Prohibits
    - Sourcing from areas without effective social laws
    - Illegal timber

- FSC Controlled Wood
  - Identified material from acceptable uncertified sources that can be mixed with FSC-certified material in products that carry the “FSC Mix” label
  - Prohibits
    - GMO Trees
    - Conversion to non-forest use
    - Threats to forests with High Conservation Values
    - Violation of traditional or civil rights
    - Illegal harvest

Example of fiber sourcing from a major timber company
Certification: Alignment with Climate Change

Pillars are in line with forest adaptation and mitigation
Mitigation & Adaptation

• Harvested wood is part of the climate solution – but ONLY if it is sustainable

• Certification can ensure sustainability in management and procurement (and in climate benefits!)

SFI example:
Obj. 2: Forest Productivity and Health
• to protect forests from economically or environmentally undesirable levels of wildfire, pests, diseases, invasive exotic plants and animals, and other damaging agents and thus maintain and improve long-term forest health

Resilient, healthy forests = climate adaptation
Clear Messaging

• Visible and recognizable logos
• Branding on labels and in stores
• Built a foundation that the climate change message can grow from
• Promotes investment in sustainable forestry
• Consumer purchasing decisions
• Foundation for lower emission products and materials
Low Risk of Deforestation In US And Canada

— 2016 State of the World's Forests Food and Agriculture Organization of the United Nations

\[\text{WWF has identified 11 places where the largest concentrations of forest loss between 2010 and 2030.}\]

Key Takeaways

1. Working forests are a crucial solution in the fight against Climate Change
2. Forests can be managed sustainably to provide sustainable materials and carbon sequestration as part of a landscape approach
3. Climate and carbon benefits are quickly dissolved when converting complex forests to simpler forests, by degradation, and by any forest loss
4. Opportunities for continued improvement, transparency, and oversight
5. Certification is a central tool in ensuring sustainability
Lauren Cooper
Forest Carbon and Climate Program
Program Director
ltcooper@msu.edu
Carbon and Sustainability Tracking
Speaker Background

- **Grant Domke**
  - **Current position:**
    - Research Forester and Group leader, USDA Forest Service
    - Fellow, Institute on the Environment, University of Minnesota
    - Adjunct Assistant Professor, Department of Forest Resources, University of Minnesota
  - **Credentials:**
    - Ph.D. Forest Ecosystem Science, University of Minnesota
    - M.S. Forest Ecology, University of Toronto
  - **Key experiences**
    - Lead scientist and UNFCCC inventory compiler for forest land and harvested wood products in the US
    - IPCC, Lead Author
    - National Climate Assessment, Lead Author
    - Second State of the Carbon Cycle, Coordinating Lead Author
Why is this important?

May 18, 2020


- Entered into force in 1994
- US is a (Annex 1) Party to the UNFCCC
- 197 countries have ratified the Convention
- “…act in the interests of human safety even in the face of scientific uncertainty.”
- Stabilize GHG concentrations “at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system.”

Scripps Institution of Oceanography, San Diego
Context within the land sector

2020 NIR: (-753) MMT CO₂ eq. (14%)
National forest inventory (NFI)

- Designed to track change over time
  - Permanent sample plots
  - Remeasurement every 5-10 years
    - ca. 15% of plots remeasured annually

- Multiple approaches for assessing disturbance (e.g., disturbance code), and ecosystem variables (e.g., growth, mortality, removals)

- Observed land cover and land use attributes
Ecosystem C pools

- Aboveground live biomass
- Belowground live biomass
- Dead wood
- Litter
- Soil organic matter
  - Mineral
  - Organic

Carbon stocks by pool in the US

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>51,527</td>
<td>52,358</td>
<td>53,161</td>
<td>53,886</td>
<td>54,663</td>
<td>55,746</td>
<td>55,897</td>
<td>56,051</td>
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<tr>
<td>Aboveground biomass</td>
<td>11,833</td>
<td>12,408</td>
<td>12,962</td>
<td>13,484</td>
<td>14,020</td>
<td>14,780</td>
<td>14,884</td>
<td>14,989</td>
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<tr>
<td>Belowground biomass</td>
<td>2,350</td>
<td>2,483</td>
<td>2,612</td>
<td>2,734</td>
<td>2,858</td>
<td>3,033</td>
<td>3,056</td>
<td>3,081</td>
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<tr>
<td>Dead wood</td>
<td>2,120</td>
<td>2,233</td>
<td>2,346</td>
<td>2,454</td>
<td>2,568</td>
<td>2,731</td>
<td>2,753</td>
<td>2,777</td>
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<tr>
<td>Litter</td>
<td>3,662</td>
<td>3,670</td>
<td>3,676</td>
<td>3,647</td>
<td>3,646</td>
<td>3,646</td>
<td>3,640</td>
<td>3,641</td>
</tr>
<tr>
<td>Soil (mineral)</td>
<td>25,636</td>
<td>25,636</td>
<td>25,637</td>
<td>25,639</td>
<td>25,641</td>
<td>25,637</td>
<td>25,637</td>
<td>25,638</td>
</tr>
<tr>
<td>Soil (organic)</td>
<td>5,927</td>
<td>5,928</td>
<td>5,928</td>
<td>5,929</td>
<td>5,929</td>
<td>5,926</td>
<td>5,926</td>
<td>5,926</td>
</tr>
<tr>
<td>Harvested wood</td>
<td>1,895</td>
<td>2,061</td>
<td>2,218</td>
<td>2,353</td>
<td>2,462</td>
<td>2,616</td>
<td>2,642</td>
<td>2,669</td>
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<tr>
<td>Products in use</td>
<td>1,249</td>
<td>1,326</td>
<td>1,395</td>
<td>1,447</td>
<td>1,471</td>
<td>1,505</td>
<td>1,513</td>
<td>1,521</td>
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<tr>
<td>SWDS</td>
<td>646</td>
<td>735</td>
<td>823</td>
<td>906</td>
<td>991</td>
<td>1,112</td>
<td>1,129</td>
<td>1,148</td>
</tr>
<tr>
<td><strong>Total stocks</strong></td>
<td>53,423</td>
<td>54,419</td>
<td>55,380</td>
<td>56,239</td>
<td>57,124</td>
<td>58,362</td>
<td>58,539</td>
<td>58,720</td>
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</table>


### Estimated emissions and removals

<table>
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<tr>
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<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest land remaining forest land</td>
<td>(610.1)</td>
<td>(598.7)</td>
<td>(572.1)</td>
<td>(572.6)</td>
<td>(556.2)</td>
<td>(565.5)</td>
<td>(552.0)</td>
<td>(564.5)</td>
</tr>
<tr>
<td>Non-CO₂ emissions from fire</td>
<td>1.5</td>
<td>0.6</td>
<td>2.9</td>
<td>8.2</td>
<td>4.6</td>
<td>5.6</td>
<td>18.8</td>
<td>18.8</td>
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<tr>
<td>N₂O emissions from forest soils</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
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<tr>
<td>Non-CO₂ emissions from drained organic soils</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Forest land converted to non-forest land</td>
<td>119.1</td>
<td>120.8</td>
<td>122.5</td>
<td>124.4</td>
<td>126.0</td>
<td>127.4</td>
<td>127.4</td>
<td>127.4</td>
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<tr>
<td>Non-forest land converted to forest land</td>
<td>(109.4)</td>
<td>(109.7)</td>
<td>(109.9)</td>
<td>(110.2)</td>
<td>(110.4)</td>
<td>(110.6)</td>
<td>(110.6)</td>
<td>(110.6)</td>
</tr>
<tr>
<td>Harvested wood products</td>
<td>(123.8)</td>
<td>(112.2)</td>
<td>(93.4)</td>
<td>(106.0)</td>
<td>(69.1)</td>
<td>(92.4)</td>
<td>(95.7)</td>
<td>(98.8)</td>
</tr>
<tr>
<td>Woodlands remaining woodlands</td>
<td>5.0</td>
<td>4.9</td>
<td>4.8</td>
<td>4.6</td>
<td>4.4</td>
<td>4.1</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Urban trees in settlements</td>
<td>(96.4)</td>
<td>(103.3)</td>
<td>(110.4)</td>
<td>(117.4)</td>
<td>(124.6)</td>
<td>(129.8)</td>
<td>(129.8)</td>
<td>(129.8)</td>
</tr>
<tr>
<td>Total Emissions and Removals</td>
<td>(813.9)</td>
<td>(797.2)</td>
<td>(755.0)</td>
<td>(768.4)</td>
<td>(724.7)</td>
<td>(760.6)</td>
<td>(737.3)</td>
<td>(752.9)</td>
</tr>
</tbody>
</table>

---


Emissions and removals, 2018
Aboveground live carbon by ownership

[Graph showing aboveground live tree C density and mean annual net change by ownership and stocking level.]
Harvested wood products estimation

1. Stock change methods
   - All HWP consumed in the area, regardless of origin
   - Imports are included, exports are excluded

2. Production methods
   - All HWP produced from timber harvested in the area
   - Exports are included, imports are excluded

3. Atmospheric flow methods
   - Direct estimation of annual atmospheric flux within domain boundaries

4. Combined methods

Final thoughts

- Forest Service continues to expand role in GHG estimation and reporting
- FIA data serves as the foundation
- Developing more spatially and temporally resolved information
- Continue to improve and expand capabilities - collaboration and partnerships are essential
- Inform policy and land management practices across scales
Thank you

Grant Domke: grant.m.domke@usda.gov

FIA program: www.fia.fs.fed.us

FIA carbon: http://www.fia.fs.fed.us/forestcarbon/
Speaker Background

Maggie Wildnauer

- Consulting Director, Sustainability @ Sphera
- Credentials:
  - M.S. Structural Engineering, MIT
  - B.S. Civil Engineering, Johns Hopkins
  - LEED GA
- Key experiences
  - LCA Practitioner for 7 years
  - Provided background data for the Tally tool
  - Contributed to LCA data in Quartz
  - Former researcher at Concrete Sustainability Hub
Life Cycle Inventory (LCI)

- Translate to natural resources and emissions to air, water, and soil
- Primary and secondary data sources (e.g., LCI databases)

<table>
<thead>
<tr>
<th>Flow</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>100,000 MWh</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>100,000 MJ</td>
</tr>
<tr>
<td>Emissions</td>
<td>100,000 tons</td>
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</tbody>
</table>

+ Materials

<table>
<thead>
<tr>
<th>Flow</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>100,000 ft³</td>
</tr>
<tr>
<td>Electricity</td>
<td>100,000 MWh</td>
</tr>
<tr>
<td>Waste</td>
<td>100,000 tons</td>
</tr>
</tbody>
</table>

+ Manufacturing

<table>
<thead>
<tr>
<th>Flow</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Fuel</td>
<td>100,000 gal.</td>
</tr>
</tbody>
</table>

= elementary flows/exchanges

<table>
<thead>
<tr>
<th>Resources</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 MJ</td>
<td>Crude oil 6.5 kg CO₂, to air</td>
</tr>
<tr>
<td>0.9 MJ</td>
<td>Hard coal 0.03 kg NOₓ, to air</td>
</tr>
<tr>
<td>200 kg</td>
<td>Ground water 0.03 kg Nitrates, to water</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Wood Carbon Seminars, Maggie Wildnauer
Life Cycle Impact Assessment (LCIA)

- CO₂
- SO₂
- NOₓ
- CH₄
- VOC

**Classification**

- CO₂: ability to increase radiative forcing
- SO₂: capacity to form H⁺ ions
- NOₓ: capacity to form tropospheric ozone

**Characterization**

- kg CO₂ equivalents: ∑ global warming potential
- kg SO₂ equivalents: ∑ acidification potential
- kg O₃ equivalents: ∑ summer smog potential
### Life Cycle Impact Assessment (LCIA)

<table>
<thead>
<tr>
<th>Inventory value</th>
<th>GWP Factor</th>
<th>Impact potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 kg CO₂</td>
<td>1</td>
<td>25 [kg CO₂-Equivalent]</td>
</tr>
<tr>
<td>2 kg CH₄</td>
<td>30</td>
<td>60 [kg CO₂-Equivalent]</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Elementary flow/exchange**

**LCI value**

**Total:** 85 [kg CO₂-Equivalent]

**LCIA result**
Topics

LCA Software
- GaBi
- SimaPro
- Open LCA
- Umberto

LCI Databases
- GaBi
- Ecoinvent
- US LCI / Federal LCA Commons

LCA Tools
- Tally
- Athena Impact Estimator for Buildings
- EC3
- OneClick LCA

LCIA Databases
- Quartz (suspended)
LCI Software

- Software
  - GaBi
  - SimaPro
  - Open LCA
  - Umberto

- Characteristics
  - Can use multiple LCI Databases within each software
  - Requires an experienced LCA practitioner
  - Methodological decisions are up to the practitioner
LCI Software (GaBi screenshots)

- Provides life cycle inventories by elementary flows/exchanges
- Can apply any impact assessment methodology to obtain LCIA results
- Typically include details on carbon contents of products
LCI Databases

- LCI Databases
  - GaBi
  - Ecoinvent
  - US LCI / Federal LCA commons

- Characteristics
  - Emissions to air
    - Carbon dioxide, non-fossil/biogenic [To Environment]
    - Methane, non-fossil/biogenic [To Environment]
  - Natural resource inputs
    - Carbon dioxide from air
    - Carbon, organic, in soil or biomass stock
  - Elemental composition as a property of reference flow/exchanges (i.e. carbon content both fossil and non-fossil) does not contribute to final impacts but can be used to ensure carbon balances
Challenges in modeling biogenic carbon

- Biomass feedstock carbon contents may vary
- Not all carbon-containing flows and emissions may be tracked throughout manufacturing of the final product
- If multi-output processes are allocated using any other allocation key than the carbon content, the carbon balance will not be closed → either too many or too little inputs of carbon-containing flows

Pragmatic solution

- Find out the biogenic carbon content of the final product
- Add a process inventory that makes sure that the cradle-to-gate carbon balance matches the biogenic carbon content of the product
Biogenic Carbon Modeling in LCA Software

- Biogenic carbon is only ‘carbon neutral’ if all of the CO₂ that was removed from the atmosphere is released as CO₂ again, i.e. not transformed to CH₄.
- Without the proper accounting of biogenic carbon flows, the contribution of bio-based materials to climate (net source or sink) may be inaccurate or omitted.
- Accounting for 100% of all biogenic carbon flows in the product system can be challenging.
- ‘Back-calculating’ the carbon removals from the carbon content of the material in question is a pragmatic way to close the carbon balance.
## GWP100 Characterization Factors

<table>
<thead>
<tr>
<th>Emission</th>
<th>TRACI 2.1 (IPCC AR4)</th>
<th>IPCC AR5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incl. biogenic</td>
<td>Excl. biogenic</td>
</tr>
<tr>
<td>Carbon dioxide, fossil</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Carbon dioxide, biogenic</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Methane, fossil</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Methane, biogenic</td>
<td>25</td>
<td>22.3</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>298</td>
<td>298</td>
</tr>
</tbody>
</table>
## LCA Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Data Source</th>
<th>LCIA Methodology (North America)</th>
<th>Treatment of biogenic carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tally</td>
<td>GaBi, EPDs conducted using GaBi data</td>
<td>TRACI 2.1</td>
<td>GWP including and excluding biogenic carbon</td>
</tr>
<tr>
<td>Athena Impact Estimator for Buildings</td>
<td>Primarily from LCAs conducted by the Athena Institute</td>
<td>TRACI 2.1 (though LCI also presented)</td>
<td>GWP including biogenic carbon</td>
</tr>
<tr>
<td>One Click LCA</td>
<td>Various public and private sources (both generic data and EPDs) using a variety of background data sources</td>
<td>TRACI 2.1</td>
<td>Unclear, may depend on selected EPDs</td>
</tr>
<tr>
<td>EC3</td>
<td>Publicly available EPDs (manufacturing impacts only)</td>
<td>Likely TRACI 2.1 but dependent on EPDs, GWP only</td>
<td>Estimates to include biogenic carbon where not provided by the EPD</td>
</tr>
</tbody>
</table>
LCA Tools

- LCA Tools for Buildings
  - Tally
  - Athena Impact Estimator for Buildings
  - OneClick LCA
  - EC3

- Characteristics
  - May present impact assessment results only (though Athena does present LCI results)
  - Impact categories are selected by the tool creator or the source of data (i.e., EPD)
    - Where LCI is presented (i.e. Athena) the user could manually apply other impact category methodologies if desired
  - Interpretation of results is up to the user of the tool
Additional Comments

- Inclusion or exclusion of things like forest management and land use change (direct and indirect), etc. will depend on the details of the background data
  - ISO 21930 allows for wood from sustainably managed forests to be counted as having zero emissions from land-use change (incl. CSA, FSC, SFI standards)

- Selection of GWP indicator including or excluding biogenic carbon is up to the LCA practitioner in EPDs
  - ISO 21930 mandates the declaration of emissions and removals of biogenic carbon if included in the GWP calculation
Conclusions

- LCA Software and LCI Databases allow the practitioner to choose whether to include biogenic carbon or not
  - Ensuring you’ve accurately modeled the carbon flows in your model is crucial
- System boundaries for LCI Data will vary and the practitioner should review the assumptions of the background data selected
- LCA Tools have often made the decision for the user, though tools like Tally still allow for distinction between GWP including and excluding biogenic carbon
Additional Slides
Biogenic Carbon Modeling in LCA software

![Diagram showing the life cycle of biogenic carbon](image-url)
Biogenic Carbon Modeling in LCA software

Cradle-to-gate

- CO$_2$
- CO$_2$/CH$_4$
- CO$_2$/CH$_4$
- Product output with x kg C/kg
- CO$_2$/CH$_4$
- CO$_2$/CH$_4$

- biomass cultivation
- processing
- manufacturing
- carbon correction
- use
- EoL

C (waste, by-products)
C (waste, by-products)
C (waste, by-products)

GWP excl. bio CO2 – GWP incl bio CO2 ≡ C content of product
Economics of Wood Products
Speaker Background

- Pat Layton
  - Current position:
    - Director, Clemson Wood Utilization & Design Institute
    - Professor, Department of Forestry and Environmental Conservation, Clemson University
  - Credentials:
    - MS and PhD Forest Genetics
    - BS Forest Resource Management
    - Fellow, Society of American Foresters
  - Key experiences
    - 20 years at Clemson University as Professor, Chair and Director
    - 13 years in the pulp and paper industry
    - 4 years in biomass energy and 10 in learning wood products
Forest Change in the US South
Natural fire-dominated landscape

Cheesman Lake 1900

Prescribed fire/stocking issues

South Platte 2002

Office of the Colorado State Forester, 2003-4
Who Owns the Nation’s Forest

- Private entities own and manage 445 million acres
- Private corporate ownership - 147.4 million acres
- Private non-corporate ownership - 297.6 million acres
- More than 10 million private owners
- Highest % is family and individual – ave. 22 acres or less
- Private owners have differing goals for forest management

**FORESTLAND OWNERSHIP IN THE UNITED STATES**

Data Source: FIA 2012
Area of Forest and Woodlands for Selected Regions, Types, Ownerships and Origins – Who Plants Trees

<table>
<thead>
<tr>
<th>Forest-type group</th>
<th>Total</th>
<th>Planted</th>
<th>Natural origin</th>
<th>Thousand acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>All owners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other public</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private corporate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private non-corporate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South total:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loblolly-shortleaf</td>
<td>63,904</td>
<td>34,202</td>
<td>29,702</td>
<td></td>
</tr>
<tr>
<td>Longleaf-slash pine</td>
<td>12,999</td>
<td>7,250</td>
<td>5,799</td>
<td></td>
</tr>
<tr>
<td>13,130</td>
<td>878</td>
<td>12,251</td>
<td>197,277</td>
<td></td>
</tr>
<tr>
<td>20,131</td>
<td>1,749</td>
<td>18,382</td>
<td>245,513</td>
<td></td>
</tr>
<tr>
<td>5,423</td>
<td>3,891</td>
<td>1,532</td>
<td>650</td>
<td>2,401</td>
</tr>
<tr>
<td>4,102</td>
<td>1,700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72%</td>
<td>53%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>66% of planted Douglas-firs are on private land</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95% of planted pines in South are on private land</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

US Forests are data-rich. The USFS, States and others provide these data to all. Internet searches can provide many analyses, but look closely as not all data are equal, i.e. time frame or measured the same. Changes through decades may be significant, e.g., the change in corporate landownership from the 1990 to 2010.
SC Landowners - Managed Forests

Private Corporate

Private Non-Corporate

Photos by Pat Layton
Prescribed Fire Use for Forestry Objectives by State in 2017

[Map showing prescribed fire activity by state in 2017]
Economics of the system

- Transportation of water and air is expensive.
- Logs when harvested are half water
- Logs are often merchandized on site
- Products are transported to mills
- Merchandizing on site may vary by the type of mills that are close
- Reducing embodied carbon begins by reducing hauling distance
“Wood Baskets” for Mills

A wood basket is the area around the mill from which logs are received
- In the SE most logs with 50 miles
- More than 75 miles is rare for pine

Wood baskets can overlap
- Different types of mills
- Competition

Distance from the mill impacts
- Price paid to landowner
- Carbon emitted in transportation
Washington State Wood Processing Facilities by Timbershed

Modern Softwood Sawmills – What Logs Are Harvested

- ≈ 10% or fewer mills in the SE take logs with butt diameters ≥ 28”
- Only 8 mills take these sizes in the PNW (≈ 9%) (source Forest2Market)
- Size matters to the efficiency of sawmills
- Markets drying up for big logs
  - Export Markets
  - Pole/Pilings
Grading and Sorting

- Every log is processed into multiple products depending on log quality and size
- All boards from each log are sorted by size and then dried
- Dried stacks are then planned, graded to standards, trimmed to enhance grading, restacked by size, packaged and shipped
- Shipping dried, well-stacked lumber to distribution centers reduces costs and fossil-based carbon

Courtesy of Collum’s Lumber Products, LLC
Grade Marking Southern Pine

Grade Mark Key
1. Registered Trademark
2. Grade of Lumber
3. Moisture Content
4. Mill Identification Number
5. Heat Treated for Pest Pasteurization
Grade Marking Western Wood Products

- WWPA certification mark
- 12 – Mill ID
- Stand – Grade Identification
- Species
- Seasoning
  - Includes type of drying and moisture content
Distribution Centers, Plywood (squares) and OSB (diamonds) Mills
Distribution Centers to Building Suppliers to Job Sites

Photos by Pat Layton
Mass Timber – Sawmill to Secondary Manufacturer

Structurlam Mass Timber Products

Photos by Pat Layton
Manufacturer to Mass Timber Buildings

UMASS: Total SQ FT: 76,030
76 Truckloads delivered to jobsite
1,025,808 bd ft of Mass Timber: 245,136 Glulam Beams + 780,672 CLT.
Interestingly, for this project, which used HBV connectors to create composite floor slabs, the steel accounted for 20% of the material structural cost (not accounting for labor)

Platte 15: Total SQ FT: 128,410
70 Truckloads delivered to jobsite
1,013,940 bd ft of Mass Timber: 559,680 Glulam Beams + 454,260 CLT

Quattlebaum: Total SQ FT 16,500
354,000 bd ft of Mass Timber: 72,000 bd ft Glulam Beams + 282,000 bd ft of CLT (885 -- 20” dbh trees)
Quattlebaum Building - Wood Sources

**LEGEND**

**SmartLam (SL) - CLT**
- C = Canfor (60%)  
- R = Rex Lumber (20%)  
- I = Interfor (15%)  
- H = Harrigan Lumber (5%)  
% = percentages of lumber used in CLT

**Structural Wood Systems (SWS)**
- All glulam lumber provided by Canfor in Fulton, AL
Influencing Carbon in Wood Products

- Use certified wood sources, C of C for mills, distributors, secondary manufacturers
  - Carbon being incorporated into the standards
- USFS wood is not certified but does need markets
- Private landowners and wood production
  - Landowner objectives differ significantly
  - All ecosystem services are critical – water, air, habitat, diversity
- Not all lumber is equal, even from a single tree
- Wood selection
  - Local or not?
- Off-site/premanufacturing
- Design for reuse/deconstruction
Understanding Trees and Embodied Carbon

- Live trees sequester carbon up to a certain age
- Not all US forests produce wood for buildings
- Ecosystem services from managed forests are important
- Deforestation is not “sustainably managed forestry”
- Using wood in building, consider the whole life of the building
- Fossil fuel prices dominate the economics of wood/lumber

Cooper Carry
Going beyond neutrality in embodied carbon accounting for forest products

...and why carbon-friendly forestry is not always climate-smart forestry
David Diaz

- Director of Forestry Technology & Analytics, Ecotrust
- Research Assistant, Center for Sustainable Forestry Pack Forest
  - Work at the intersection of ecosystem science, conservation finance, forest management planning, and computation/data science
- Credentials:
  - BA in Environmental History, Harvard University
  - MS in Soil Science, Oregon State University
  - PhD Candidate in Forestry, University of Washington
- Key experiences
  - 2011-2013 – Senior Portfolio Associate at The Climate Trust, originating carbon offset contracts and contributing to offset accounting standards for forest and other land use projects
  - 2013 – present – Ecotrust, lead on forest modeling, geospatial analysis, and technology development
- Forest carbon balance exerts a significant influence on our global climate.

- Choices around how forests are treated and where we source wood products from are moving to forefront of business decisions amidst our climate crisis.

- Forests provide fundamental benefits including food, clean water, and shelter, in addition to economic development opportunities.
Reforestation, forest protection, conservation and “improved” management in both natural forests and plantations can be expanded to yield millions of tons of CO$_2$-equivalent mitigation.

Not an accident that forests were the first type of carbon offsets introduced in the 1990s.

Millions are being invested into forests that go beyond carbon neutrality.
FOCUSING ON EMBODIED CARBON

Embodied Carbon
Manufacture, transport and installation of construction materials

Operational Carbon
Building energy consumption

SKANSKA
4 General Approaches to Forest Product LCA Calculations

1. CO₂ is removed from the atmosphere before harvesting while the tree is growing
2. CO₂ is removed from the atmosphere after harvest by the trees that replace the tree that was harvested
3. CO₂ is removed from the atmosphere in the year of harvest by non-harvested trees growing across the landscape
4. Any of the previous approaches adjusted to account for foregone sequestration
So the answer to the question is…… it depends

The traditional LCA approach (Approach 1) results in biogenic carbon being “neutral” in most circumstances

• It can miss deforestation unless constraints are added
• It can miss forests that gain carbon over time

The landscape or supply area approach (Approach 3) is best aligned with wood procurement practices

• Where supply area carbon stocks are stable non-declining over time, biogenic carbon is can be conservatively simplified as “neutral”.
• It can include effects of deforestation carbon gains and losses, although the impact depends on the scale used to define the supply area
• It may be difficult to isolate the C uptake due to our product

Adapted from Wood Carbon Seminars, Reid Miner
Goodbye to carbon neutral: Getting biomass footprints right

Eric Johnson *

Atlantic Consulting, Obereggstrasse 14, CH-8736 Gattikon, Switzerland

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Biodiesels
Sequestration credits
Carbon footprinting
LCA

ABSTRACT

Most guidance for carbon footprinting, and most published carbon footprints or LCAs, presume that biomass
heating fuels are carbon neutral. However, it is recognised increasingly that this is incorrect: biomass fuels
are not always carbon neutral. Indeed, they can in some cases be far more carbon positive than fossil fuels.
This flaw in carbon footprinting guidance and practice can be remedied. In carbon footprints (not just of
biomass or heating fuels, but all carbon footprints), rather than applying sequestration credits and
combustion deficits, a 'carbon-stock change' line item could be applied instead. Not only would this make
carbon footprints more accurate, it would make them consistent with UNFCCC reporting requirements and
national reporting practice.

There is a strong precedent for this change. This same flaw has already been recognised and partly remedied
in standards for and studies of liquid biofuels (e.g. biodiesel and bioethanol), which now account for land-use
change, i.e. deforestation, but it is partially or completely missing from other studies and from standards for
footprinting and LCA of solid fuels.

Carbon-stock changes can be estimated from currently available data. Accuracy of estimates will increase as
Kyoto compliant countries report more land use, land use change and forestry (LULUCF) data.

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ESTIMATING “UPSTREAM” EMBODIED CARBON
A basic formula for adding non-zero forest carbon balance to existing LCAs

1. **Calculate carbon stock change in the forest**
   Account for carbon gains and losses from an area of interest over a specific timeframe.

2. **Calculate timber output**
   Total output of industrial roundwood from same area and timeframe.

3. **Calculate “upstream” embodied carbon**
   Divide #1 by #2 to calculate “upstream” embodied carbon for the area of interest over a specific timeframe.

   ➤ This “upstream” embodied carbon is cleanly separated from “downstream” stocks and fluxes which are comparatively well-reflected in existing LCIs, LCAs, and EPDs for forest products.
The Landtrendr approach is applied in a project funded by NASA Carbon Monitoring System to provides wall-to-wall (30x30m) biomass estimates from 1986-2018.

Coincident annual timber harvest records exist at the county-level by owner group (Industry, NIPF + Tribal, State, USFS, BLM)

- Periodic reporting available by broader owner groups across every state.
1. **Calculate carbon stock change in the forest**
   Using NASA CMS data, convert biomass (Mg) to carbon (kgCO$_2$e) and subtract total carbon stock in at the end of the period from carbon stock at the beginning.

2. **Calculate timber output**
   Using independent timber output reports, calculate total timber produced over specified timeframe, convert Scribner boardfeet to cubic meters of industrial roundwood (assuming 0.1395 MBF per m$^3$).

3. **Calculate “upstream” embodied carbon**
   Divide #1 by #2 to calculate “upstream” embodied carbon (kgCO$_2$e /m$^3$) for that area of interest over the specified timeframe.

   ➢ The following example covers non-reserved forests of Washington State from 1990-2016.
OWNERSHIP from RTI, PADUS, and US Census data


COUNTIES to indicate “woodsheds”

BIOMASS from Landtrendr 1986-2018


DATA IN HAND
How the sausage gets made
WASHINGTON OWNERS SHAPE CARBON BALANCE
Benchmarking carbon stock change against 1990 levels

Note: These graphs illustrate the distribution of proportional carbon stock change among counties. The dark line represents the median county for that owner type in that region. Moving away from the median, shaded areas correspond to the 40-60th percentiles, 30-70th, etc.
With 1 m$^3$ of industrial roundwood, we can produce ~0.42 m$^3$ of glulam (58% of roundwood meets another fate).

Per 1 m$^3$ of industrial roundwood used for glulam, we get the following embodied carbon footprint:

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>kgCO$_2$e / m$^3$ Roundwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5</td>
<td>Forest Operations</td>
</tr>
<tr>
<td>+20</td>
<td>Lumber Production</td>
</tr>
<tr>
<td>+20 – 40</td>
<td>Glulam Production</td>
</tr>
<tr>
<td>-375 – 455</td>
<td>Retained in Product</td>
</tr>
</tbody>
</table>
**OWNERS SHAPE EMBODIED CARBON**

Looking back on Washington’s non-reserved forests from 1990-2016

**EAST SIDE**

<table>
<thead>
<tr>
<th>County Percentiles</th>
<th>0 (min)</th>
<th>5</th>
<th>25</th>
<th>50 (median)</th>
<th>75</th>
<th>95</th>
<th>100 (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USFS</strong></td>
<td>-1,567</td>
<td>-1,524</td>
<td>-744</td>
<td>-234</td>
<td>+1,861</td>
<td>+6,417</td>
<td>+9,028</td>
</tr>
<tr>
<td><strong>State &amp; Local</strong></td>
<td>-457</td>
<td>-448</td>
<td>-271</td>
<td>+137</td>
<td>+335</td>
<td>+1,070</td>
<td>+1,473</td>
</tr>
<tr>
<td><strong>Non-Industry Private</strong></td>
<td>-1,058</td>
<td>-677</td>
<td>-105</td>
<td>-20</td>
<td>+18</td>
<td>+644</td>
<td>+1,069</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>-700</td>
<td>-624</td>
<td>0</td>
<td>+138</td>
<td>+298</td>
<td>+424</td>
<td>+485</td>
</tr>
</tbody>
</table>

**WEST SIDE**

<table>
<thead>
<tr>
<th>County Percentiles</th>
<th>0 (min)</th>
<th>5</th>
<th>25</th>
<th>50 (median)</th>
<th>75</th>
<th>95</th>
<th>100 (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USFS</strong></td>
<td>-27,565</td>
<td>-18,036</td>
<td>-8,360</td>
<td>-7,751</td>
<td>-4,634</td>
<td>-2,256</td>
<td>-616</td>
</tr>
<tr>
<td><strong>State &amp; Local</strong></td>
<td>-3,859</td>
<td>-1,652</td>
<td>-504</td>
<td>-131</td>
<td>-61</td>
<td>+157</td>
<td>+200</td>
</tr>
<tr>
<td><strong>Non-Industry Private</strong></td>
<td>-910</td>
<td>-694</td>
<td>-143</td>
<td>-111</td>
<td>-88</td>
<td>-63</td>
<td>-47</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>-250</td>
<td>-223</td>
<td>-119</td>
<td>-40</td>
<td>+86</td>
<td>+153</td>
<td>+178</td>
</tr>
</tbody>
</table>

Note: Percentiles indicate distribution among counties, not adjusted/normalized by timber output.
# OWNERS SHAPE EMBODIED CARBON

*Looking back on Washington’s non-reserved forests from 1990-2016*

<table>
<thead>
<tr>
<th>timber supply percentiles</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>-238</td>
<td>-208</td>
<td>-149</td>
<td>-54</td>
<td>-24</td>
<td>-1</td>
<td>+73</td>
<td>+159</td>
<td>+181</td>
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<tr>
<td>State &amp; Local</td>
<td>-364</td>
<td>-195</td>
<td>-178</td>
<td>-116</td>
<td>-89</td>
<td>-81</td>
<td>-64</td>
<td>+48</td>
<td>+150</td>
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<td>USFS</td>
<td>-7,163</td>
<td>-5,021</td>
<td>-4,725</td>
<td>-3,521</td>
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<td>-896</td>
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<td>+1,974</td>
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<td>Other Federal</td>
<td>-1,100</td>
<td>-916</td>
<td>-916</td>
<td>-71</td>
<td>-71</td>
<td>-71</td>
<td>-71</td>
<td>+699</td>
<td>+4,111</td>
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</tbody>
</table>

**Note:** Percentiles indicate distribution across counties weighted by timber output.

**Average Annual Timber Output (2012 - 2017):**

- **Industry:** 40% 1,665 MMBF
- **Non-Industry Private:** 29% 1,203 MMBF
- **State & Local:** 24% 988 MMBF
- **USFS:** 3% 133 MMBF
- **Other Federal:** 1% 43 MMBF
GOING NATIONAL

Embodied carbon disclosure will be coming to US forests soon

Distribution of Six Forest Ownership Types in the Conterminous United States

Wood Carbon Seminars, David Diaz
If you’re trying to guide a decision about an individual action you should take or not take (e.g., what materials to use in a building project), then attributional LCA may be “good enough” (if you’re comfortable with your simplifying assumptions)...

... but if you’re trying to make sweeping (policy) decisions that will impact broader social, economic, and ecological systems, attributional LCA is probably not “good enough.”

➢ To identify and address relevant (policy) questions and tradeoffs, you need to enter the realm of counter-factual (or “what if...”) scenario modeling to, however crudely, interrogate how market, policy, and social and environmental interactions and impacts would occur with and without certain interventions.
...and why carbon-friendly forestry is not always climate-smart forestry
CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

CLIMATE-SMART FORESTRY

balances adaptation, resilience, and mitigation

CARBON-FRIENDLY FORESTRY

focused primarily on climate change mitigation

Note: Not drawn to scale ;)

Wood Carbon Seminars, David Diaz
CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

YOU SHOULD BUY MORE (OF THIS) WOOD

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BUT WHAT IS ALL THIS ABOUT?

CLIMATE-SMART FORESTRY
balances adaptation, resilience, and mitigation

CARBON-FRIENDLY FORESTRY
focused primarily on climate change mitigation
These photos, taken over a 45-year period, document the spread of western juniper in the mainstream John Day River valley near Dayville.

“This study demonstrates that conifer removal projects designed to retain shrub cover and structure can have benefits to multiple species of ground and shrub nesting birds, including several species of conservation concern.”

Credit: Sustainable Northwest.
https://greatnorthwestwine.com/2016/05/11/a-to-z- wineworks-pulls-western-juniper-use-vineyards/
CARBON-FRIENDLY vs. CLIMATE-SMART
Carbon is the tail, not the dog

These photos, taken over a 45-year period, document the spread of western juniper in the mainstream John Day River valley near Dayville.


Ecosystem Water Availability in Juniper versus Sagebrush Snow-Dominated Rangelands ☆

Patrick R. Kormos 8,9,10,11, Danny Marks 8, Frederick B. Pierson 8, C. Jason Williams 8, Stuart P. Hardegree 9, Scott Havens 8, Andrew Hedrick 9, Jonathan D. Bates 8, Tony J. Svejcar 8

“…juniper-dominated catchments have… earlier snow melt, and less streamflow relative to sagebrush-dominated catchments….

The delayed water input… has wide-ranging implications for available surface water, soil water, and vegetation dynamics associated with wildlife habitat…”

Wood Carbon Seminars, David Diaz
CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

Credit: Marcus Yam/Los Angeles Times.

Credit: USDA Forest Service.
https://www.fs.usda.gov/Internet/FSE_MEDIA/stelprdb5424132.jpg
CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

From Forests to Faucets

A Watershed Management Story

https://dw.maps.arcgis.com/apps/Cascade/index.html?appid=5fdefb803d44a3b3ef128528e38eac
CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

Credit: The Nature Conservancy
THANK YOU.

David Diaz
ddiaz@ecotrust.org

Ecotrust

School of Environmental and Forest Sciences
Center for Sustainable Forestry
at Pack Forest
Summary of What We’ve Learned
Speaker Background

- Edie Sonne Hall
  - Founder and Principal, Three Trees Consulting
    - Facilitator, North American Wood Products LCA Coordination Group (US Endowment)
  - Ph.D. Forest Resources, University of Washington, specialty forest carbon accounting and life cycle assessment
  - Work on projects for industry, non-profits, and governments in climate and forestry world, ranging from policy to research to protocol development
  - 4th generation family forest tree farmer
Lots of forests in US, owned by different landowner types. Ownership patterns different in different regions of the county.

**Total US= 765.5 million acres**
- Private non-corporate (family forests) = 287.7 million acres
- Federal = 237 million acres
- Private Corporate = 155.7 million acres
- State = 70.5 million acres
- County = 13.7 million acres

Source: [US Endowment for Forestry and Communities](https://usaforests.org), produced by Mila Alvarez, available at https://usaforests.org
Webinar 1 and 2 - Forests and Forest Products 101

Manufacturing where the trees are. Building materials (lumber, engineered wood) from PNW and US South.

![Graph showing volume of roundwood harvested by region, 2016](https://usforests.maps.arcgis.com/apps/Cascade/index.html?appid=6d3076faddfb4b8c8b6933cf4963cb)


Webinar 1 and 2 - Forests and Forest Products 101

**Carbon in Time and Space**

Carbon stocks in forests are always in flux due to variations in age, disturbance, and environmental factors. Detecting patterns and trends requires taking a broad view in both space and time.
Webinar 1 and 2 - Forests and Forest Products 101

**Forests and Carbon**

**Net Carbon Flux of US forests 1635-2000**

**USFS prediction of net carbon flux under different scenarios through 2060**

Something is “carbon neutral” when there is zero net emissions biogenic C from a product system.

- Different methods for accounting
- Start with growth, start with harvest, look at from a mill perspective

“Sustainably Managed Forests” for Biogenic C
ISO 21930: Section 7.2.11

- Option 1: Certified Wood Products
  - Canadian Standards Association - CSA
  - Forest Stewardship Council - FSC
  - Sustainable Forestry Initiative - SFI

- Option 2: National Reporting per UNFCC
  - United Nations Framework Convention on Climate Change - National Inventory Reports
  - Stable or Increasing Forest Stocks
Webinar 3 and 4 - LCA and Wood

Softwood Growing Stock Changes 1952-2016

- Major wood producing regions
- bark beetles and fire – mostly National Forests driving the trend
# Webinar 5 and 6: Carbon and Sustainability Tracking

## Annual Flux MMT CO2e

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<tbody>
<tr>
<td>Forest land remaining forest landb</td>
<td>610.1</td>
<td>598.7</td>
<td>572.1</td>
<td>572.6</td>
<td>556.2</td>
<td>565.5</td>
<td>552.0</td>
<td>564.5</td>
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<tr>
<td>Non-CO₂ emissions from fire</td>
<td>1.5</td>
<td>0.6</td>
<td>2.9</td>
<td>8.2</td>
<td>4.6</td>
<td>5.6</td>
<td>18.8</td>
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<td>N₂O emissions from forest soils</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
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<tr>
<td>Non-CO₂ emissions from drained organic soils</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
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<td>0.1</td>
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<tr>
<td>Forest land converted to non-forest landb</td>
<td>119.1</td>
<td>120.8</td>
<td>122.5</td>
<td>124.4</td>
<td>126.0</td>
<td>127.4</td>
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<tr>
<td>Non-forest land converted to forest landb</td>
<td>109.4</td>
<td>109.7</td>
<td>109.9</td>
<td>110.2</td>
<td>110.4</td>
<td>110.6</td>
<td>110.6</td>
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<tr>
<td>Harvested wood products</td>
<td>123.8</td>
<td>112.2</td>
<td>93.4</td>
<td>106.0</td>
<td>69.1</td>
<td>92.4</td>
<td>95.7</td>
<td>98.8</td>
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<tr>
<td>Woodlands remaining woodlandsc</td>
<td>5.0</td>
<td>4.9</td>
<td>4.8</td>
<td>4.6</td>
<td>4.4</td>
<td>4.1</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Urban trees in settlementsd</td>
<td>96.4</td>
<td>103.3</td>
<td>110.4</td>
<td>117.4</td>
<td>124.6</td>
<td>129.8</td>
<td>129.8</td>
<td>129.8</td>
</tr>
<tr>
<td><strong>Total Emissions and Removals</strong></td>
<td><strong>813.9</strong></td>
<td><strong>797.2</strong></td>
<td><strong>755.0</strong></td>
<td><strong>768.4</strong></td>
<td><strong>724.7</strong></td>
<td><strong>760.6</strong></td>
<td><strong>737.3</strong></td>
<td><strong>752.9</strong></td>
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</table>

| Total stocks                  | 53,423 | 54,419 | 55,380 | 56,239 | 57,124 | 58,362 | 58,539 | 58,720 |
Webinar 5 and 6: Carbon and Sustainability Tracking

Emissions and removals, 2018

Webinar 5 and 6: Carbon and Sustainability Tracking

Third Party Sustainable Forest Management Certification/ Chain-of-Custody/ Third Party Fiber Sourcing/Controlled Wood Certification

- Fiber sourcing refers to the wood entering the mill for processing, which may or not be from certified
  - Emphasis on “legal and responsible”
- SFI
  - Requires BMPs for the wood
  - Using trained loggers
  - Prohibits
    - Sourcing from areas without effective social laws
    - Illegal timber
- FSC Controlled Wood
  - Identified material from acceptable uncertified sources that can be mixed with FSC-certified material in products that carry the “FSC Mix” label
  - Prohibits
    - GMO Trees
    - Conversion to non-forest use
    - Threats to forests with High Conservation Values
    - Violation of traditional or civil rights
    - Illegal harvest

Example of fiber sourcing from a major timber company
Wood Products and Building Industry

Quattlebaum Building - Wood Sources

**LEGEND**
- SmartLam (SL) - CLT
- C = Canfor (60%)
- R = Rex Lumber (20%)
- I = Interfor (15%)
- H = Harrigan Lumber (5%)

% = percentages of lumber used in CLT

Structural Wood Systems (SWS)
- All glulam lumber provided by Canfor in Fulton, AL

CARBON-FRIENDLY vs. CLIMATE-SMART
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Wood Carbon Seminars, Edie Sonne Hall
Continuation of Discussion of this week

The FAQ document! Will answer the questions you have submitted to date in writing.