Carbon Leadership Forum

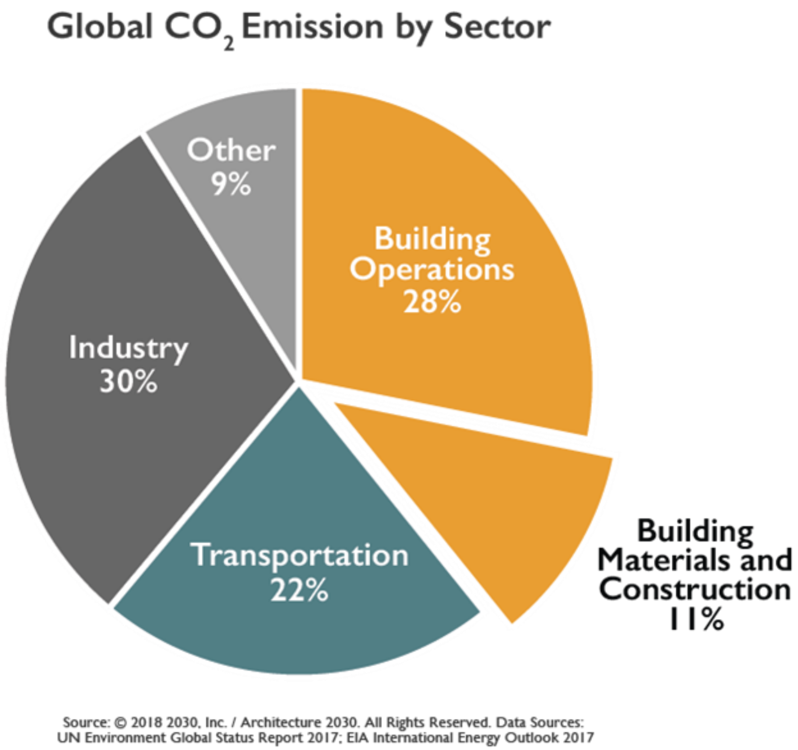
Introduction to the Wood Carbon Seminars

Speaker Background

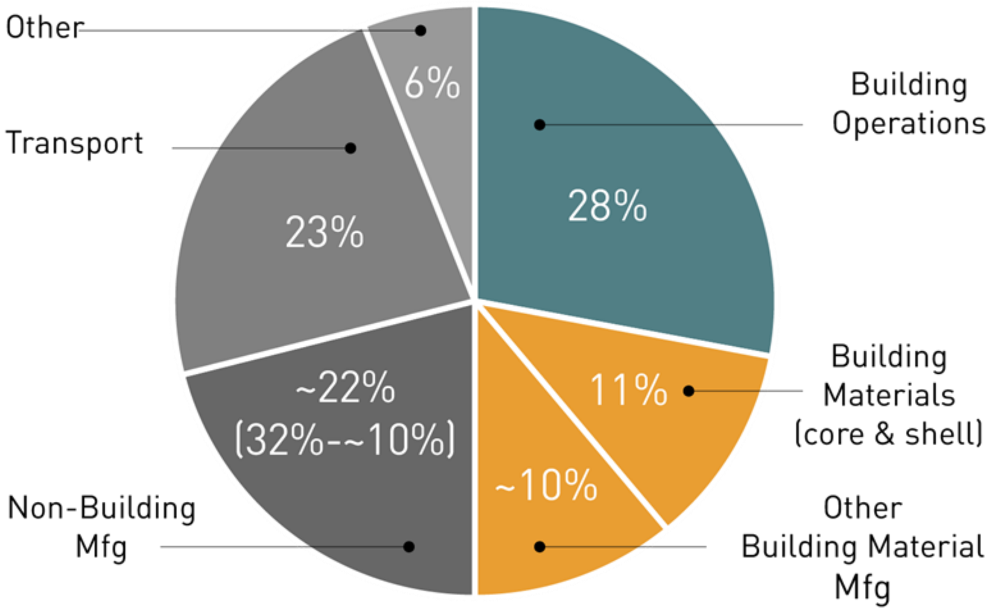
- Kate Simonen
  - Current position:
    - Associate Professor of Architecture, College of Built Environments, University of Washington
    - Department Chair, effective June 2020
    - Director, Carbon Leadership Forum
  - Credentials:
    - M.S. Structural Engineering, M.Arch Architecture
    - Licensed 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



Total Building Material Impacts?



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.

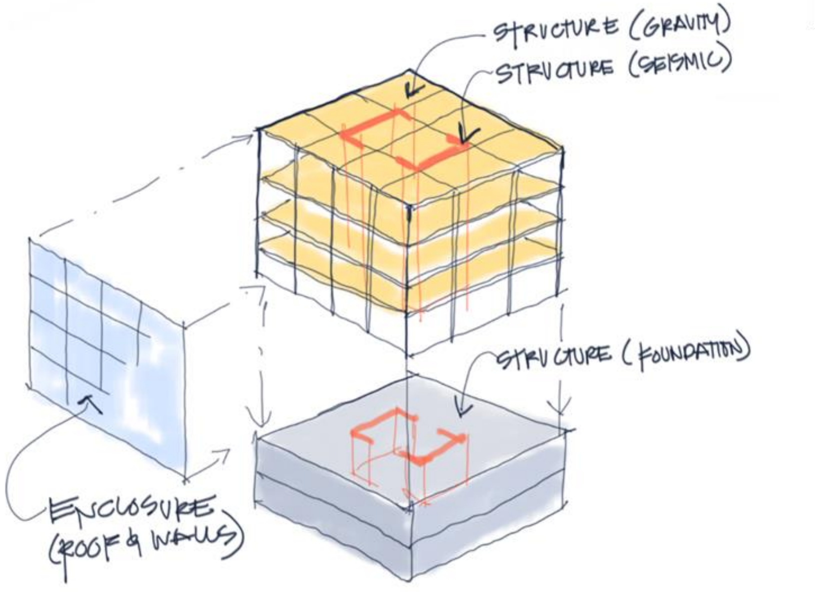
Operating and **Embodied** Carbon

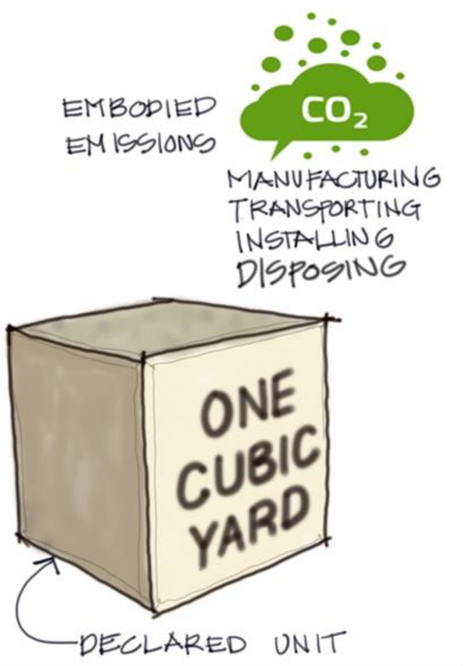
Image: S. Smedley Skanska

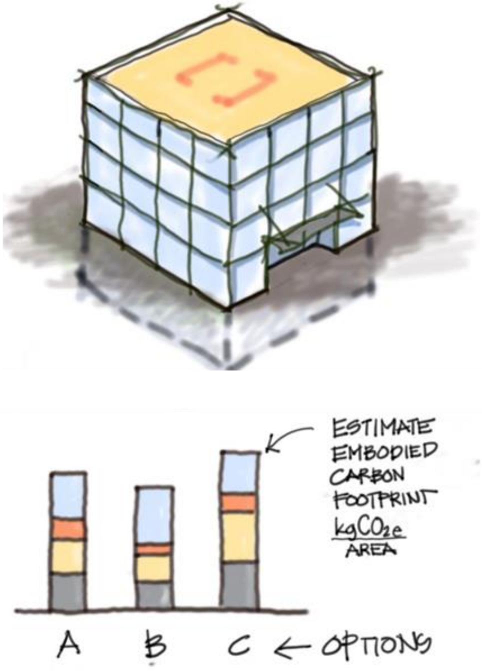
Total Carbon = Embodied Carbon + Operational Carbon

TC = EC +OC

Embodied Carbon Estimates

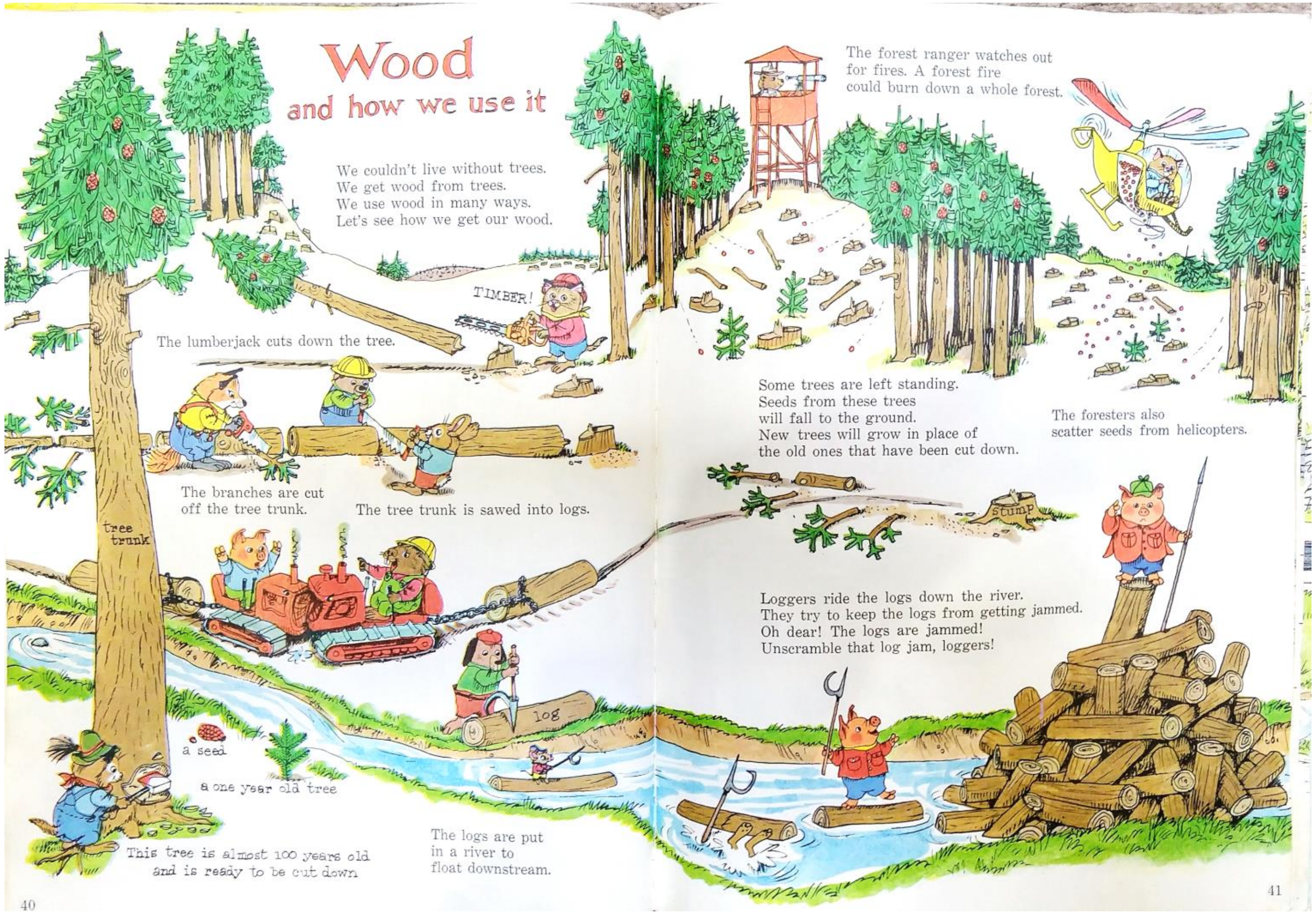






MATERIAL QUANTITY ESTIMATE × **EMBODIED CARBON PER UNIT MATERIAL** = **BUILDING EMBODIED CARBON (EC) ESTIMATE**

Busy, Busy Town and *What Do People Do All Day?* By Richard Scarry



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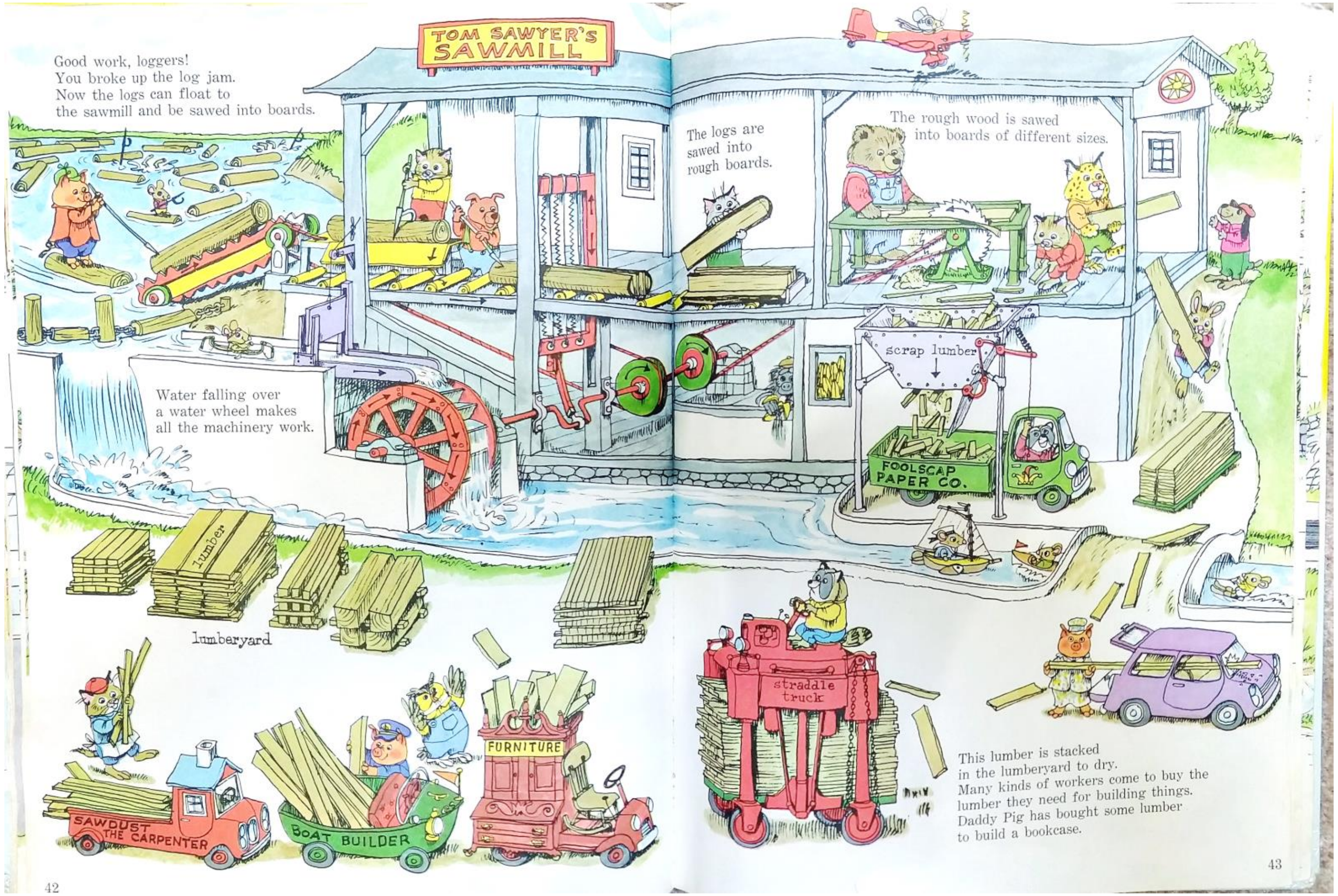
Busy, Busy Town and *What Do People Do All Day?* By Richard Scarry



Big picture

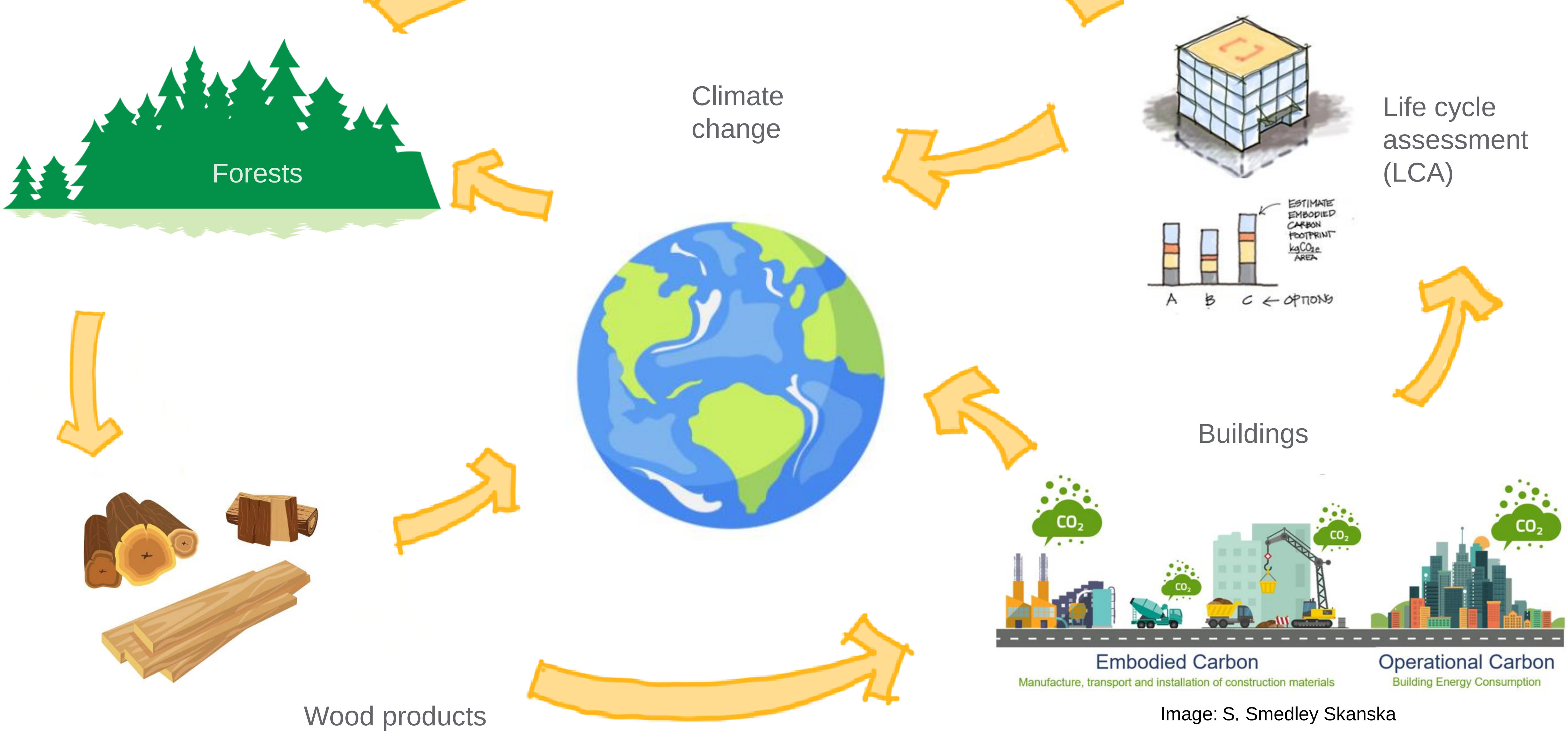
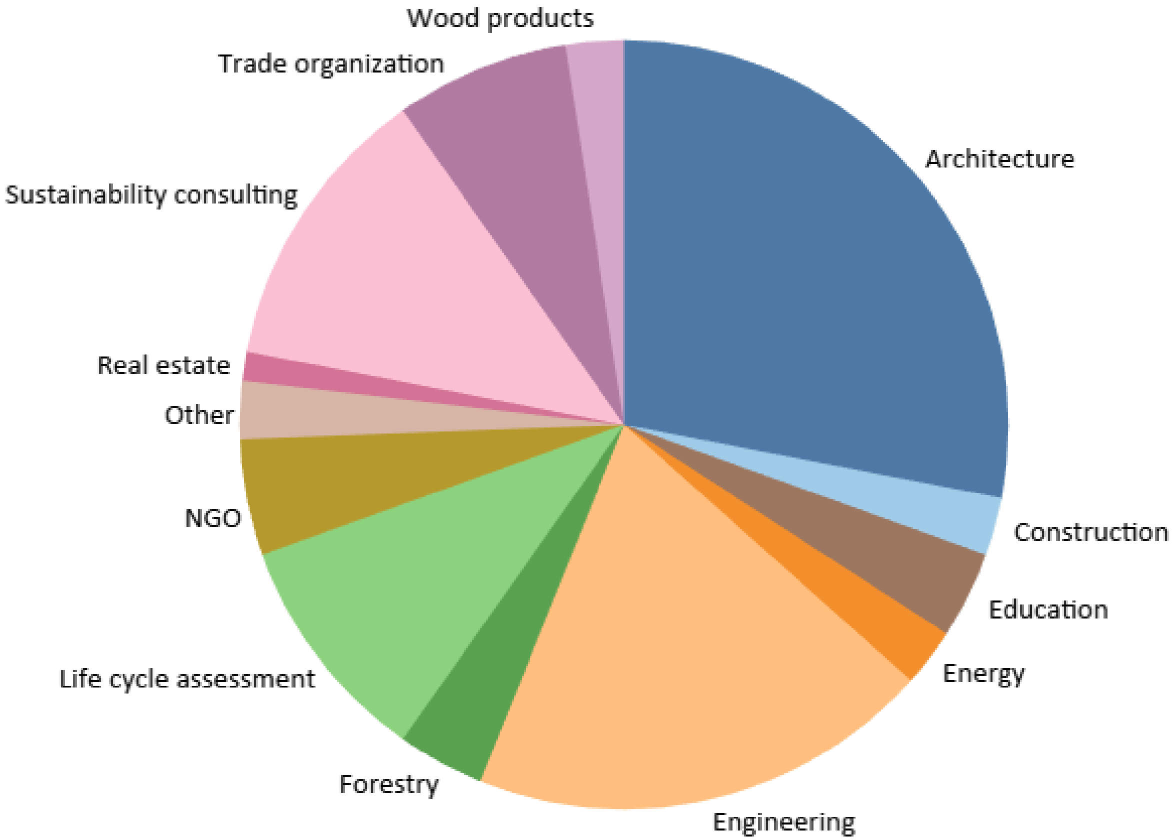


Image: S. Smedley Skanska

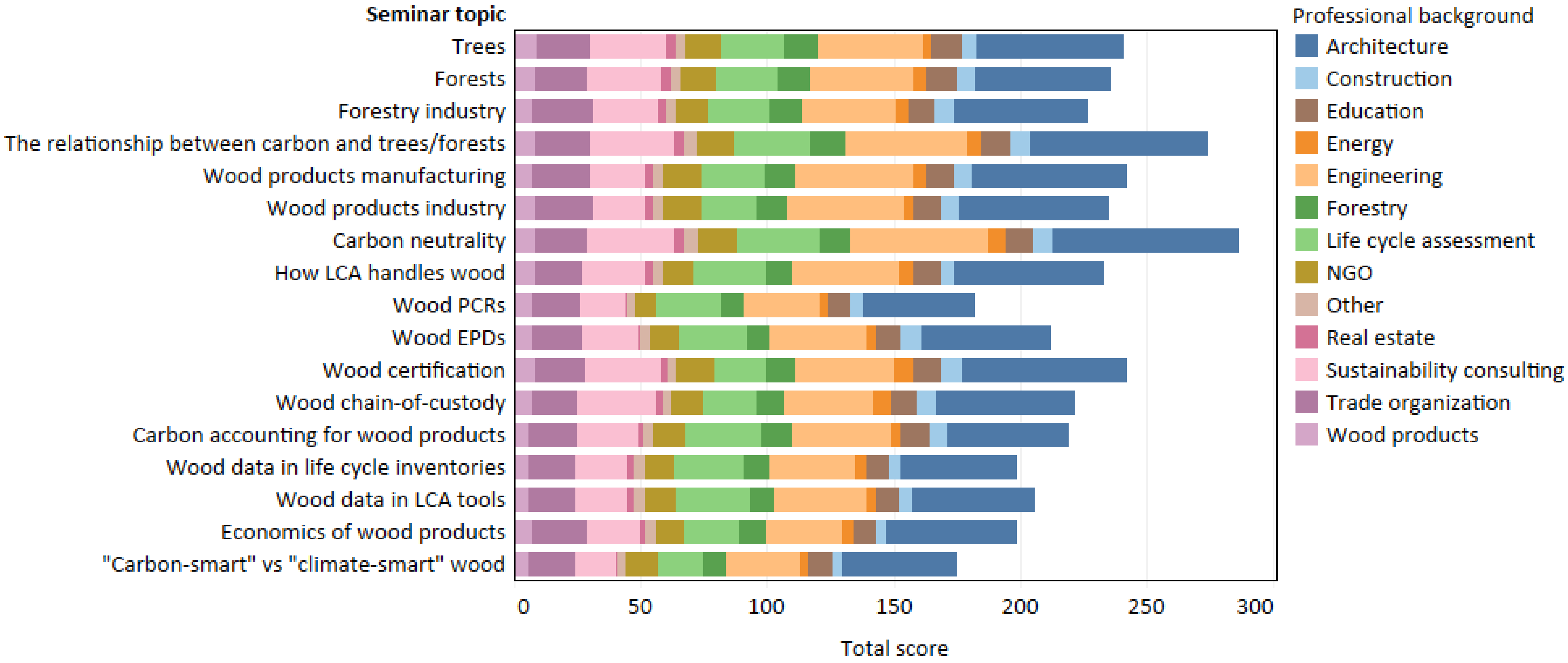
Wood Carbon Seminars – Preliminary survey

- 82 respondents



Wood Carbon Seminars - Preliminary survey

- Total score by topic



Carbon Leadership Forum

Trees, Forestry, and Carbon 101

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

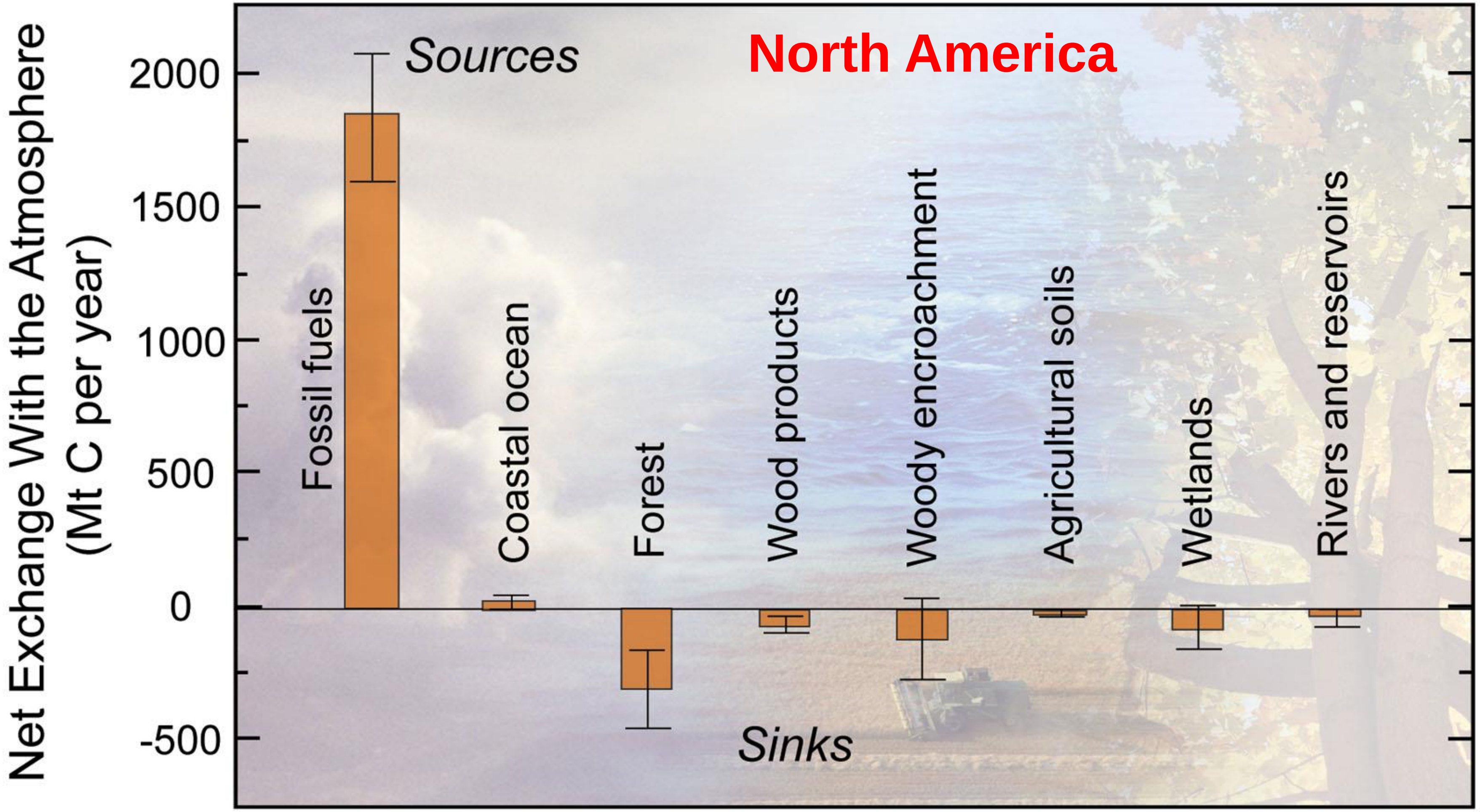
Carbon Leadership Forum

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



CCSP, 2007. *The First State of the Carbon Cycle Report (SOCCR): The North American Carbon Budget and Implications for the Global Carbon Cycle*.

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)

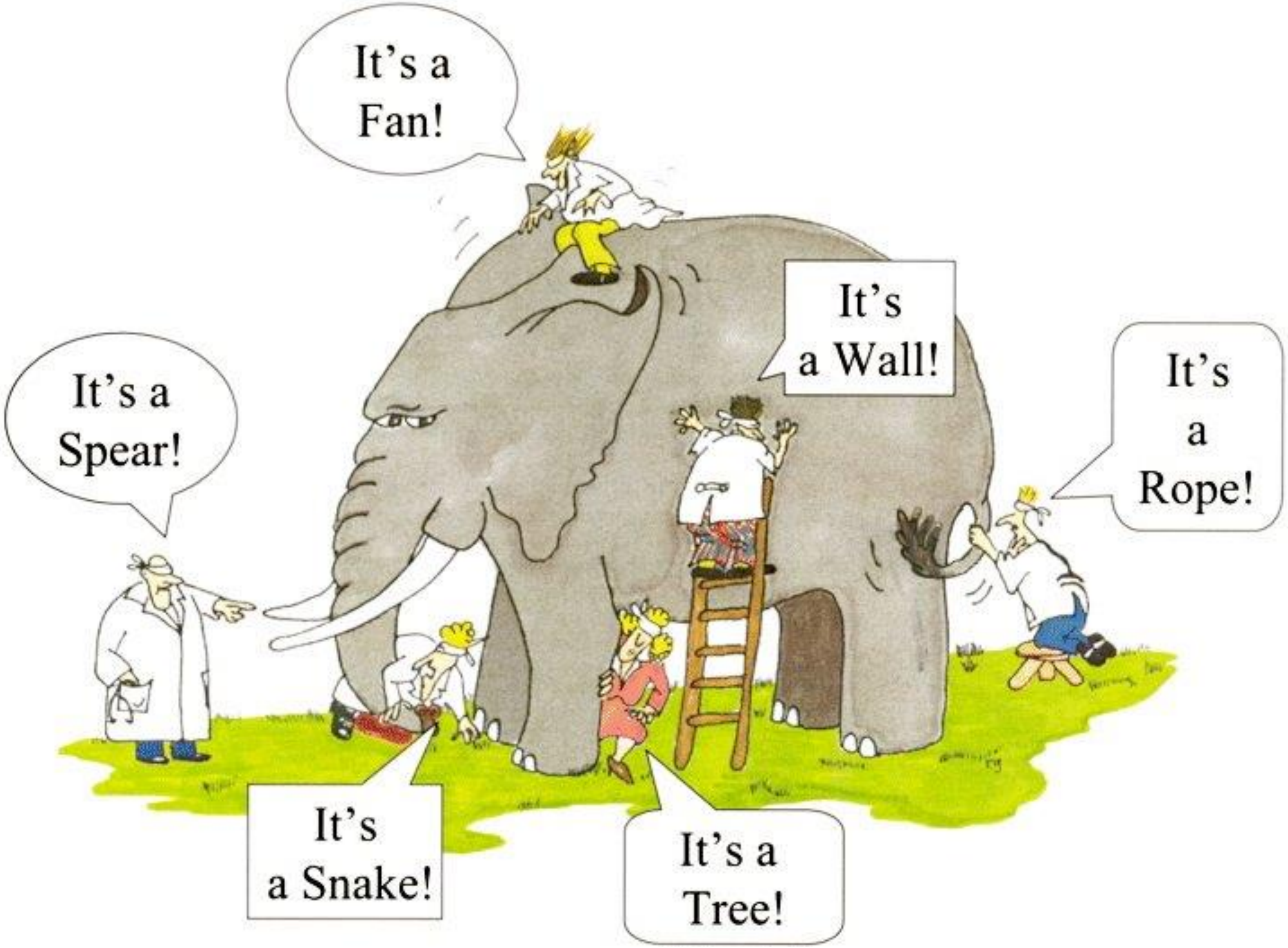
Further reading:

- *Issues in Ecology* – Ryan et al. 2010 ESA synthesis for policy and managers (available:www.esa.org/science_resources/issues.php)

- McKinley, Duncan C.; Ryan, Michael G.; Birdsey, Richard A.; Giardina, Christian P.; Harmon, Mark E.; Heath, Linda S.; Houghton, Richard A.; Jackson, Robert B.; Morrison, James F.; Murray, Brian C.; Pataki, Diane E.; Skog, Kenneth E. 2011. A synthesis of current knowledge on forests and carbon storage in the United States. Ecological Applications. 21(6): 1902-1924.

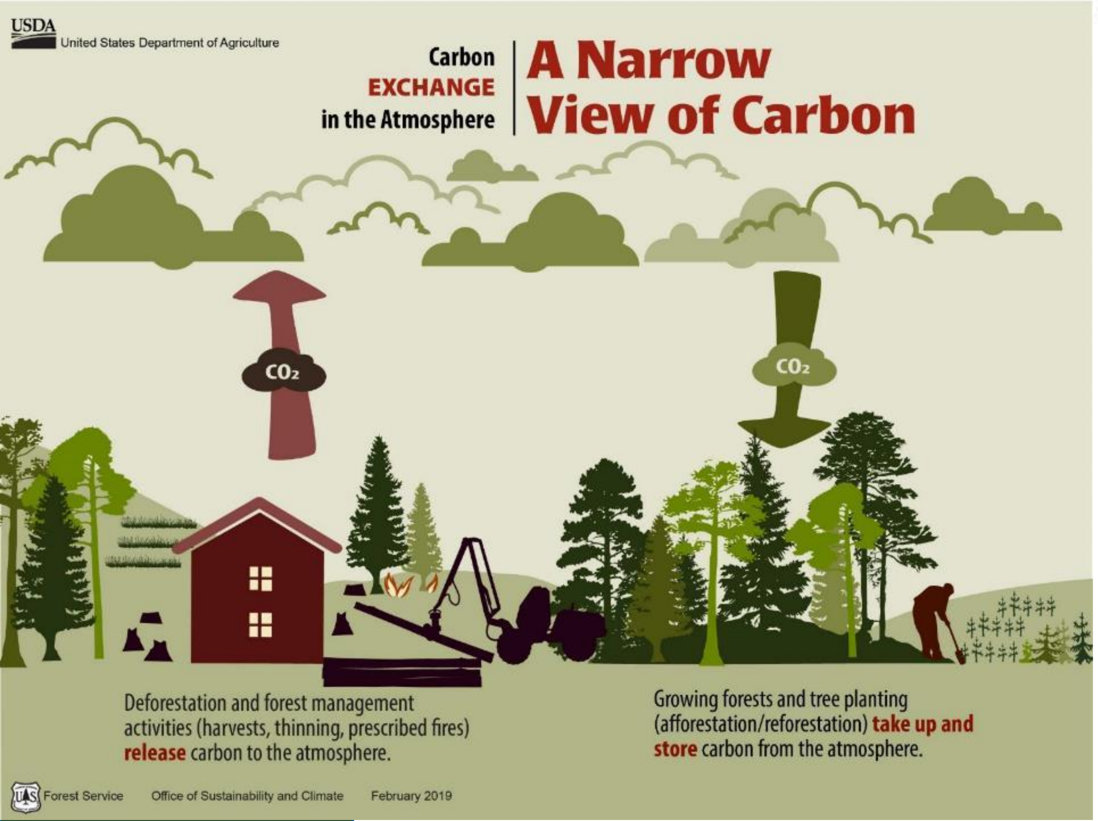
Understanding the relationship of forests, forest management & use, forest products is like an elephant….

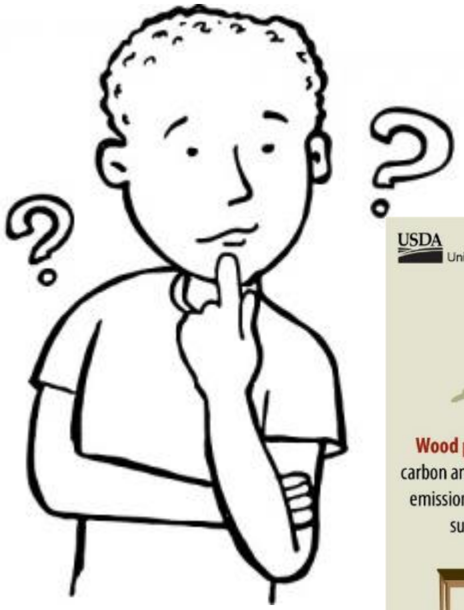
Sometimes you make the wrong conclusions when you don't look at the whole…

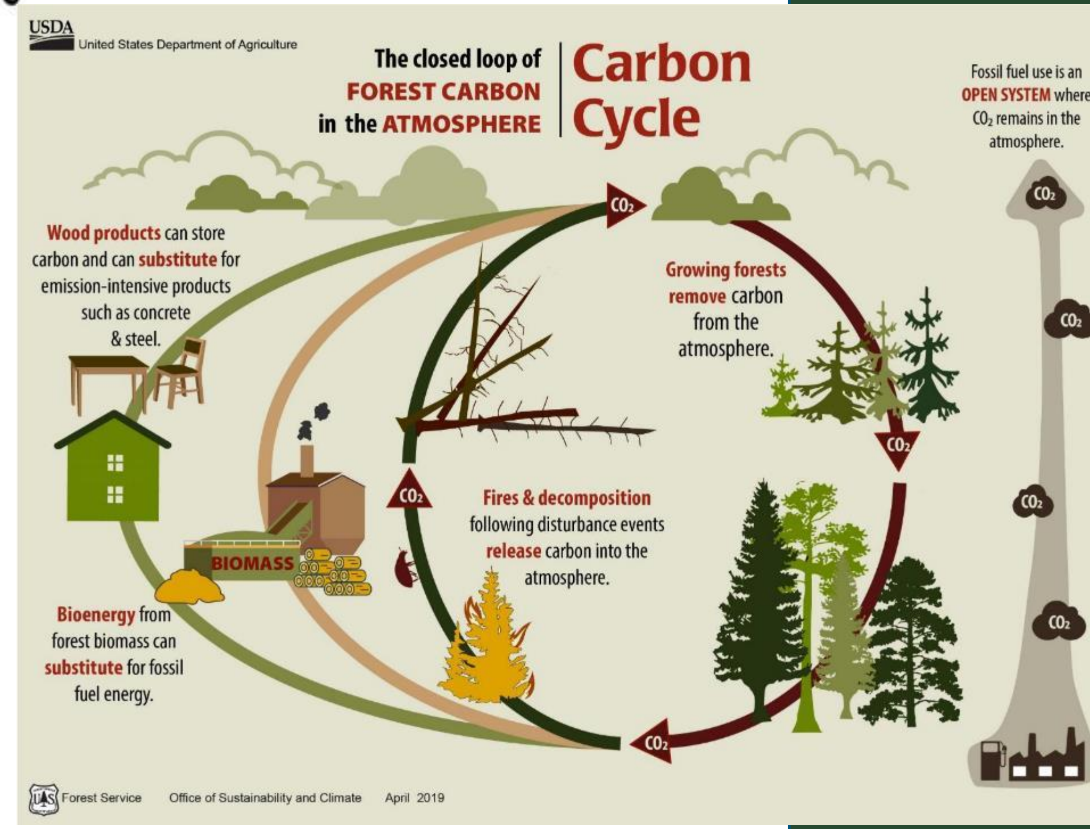


G. Renee Guzlas, artist

Challenges: Competing views

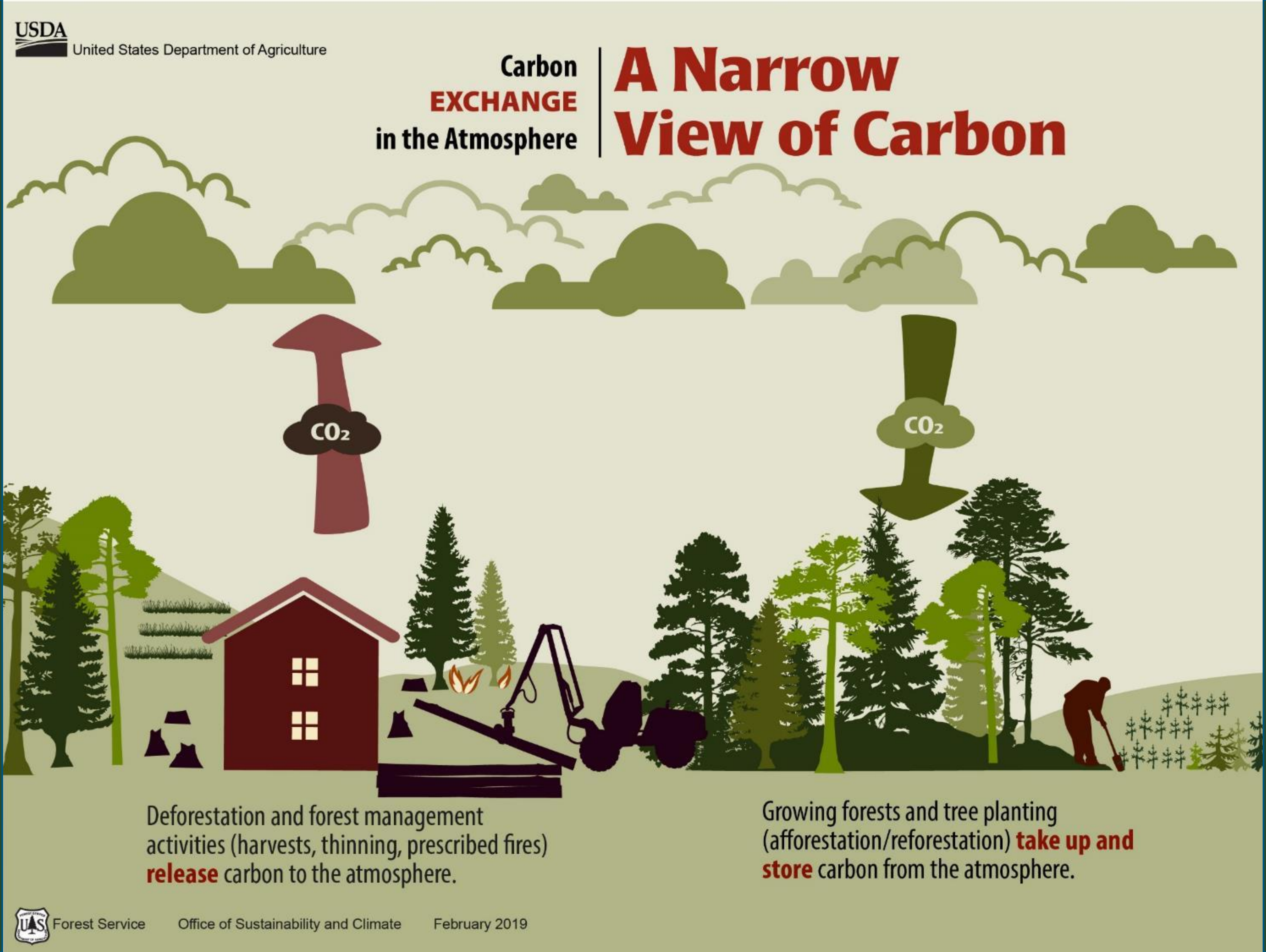






Differing perspectives on how to conceptualize the forest system is the greatest source of confusion and conflict!

How most people view the forest system …



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

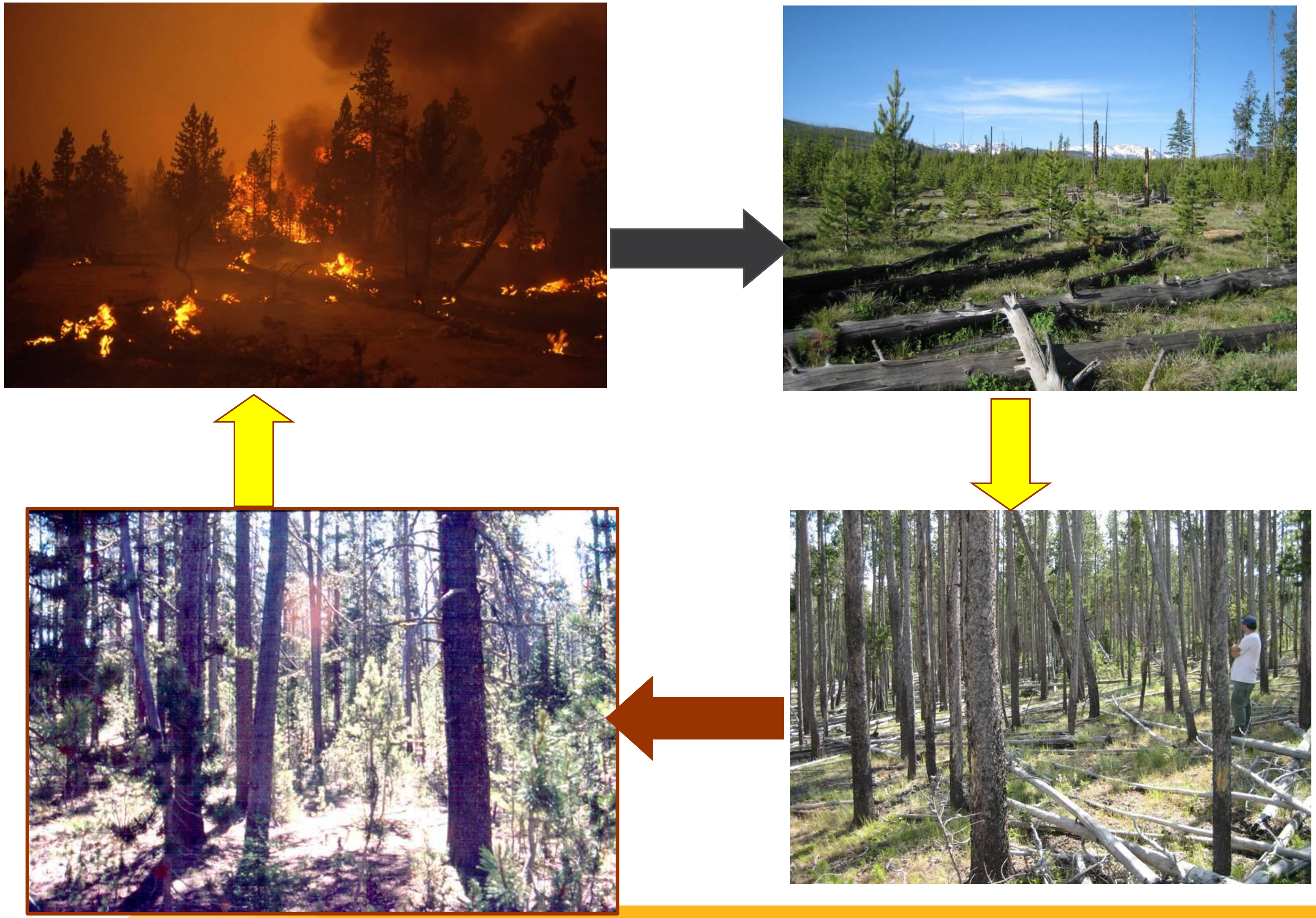
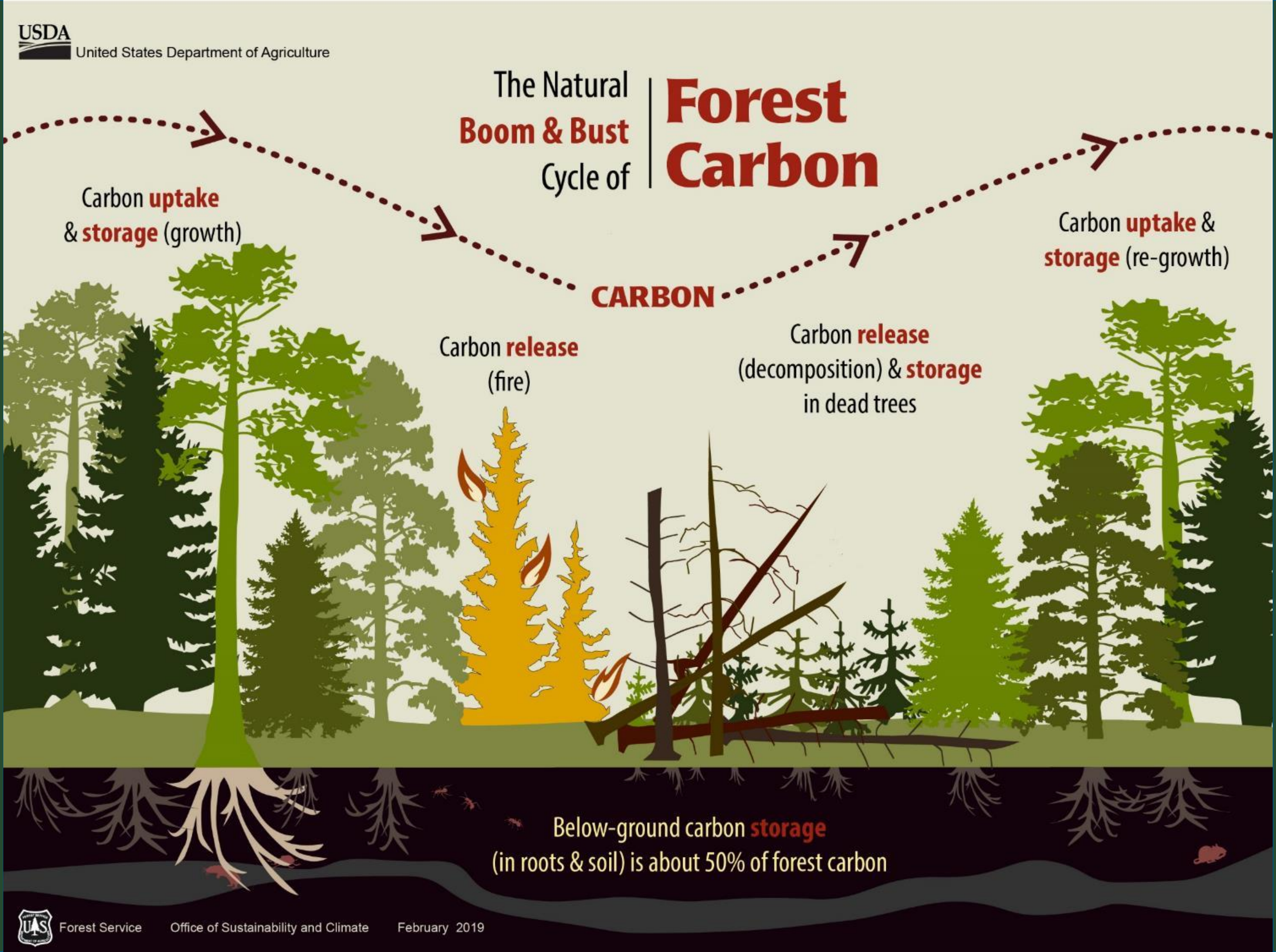
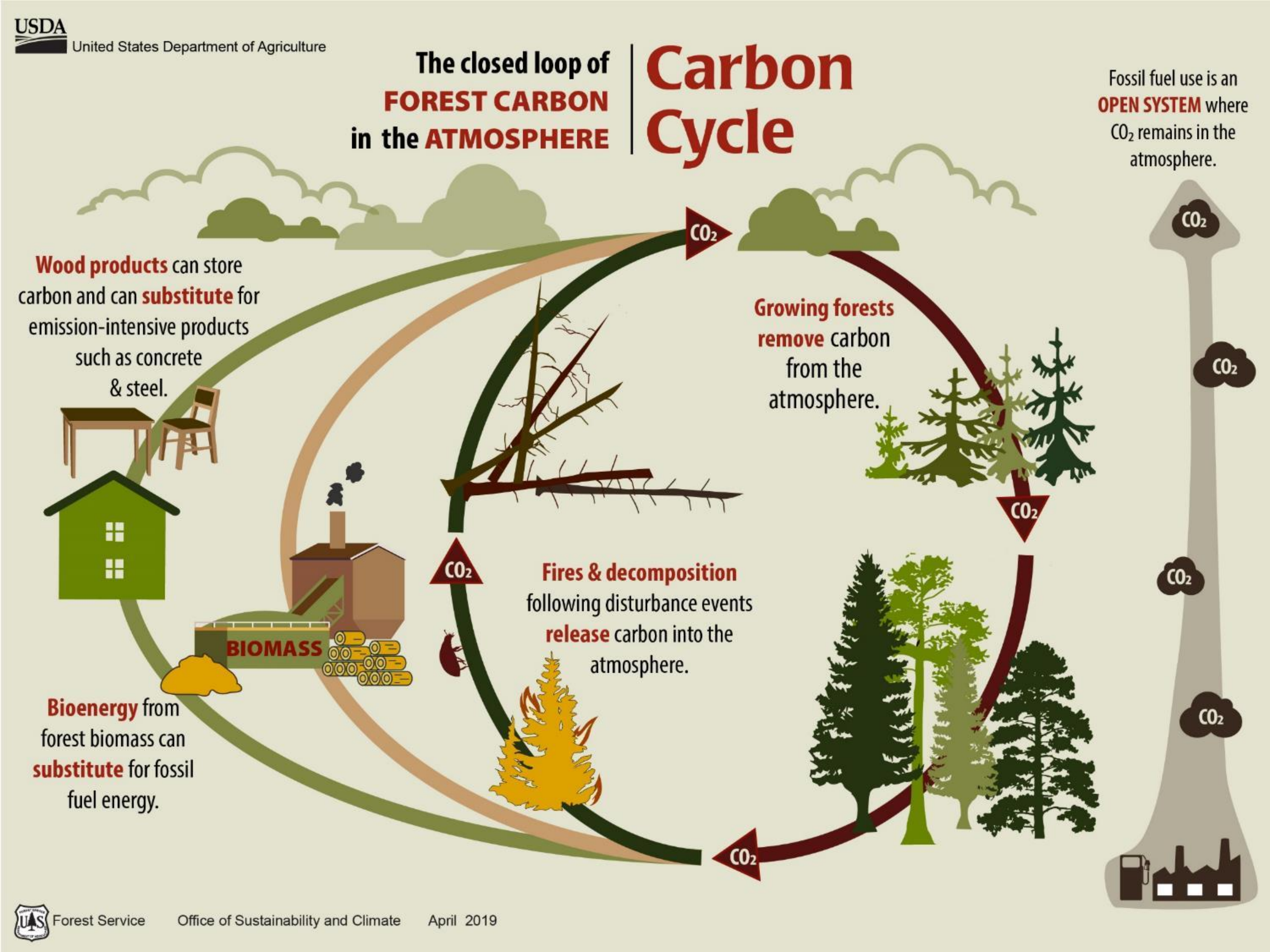
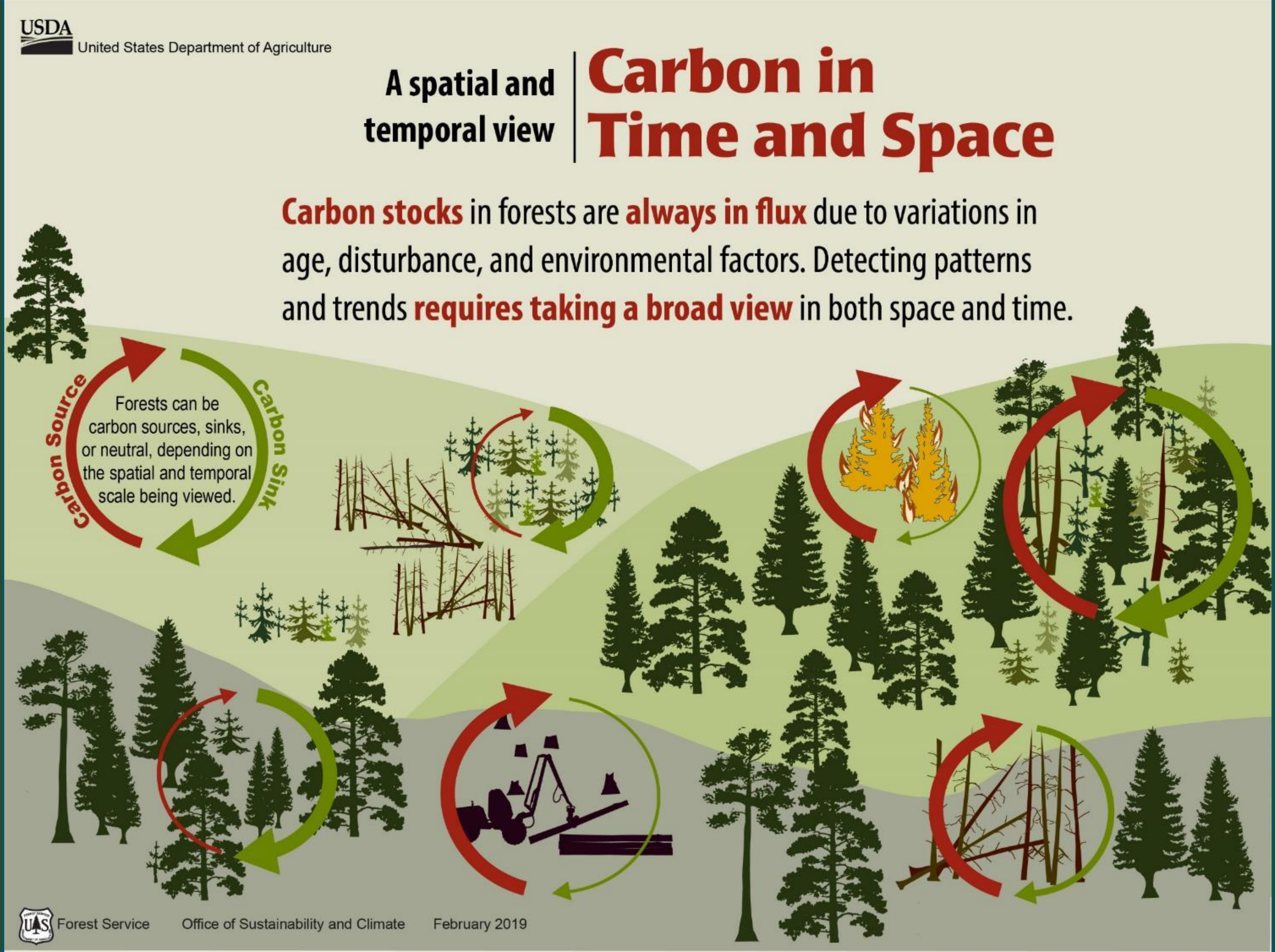


Photo by Dan Kashian

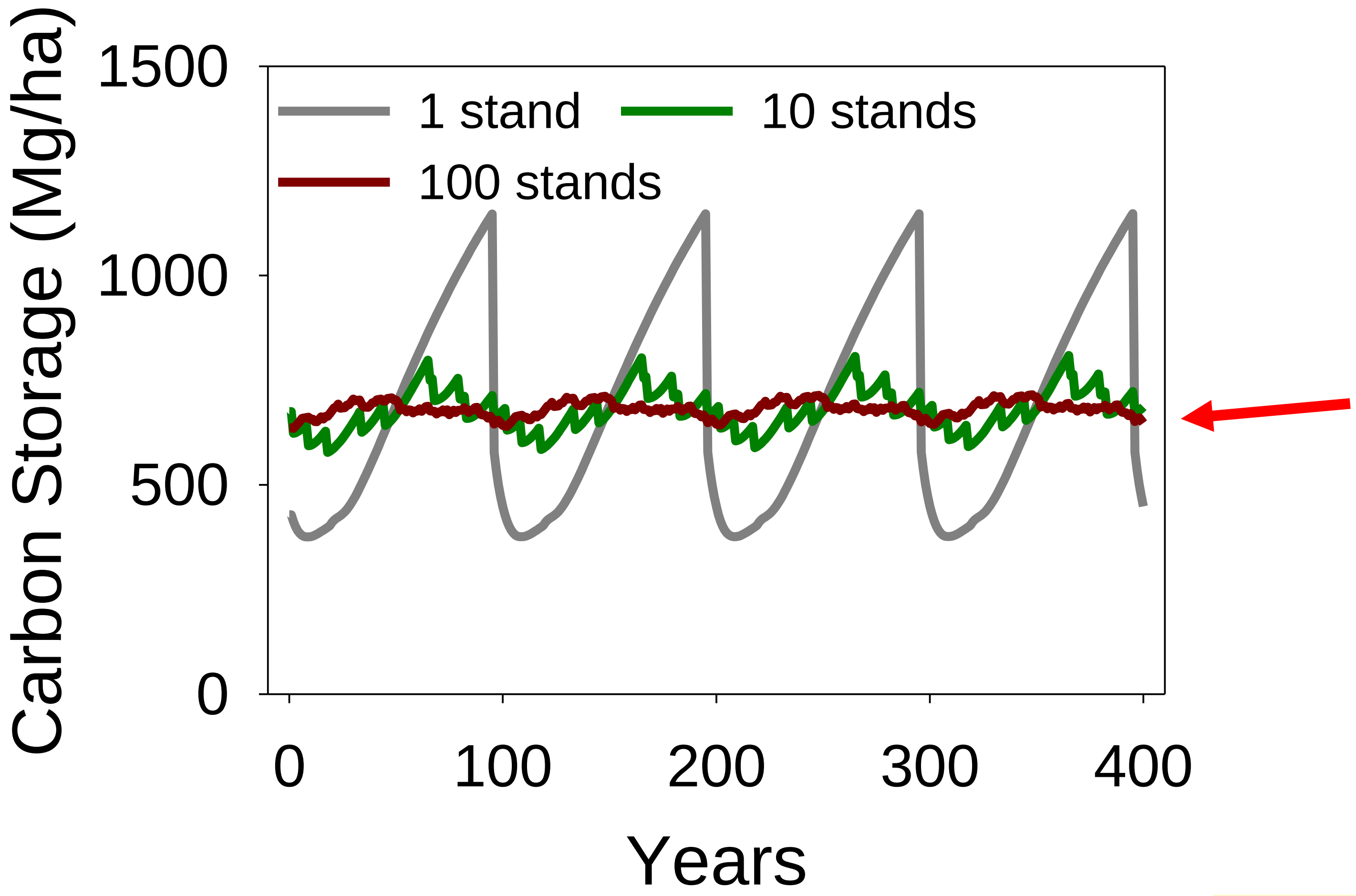
Photo by Mike Ryan


USDA
United States Department of Agriculture
The Natural Boom & Bust Cycle of
Forest Carbon
Carbon uptake & storage (growth)
CARBON
Carbon release (fire)
Carbon release (decomposition) & storage in dead trees
Carbon uptake & storage (re-growth)
Below-ground carbon storage (in roots & soil) is about 50% of forest carbon
Forest Service
Office of Sustainability and Climate
February 2019


USDA
United States Department of Agriculture
The closed loop of FOREST CARBON in the ATMOSPHERE
Carbon Cycle
Fossil fuel use is an OPEN SYSTEM where CO_2 remains in the atmosphere.
CO_2
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.
BIOMASS
Bioenergy from forest biomass can substitute for fossil fuel energy.
Forest Service
Office of Sustainability and Climate
April 2019


USDA
United States Department of Agriculture
A spatial and temporal view
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.
Carbon Source
Carbon Sink
Forests can be carbon sources, sinks, or neutral, depending on the spatial and temporal scale being viewed.
Forest Service
Office of Sustainability and Climate
February 2019

The larger the landscape considered, the more accurate the representation of the forest and the more stable the carbon seems



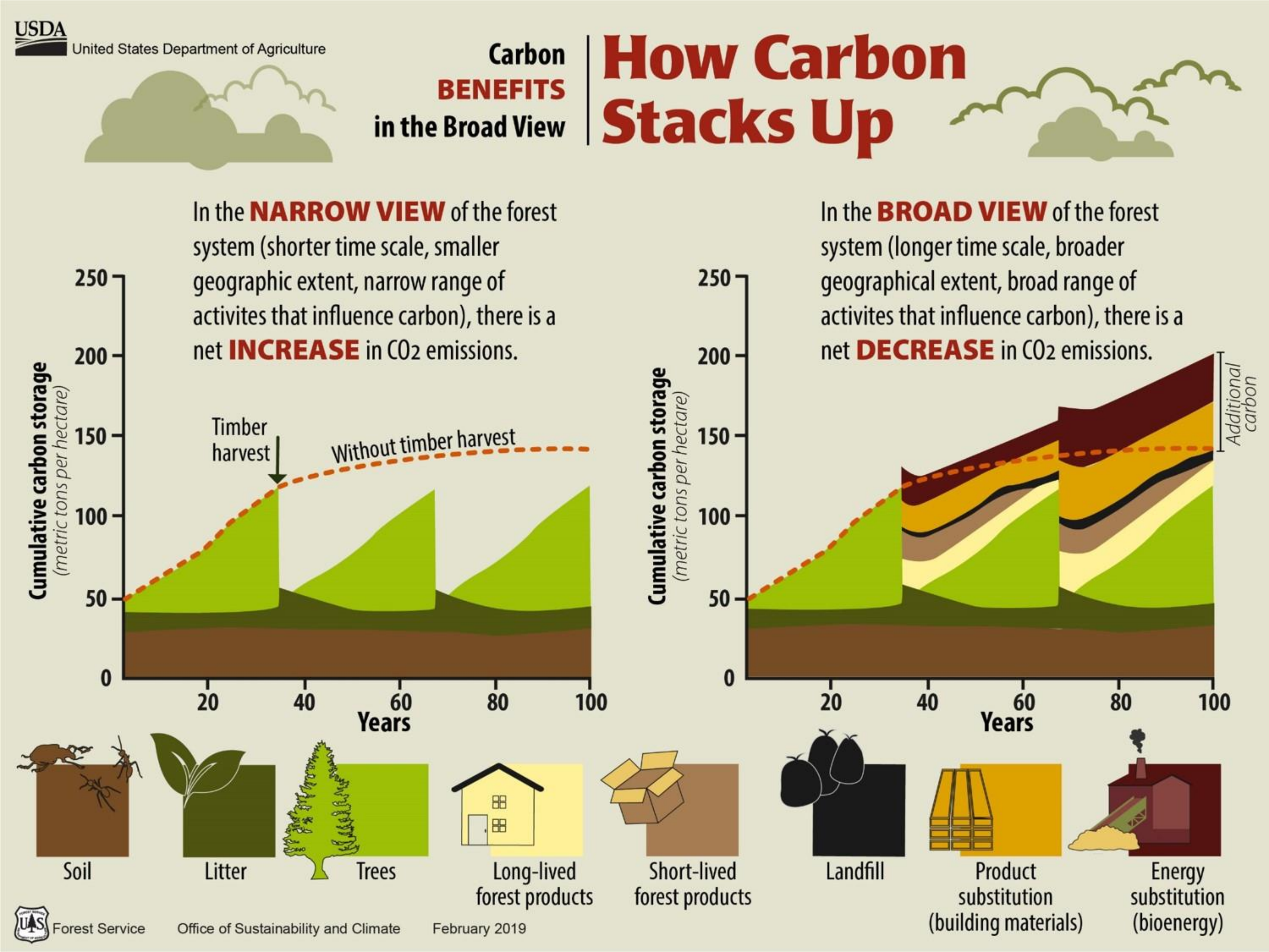
Best scale to identify trends related to environmental change and land-use

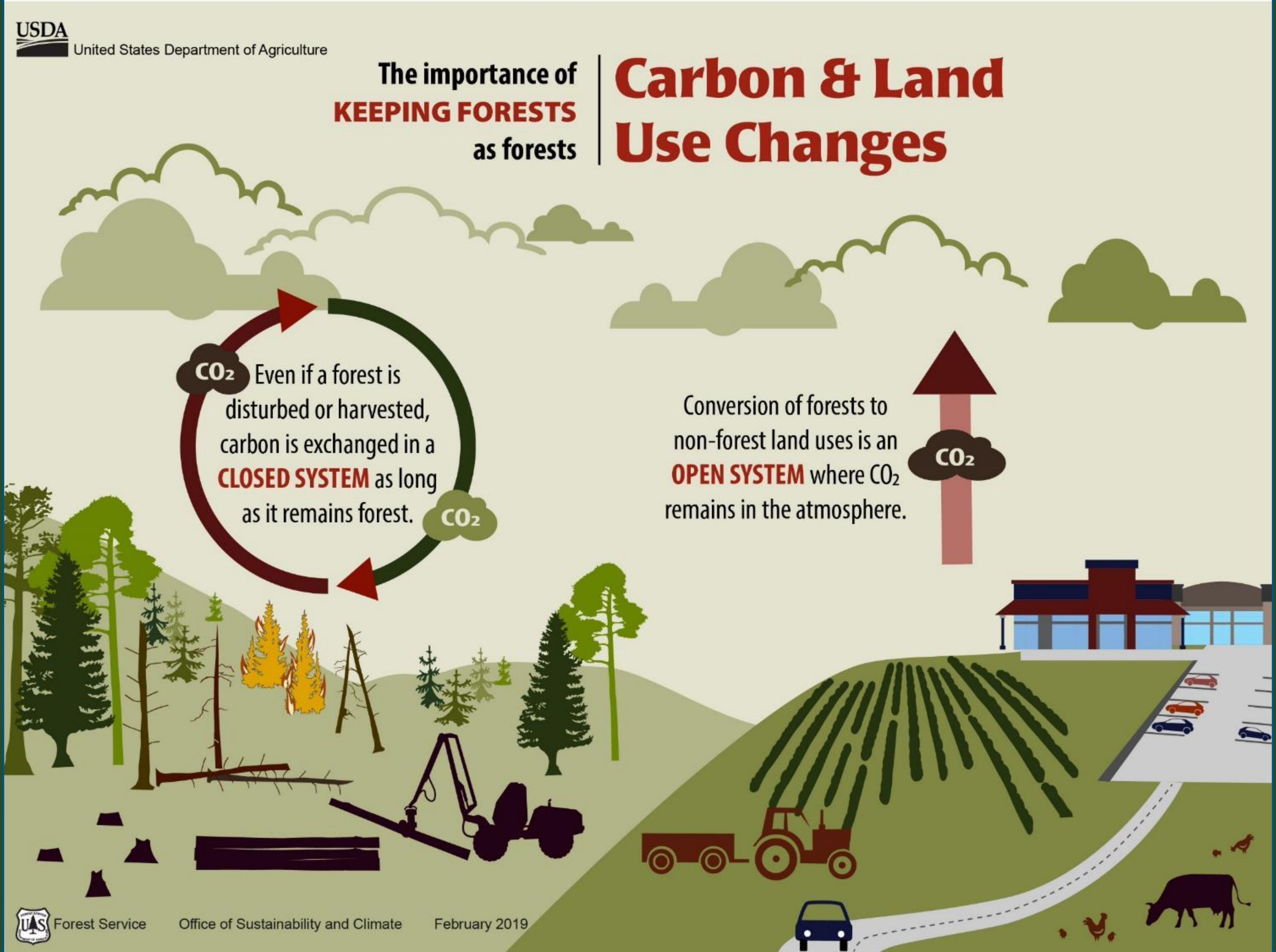
McKinley et al. 2011

To look at the complete picture of forest carbon:

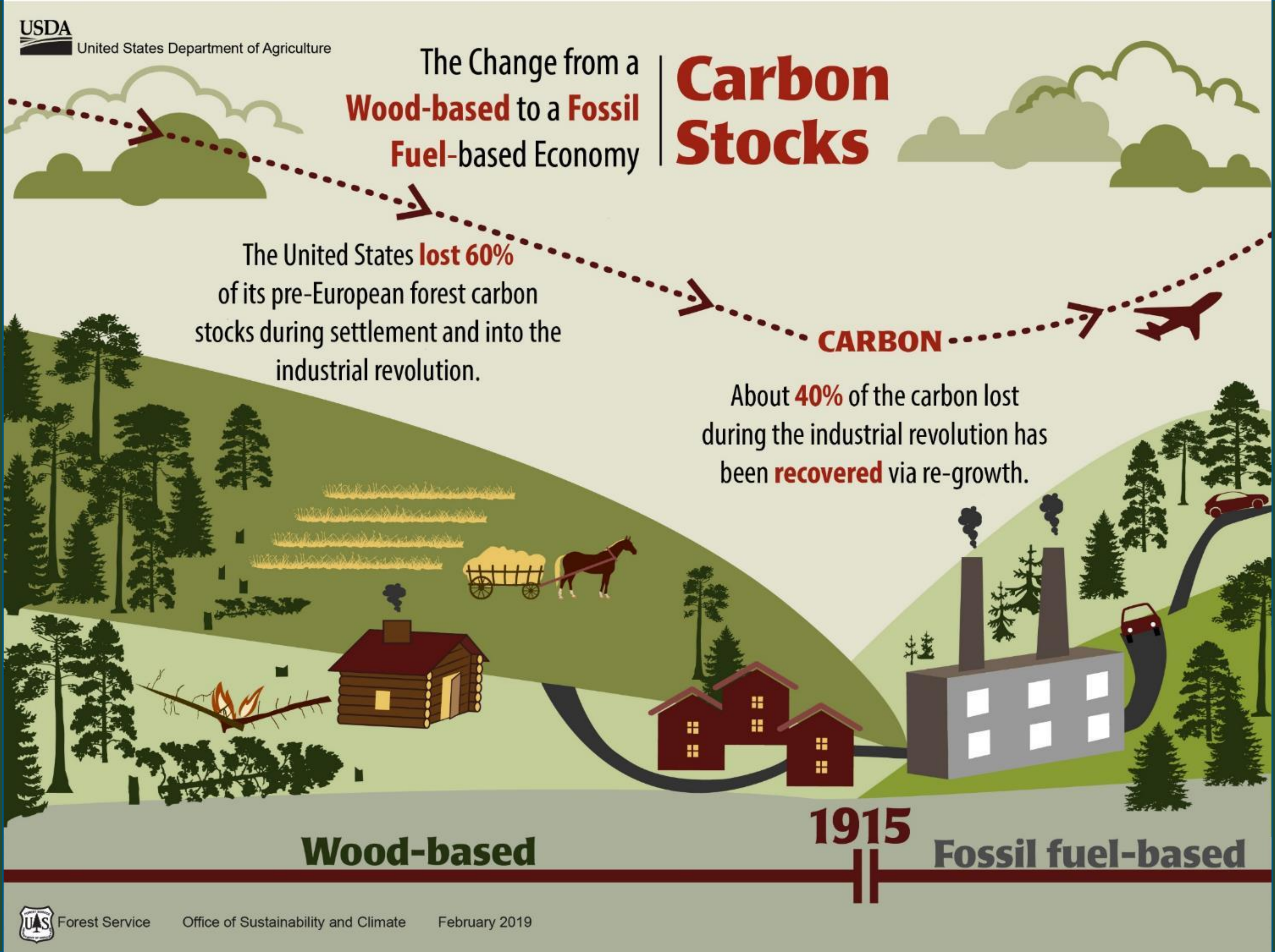
Look across an appropriate ecological time scale

Include a complete accounting of all carbon pools in the closed biogenic carbon cycle



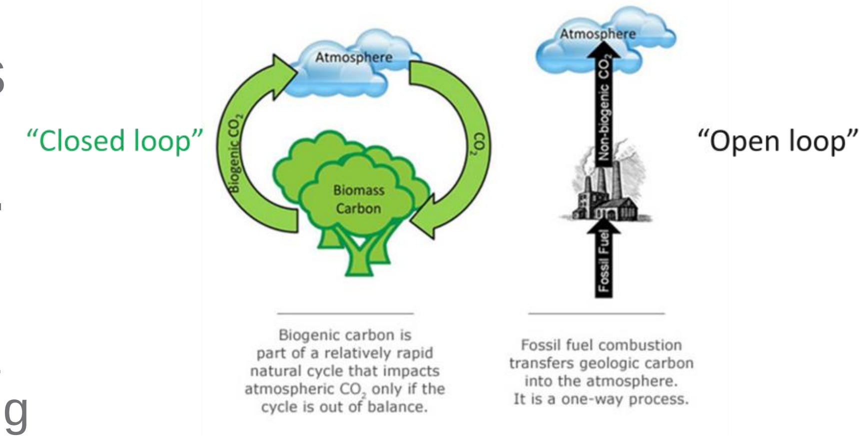


USDA
United States Department of Agriculture
The importance of KEEPING FORESTS as forests
Carbon & Land Use Changes
CO_2
Even if a forest is disturbed or harvested, carbon is exchanged in a CLOSED SYSTEM as long as it remains forest.
CO_2
Conversion of forests to non-forest land uses is an OPEN SYSTEM where CO_2 remains in the atmosphere.
CO_2
Forest Service
Office of Sustainability and Climate
February 2019


USDA
United States Department of Agriculture
The Change from a Wood-based to a Fossil Fuel-based Economy
Carbon Stocks
The United States lost 60% of its pre-European forest carbon stocks during settlement and into the industrial revolution.
CARBON
About 40% of the carbon lost during the industrial revolution has been recovered via re-growth.
Wood-based
1915
Fossil fuel-based
Forest Service
Office of Sustainability and Climate
February 2019

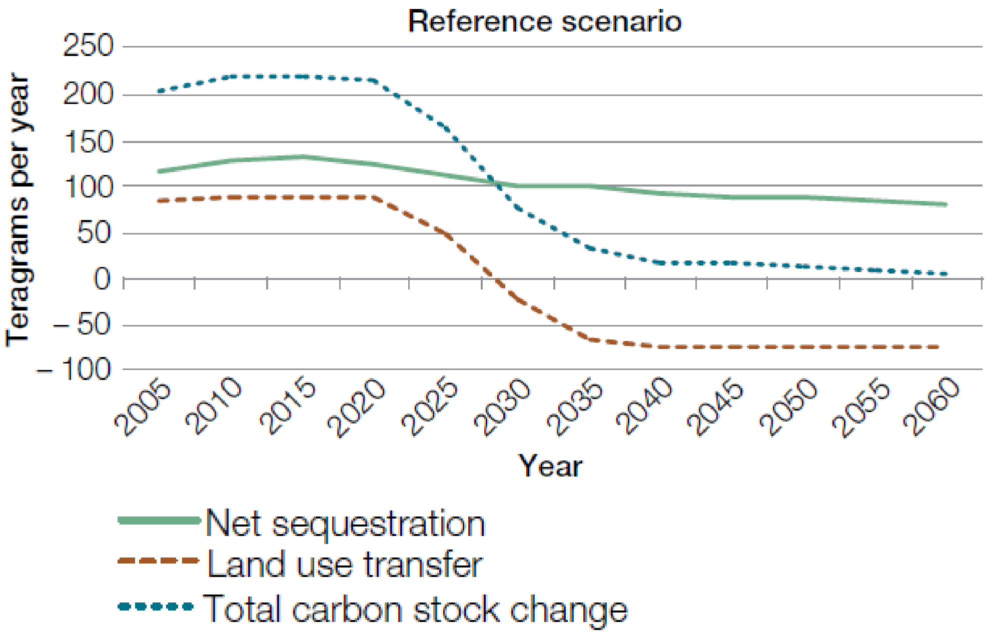
Keeping Forests as Forests is the major concern with respect to carbon

- 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)

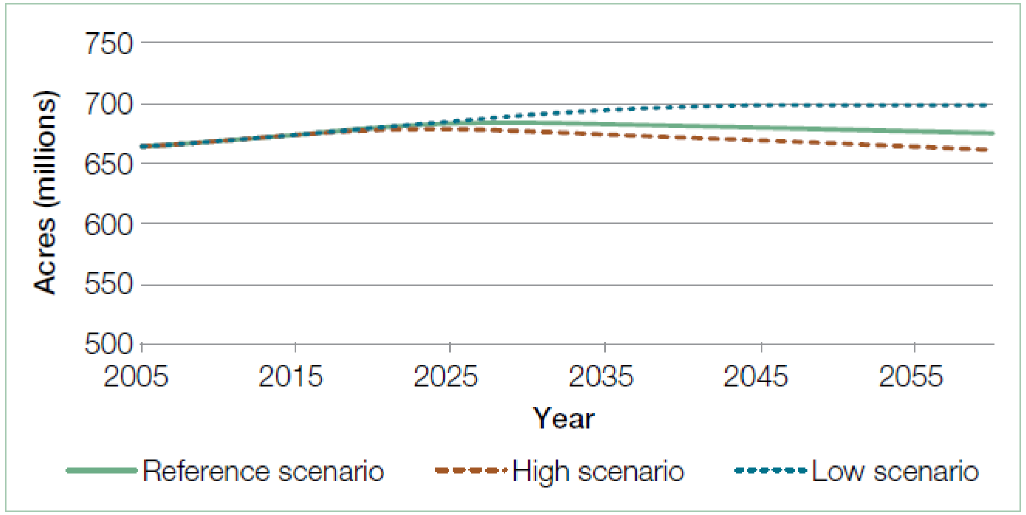


Loss of forest land is primary driver of forest carbon loss in the future

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



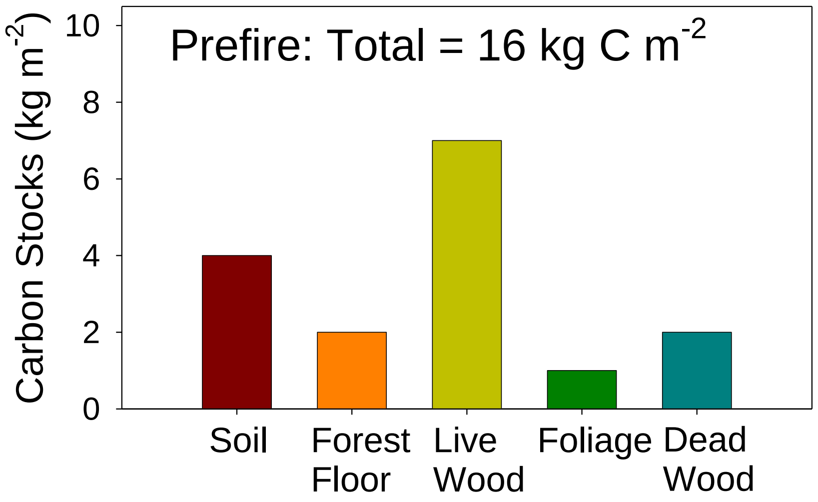
Area of U.S. forest land use

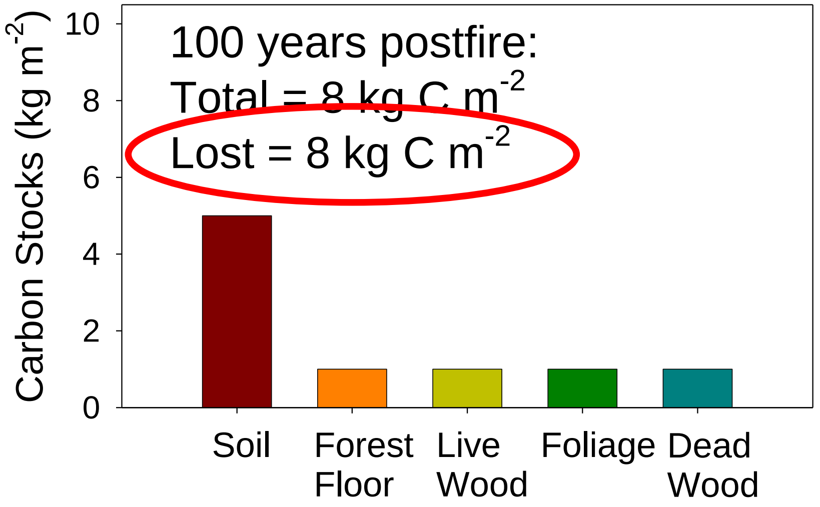


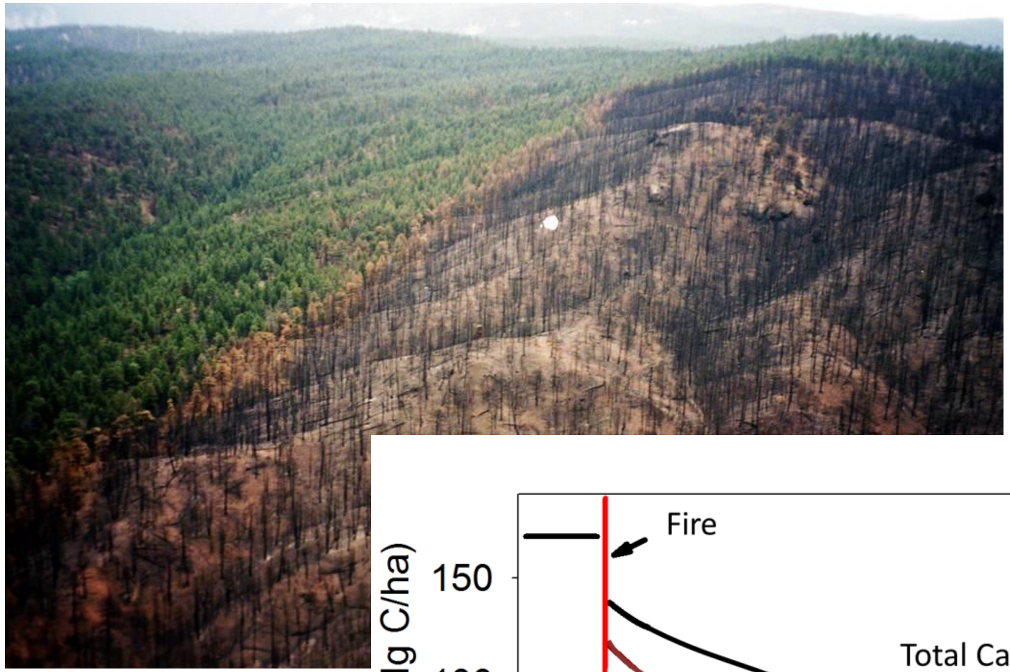
Net sequestration: forest carbon stock change minus land-use carbon transfers

What happens to carbon with no regeneration? Main concern for NFS lands

Example: Hayman Fire, Colorado, 2002







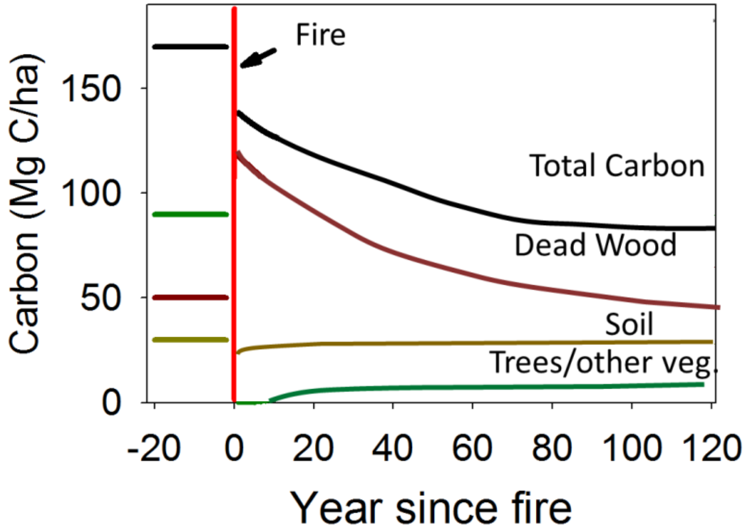
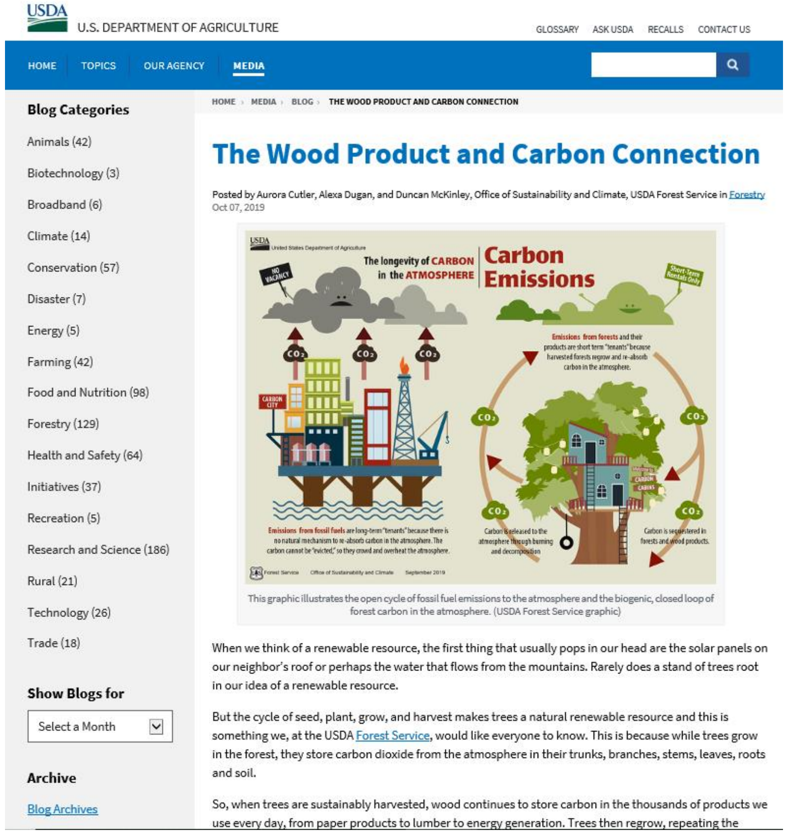


Photo by Merrill Kaufmann, USFS

M.G. Ryan

Carbon Communication Tools



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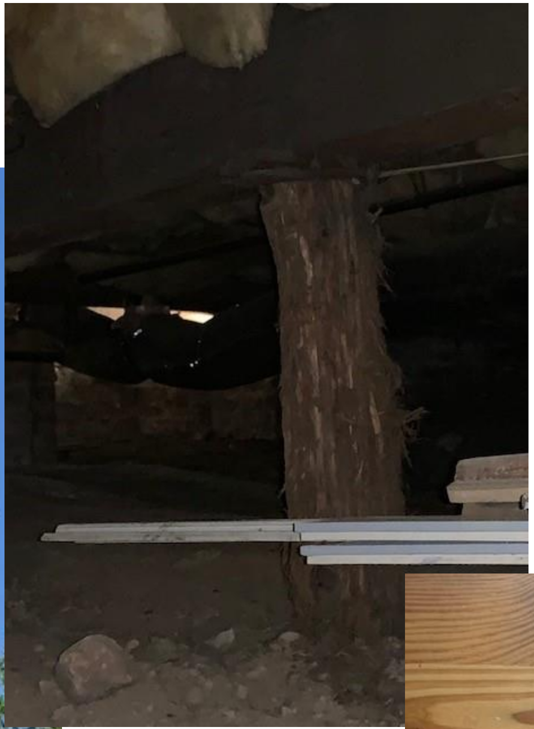
The story of “This Old House”

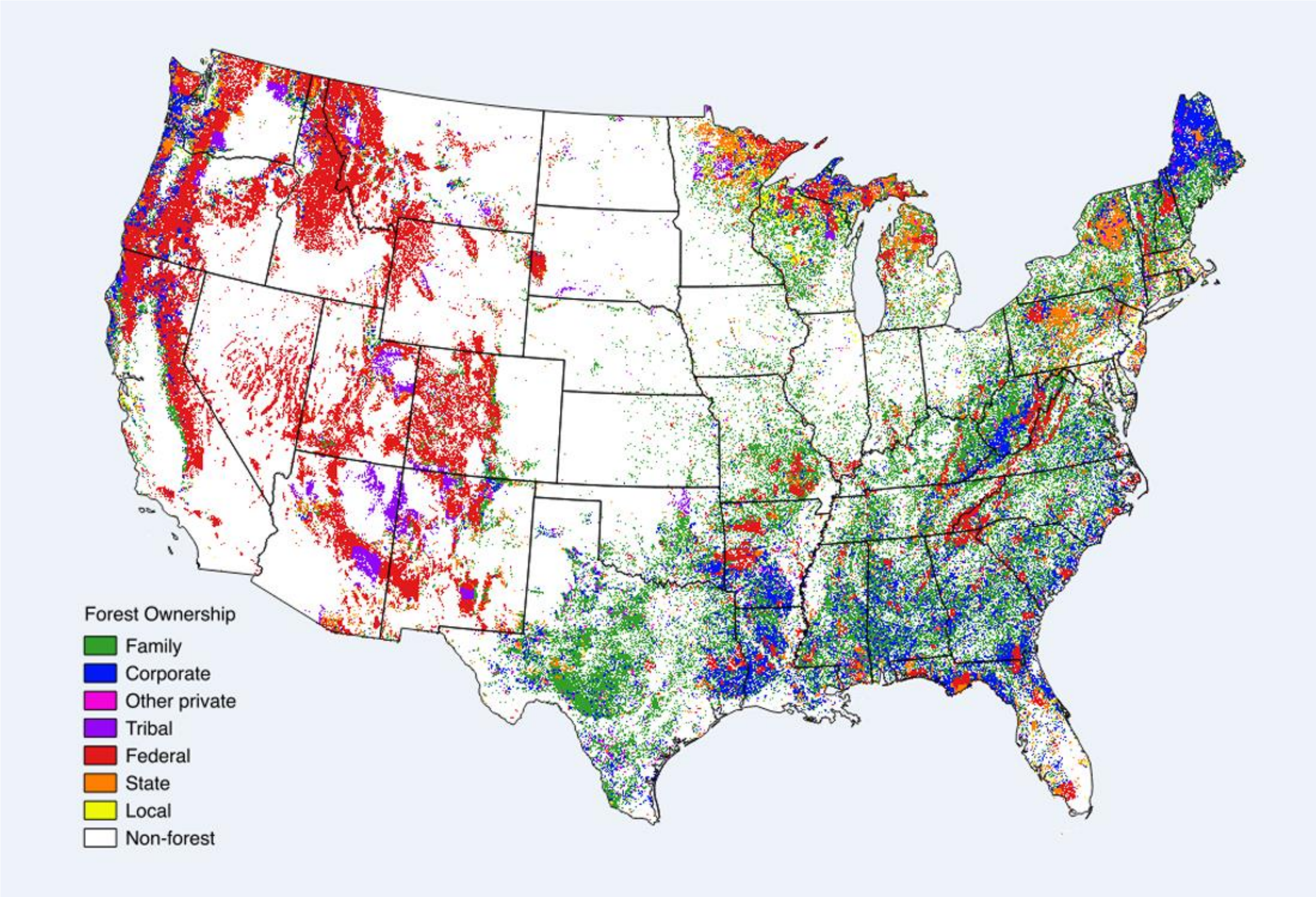



Thank You

Carbon Leadership Forum

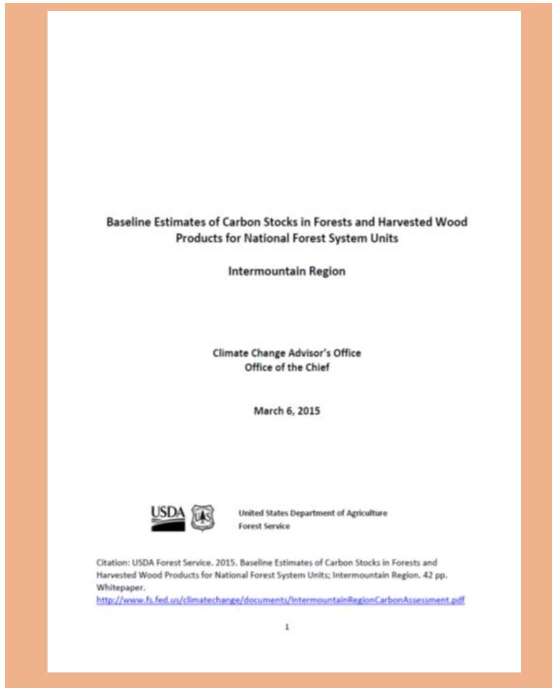
Additional slides

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



Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units

Intermountain Region

Climate Change Advisor's Office
Office of the Chief

March 6, 2015

United States Department of Agriculture
Forest Service

Citation: USDA Forest Service. 2015. Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units; Intermountain Region. 42 pp. Whitepaper.
http://www.fs.fed.us/climatechange/documents/IntermountainRegionCarbonAssessment.pdf

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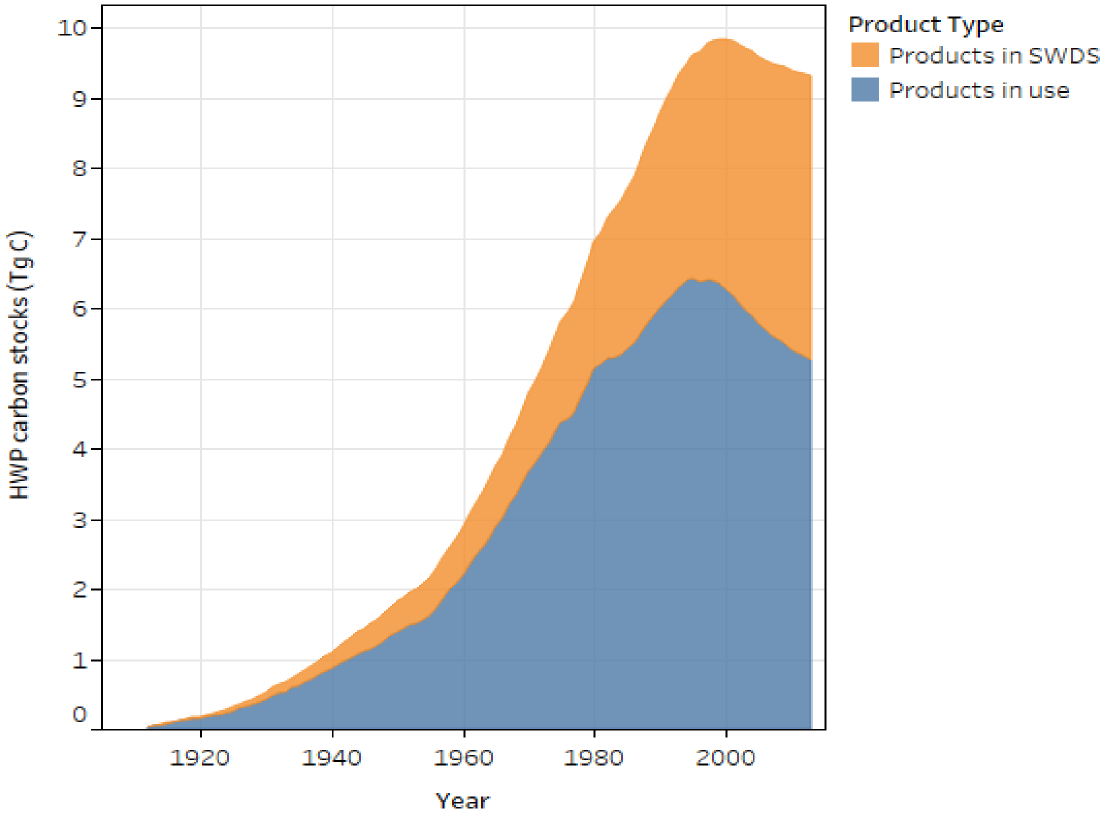


Figure 5. R4

Carbon Leadership Forum

Carbon Leadership Forum

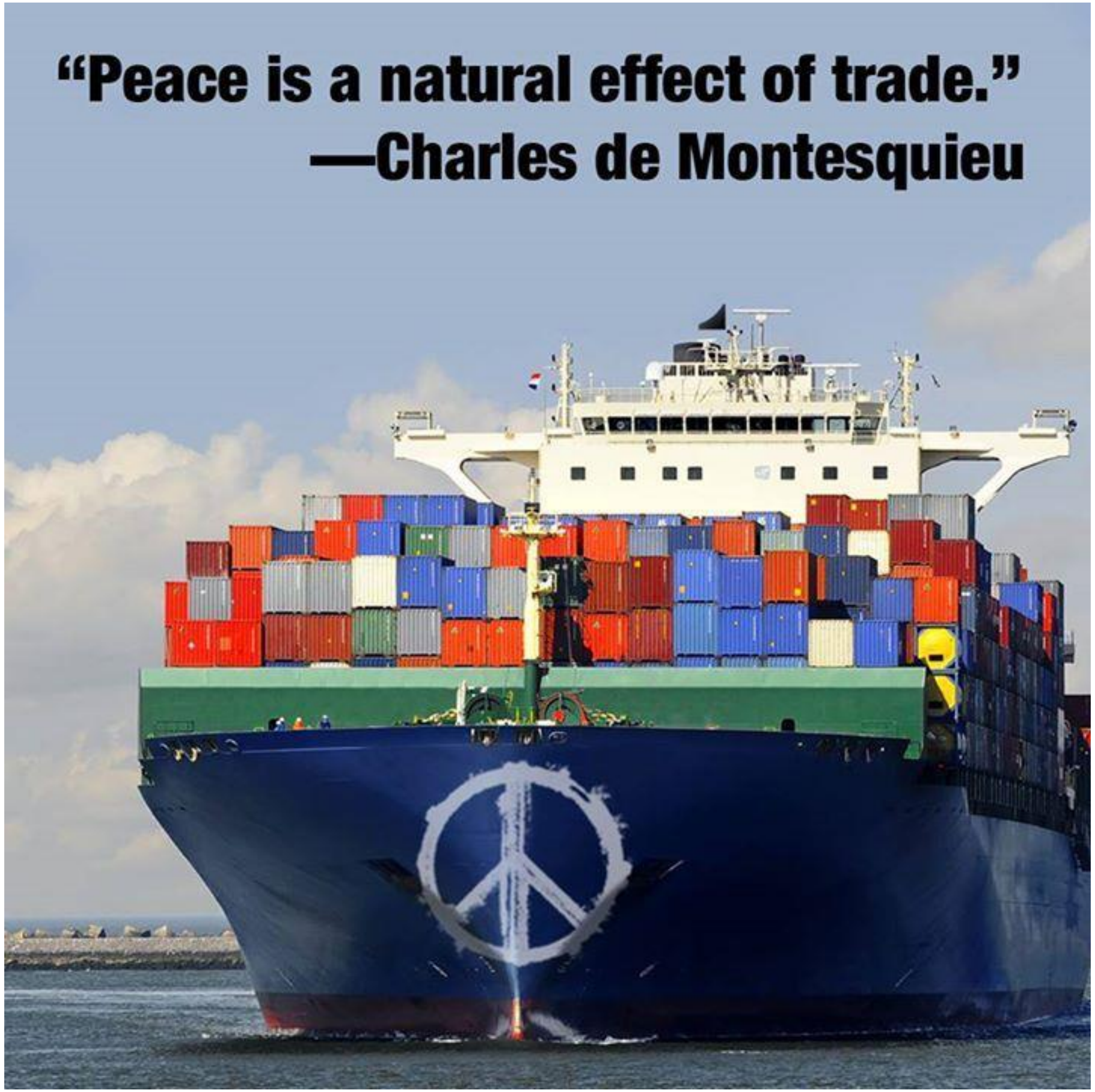
Manufacturing and the Forest Products Industry

Speaker Background

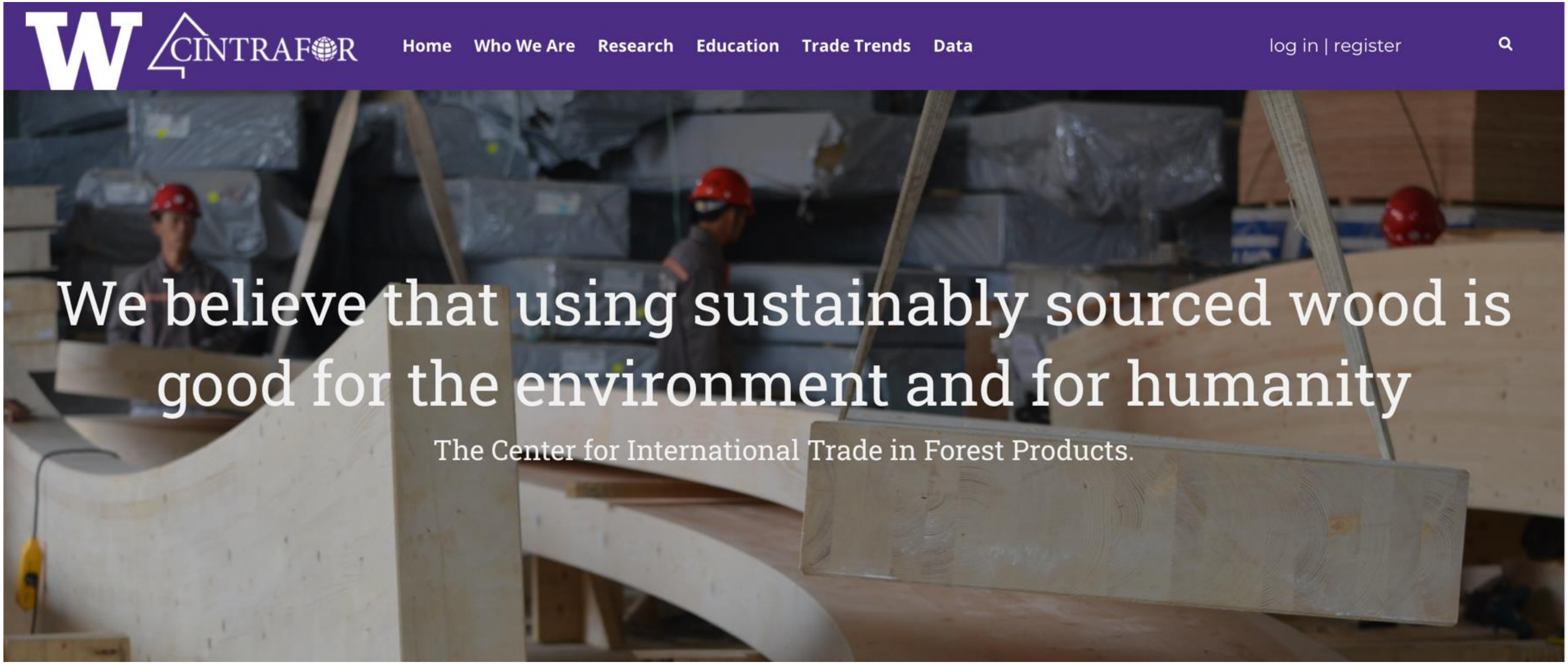
- Kent Wheiler
  - Associate Professor, University of Washington, School of Environmental and Forest Sciences
  - Director, Center for International Trade in Forest Products
    - Ph.D. in Marketing, University of Texas at Austin
    - 33 years forestry industry experience, including 26 years with Weyerhaeuser 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

CINTRAFOR
Center for International Trade in Forest Products

W
SCHOOL OF ENVIRONMENTAL AND FOREST SCIENCES
UNIVERSITY of WASHINGTON
College of the Environment



https://www.cintrafor.org/

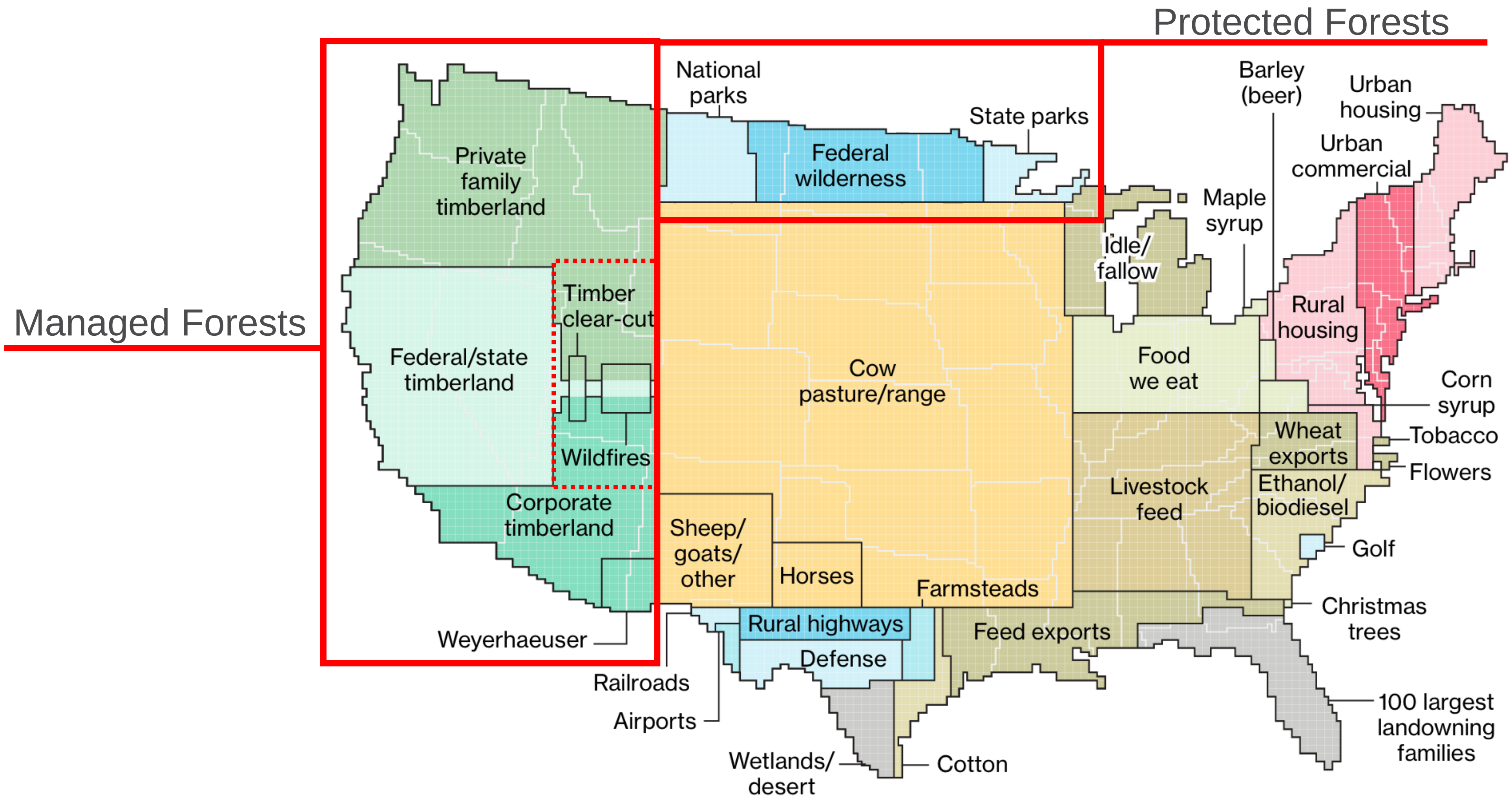


Forest Certification

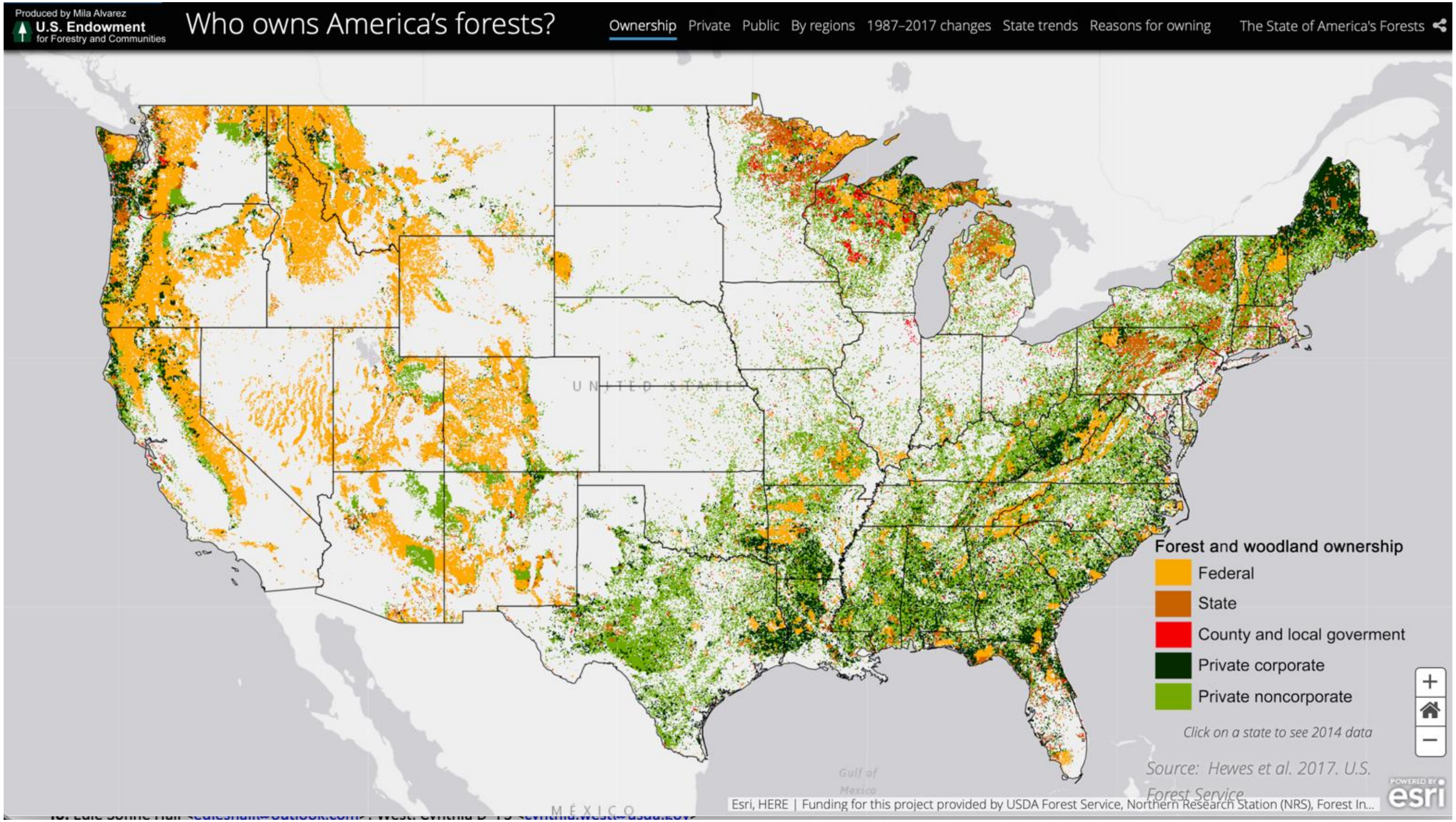
- Programme for the Endorsement of Forest Certification (PEFC)
  - Umbrella organization that endorses ~50 national forest certification systems developed through multi-stakeholder processes and tailored to local priorities and conditions.
  - For example, in the U.S. – The Sustainable Forestry Initiative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

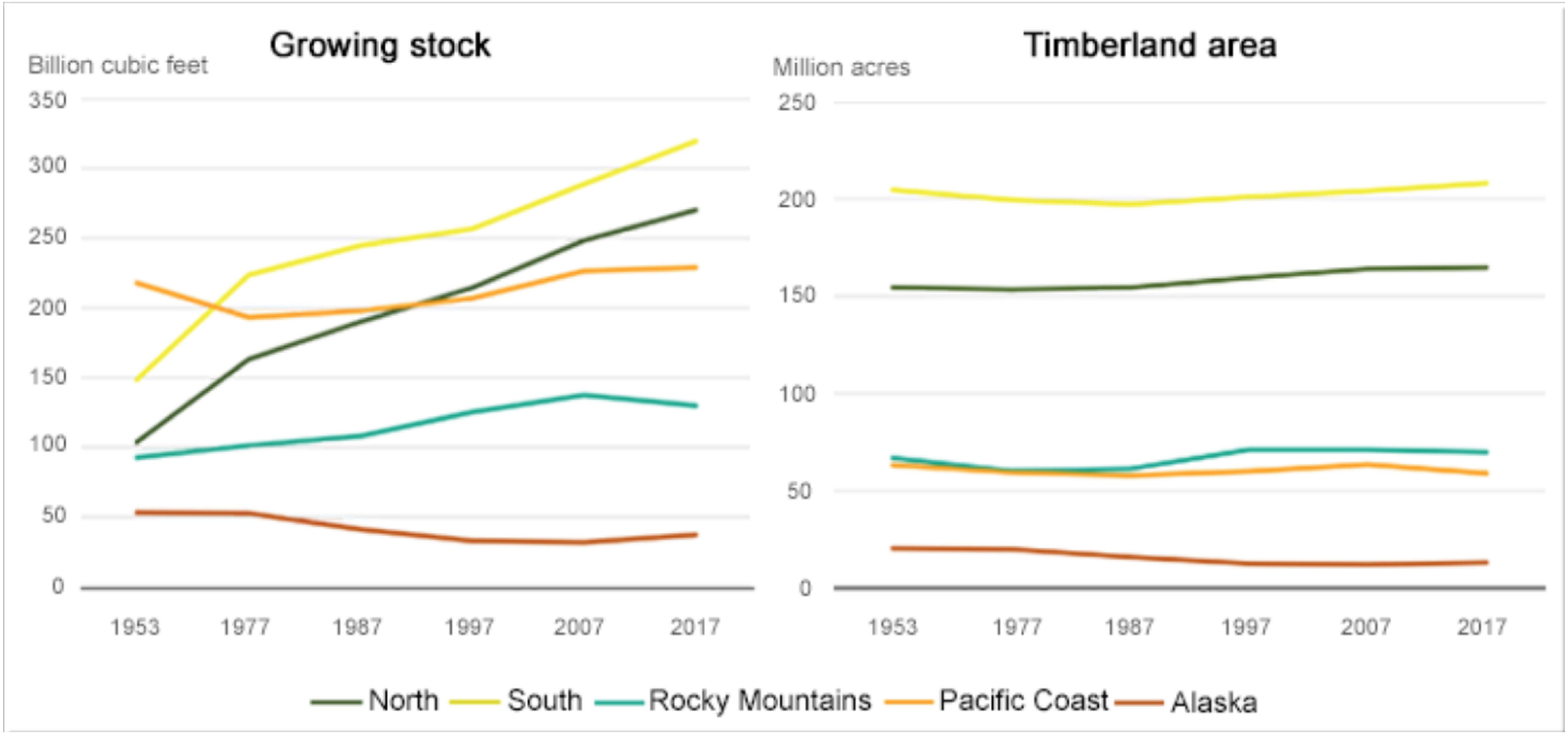
Here’s How American Uses Its Land (Merrill and Leatherby 2018)



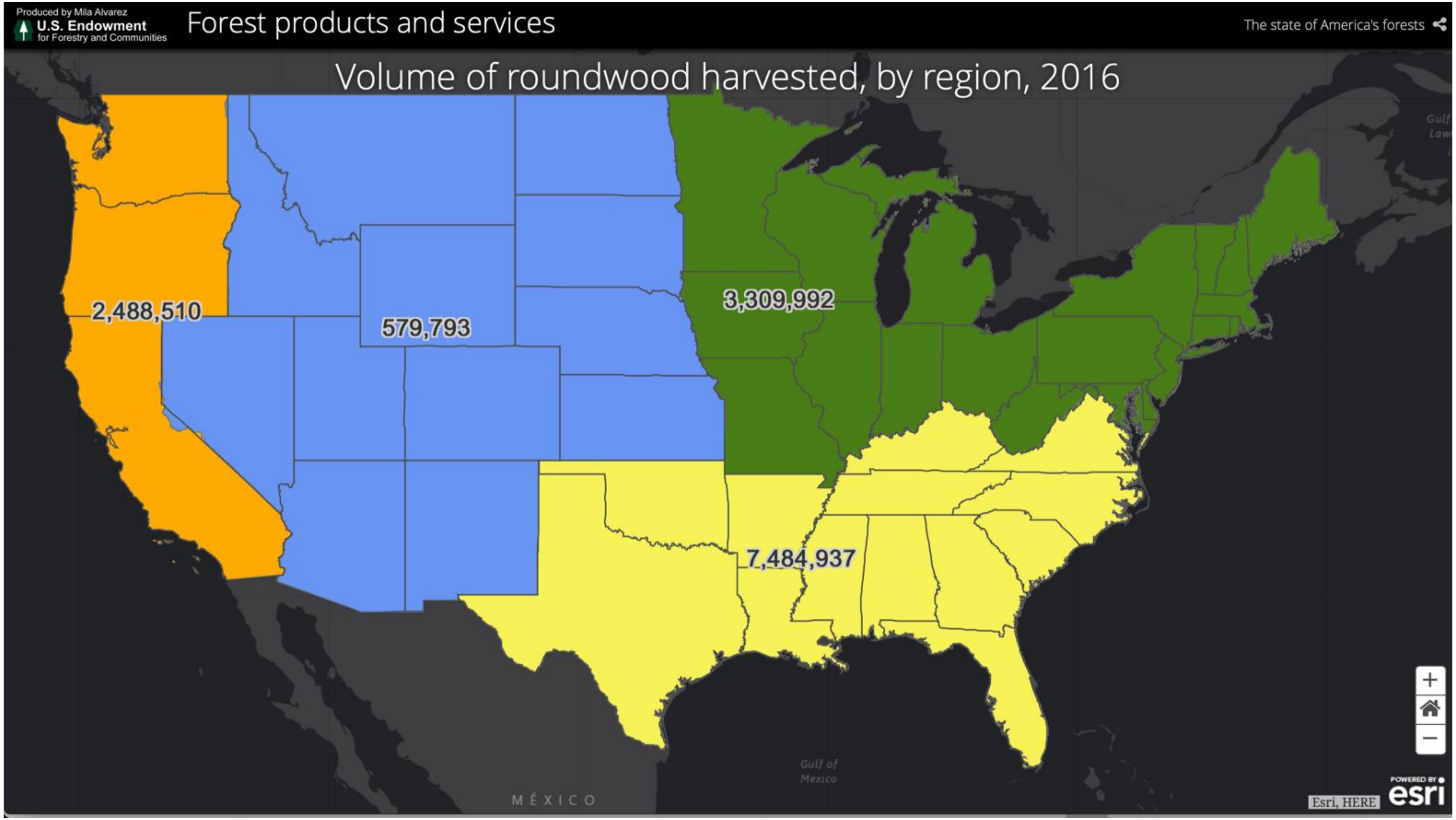
Source: **Bloomberg**, “Here’s How America Uses Its Land,” Dave Merrill and Lauren Leatherby, July 2018, available at https://www.bloomberg.com/graphics/2018-us-land-use/



Source: **US Endowment for Forestry and Communities**, produced by Mila Alvarez, available at https://usaforests.org



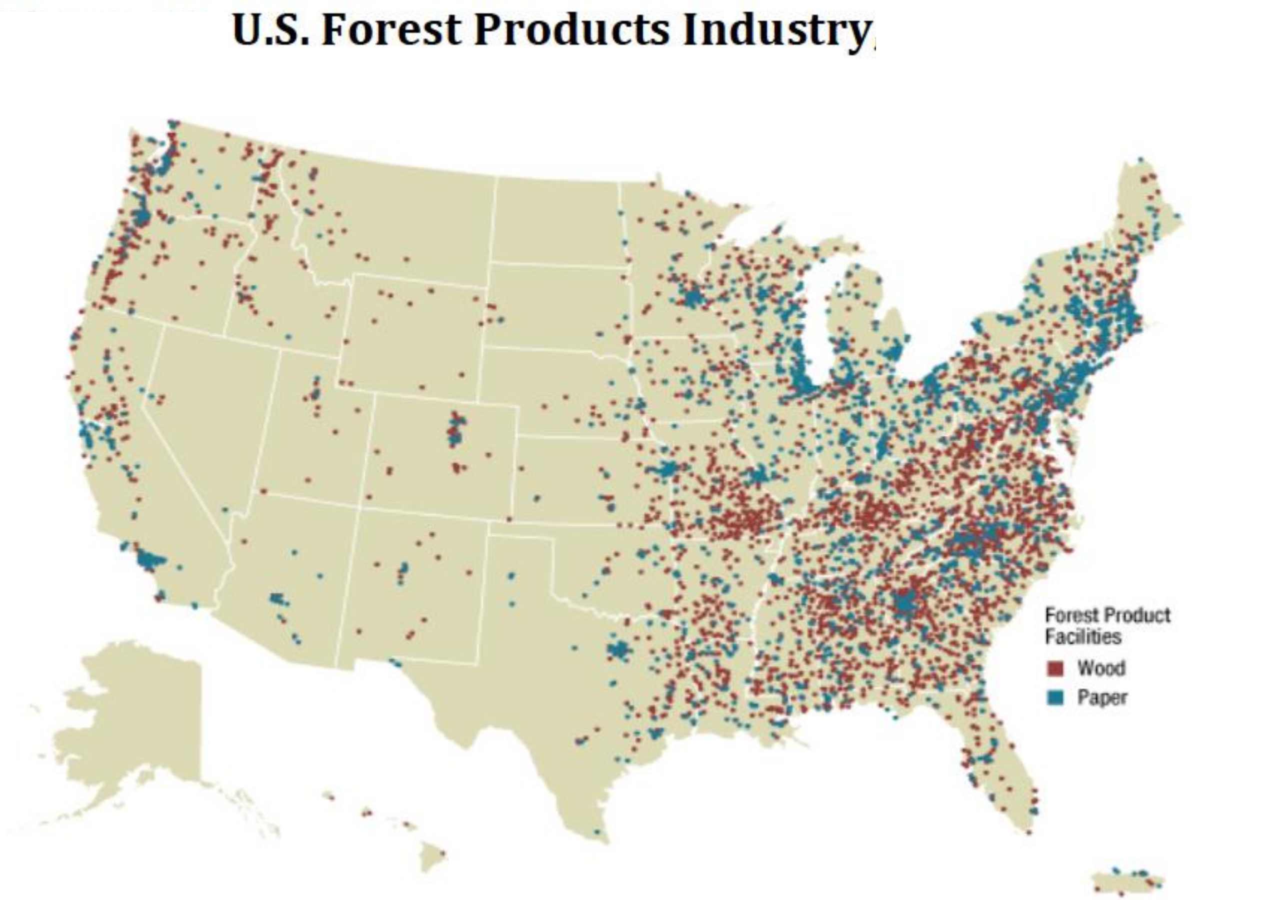
Source: **US Endowment for Forestry and Communities**, produced by Mila Alvarez, available at https://usaforests.org



Source: **US Endowment for Forestry and Communities**, produced by Mila Alvarez, available at https://usaforests.org

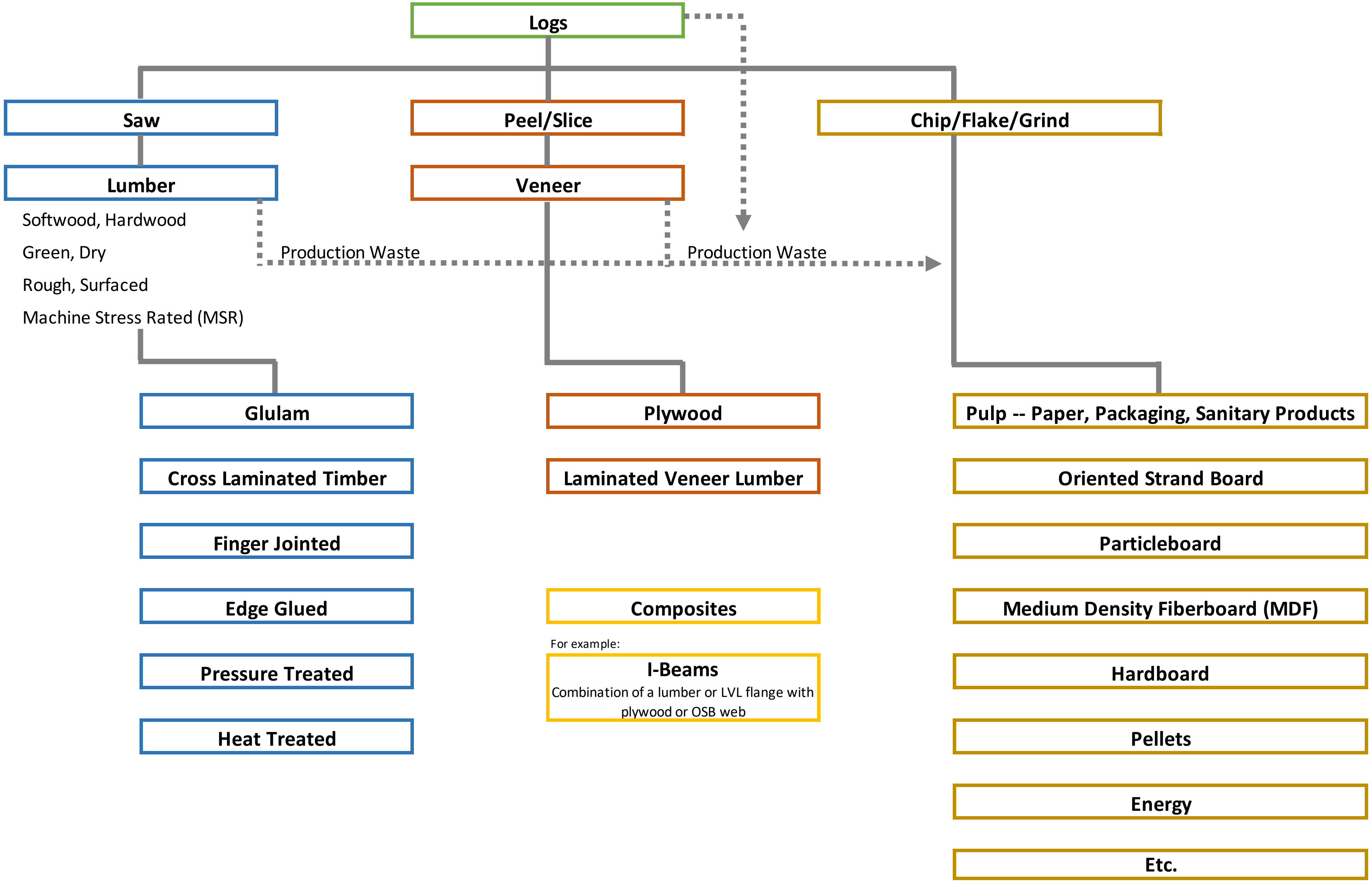
Industry is Located Where the Trees Are

- 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

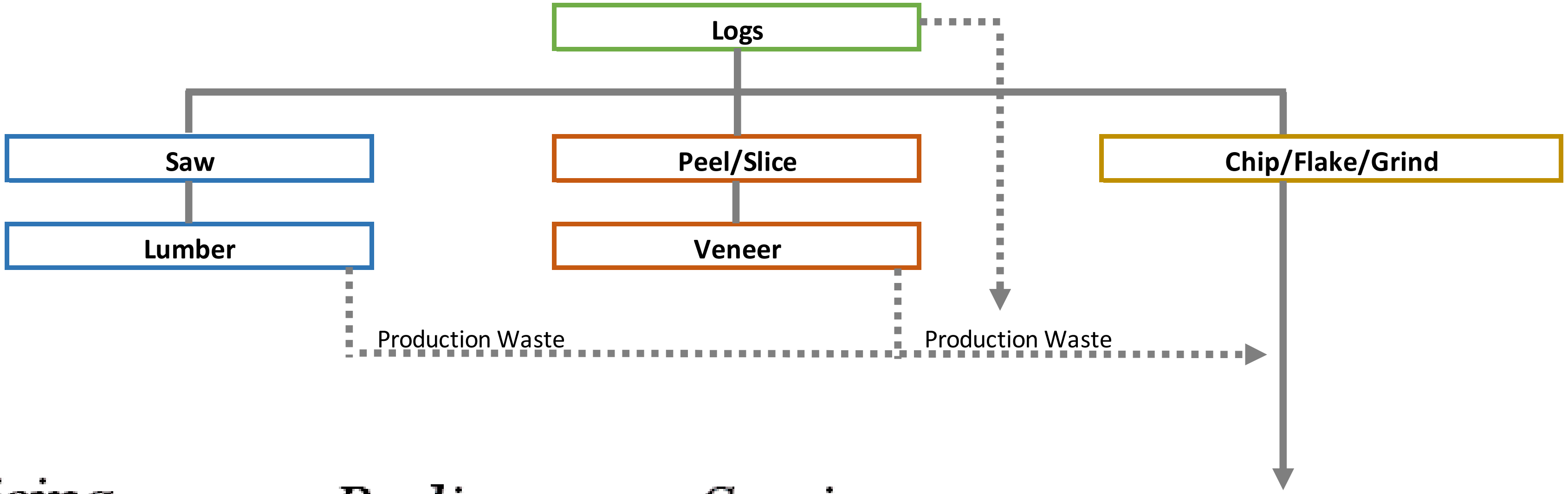


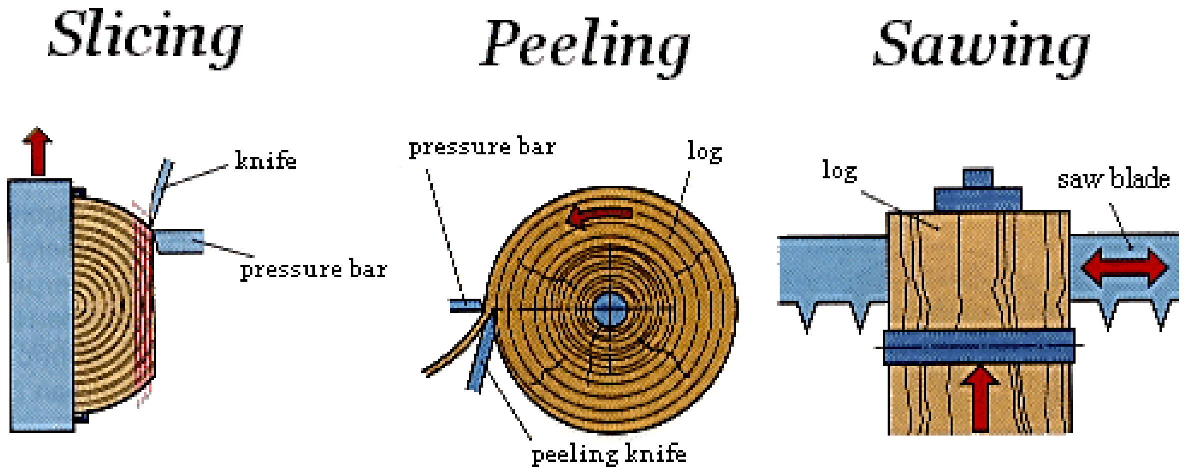
Source: U.S. Environmental Protection Agency (2011) (http://www.epa.gov/sectors/sectorinfo/sectorprofiles/forest/map.html)

Wood Products Taxonomy



Wood Products Taxonomy





http://www.metz-furniere.de/uberfurng.htm

https://cdn.newsapi.com.au

Wood Products Taxonomy

Logs

Saw

Lumber

Softwood, Hardwood

Green, Dry

Rough, Surfaced

Machine Stress Rated (MSR)

Production Waste

Glulam

Cross Laminated Timber

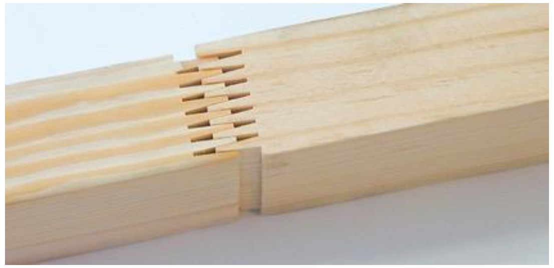
Finger Jointed

Edge Glued

Pressure Treated

Heat Treated

Pressure Treated Lumber



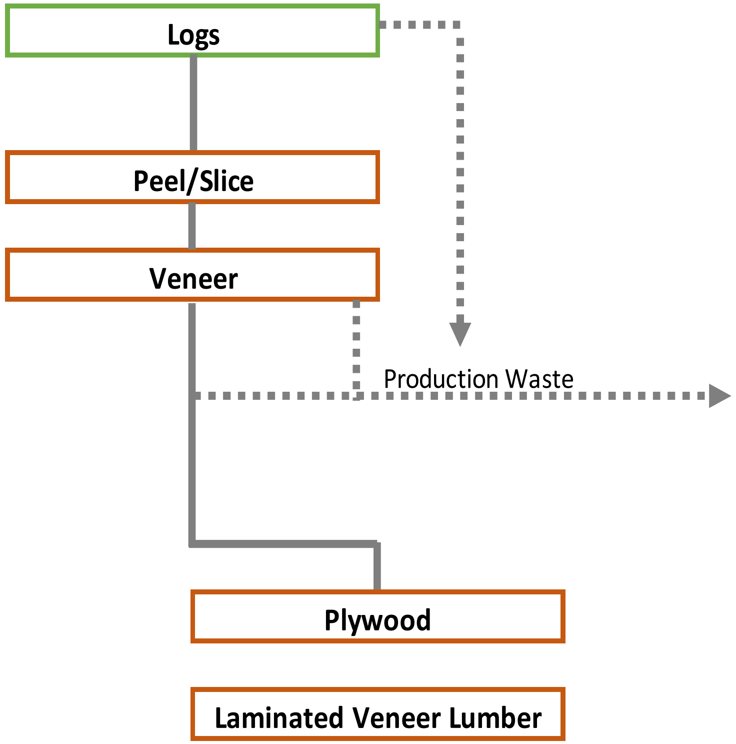
Finger Jointed Lumber

Lumber

Glulam

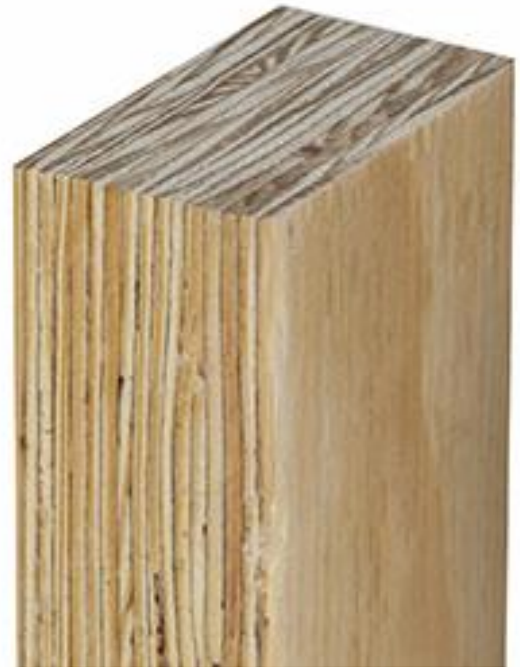
Cross Laminated Timber

Wood Products Taxonomy



Veneer

Plywood



Laminated Veneer Lumber

Wood Products Taxonomy

Logs

Waste

Chip/Flake/Grind

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

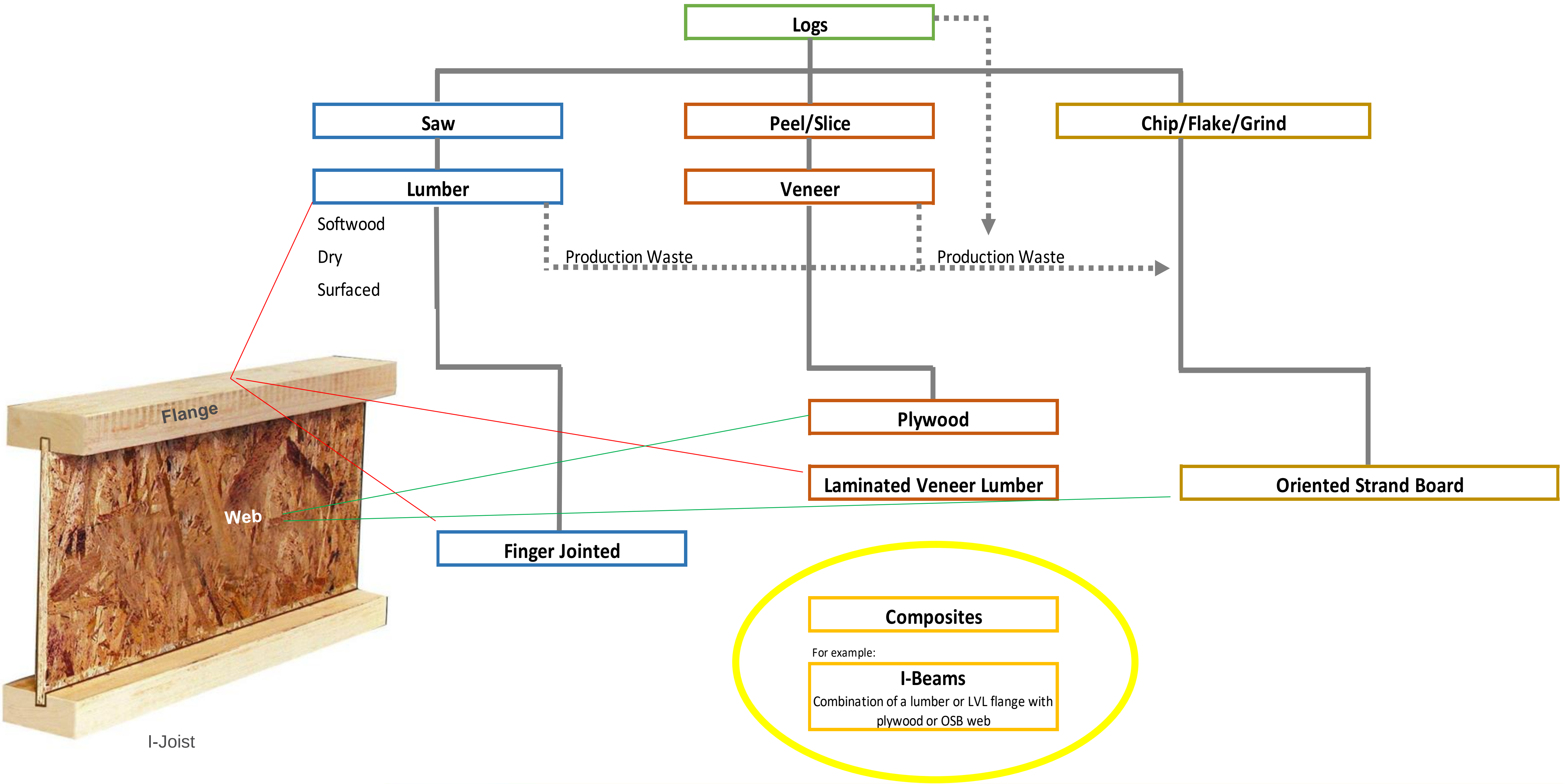
Oriented Strand Board (OSB)

Particleboard (low density fiberboard)

Medium Density Fiberboard (MDF)

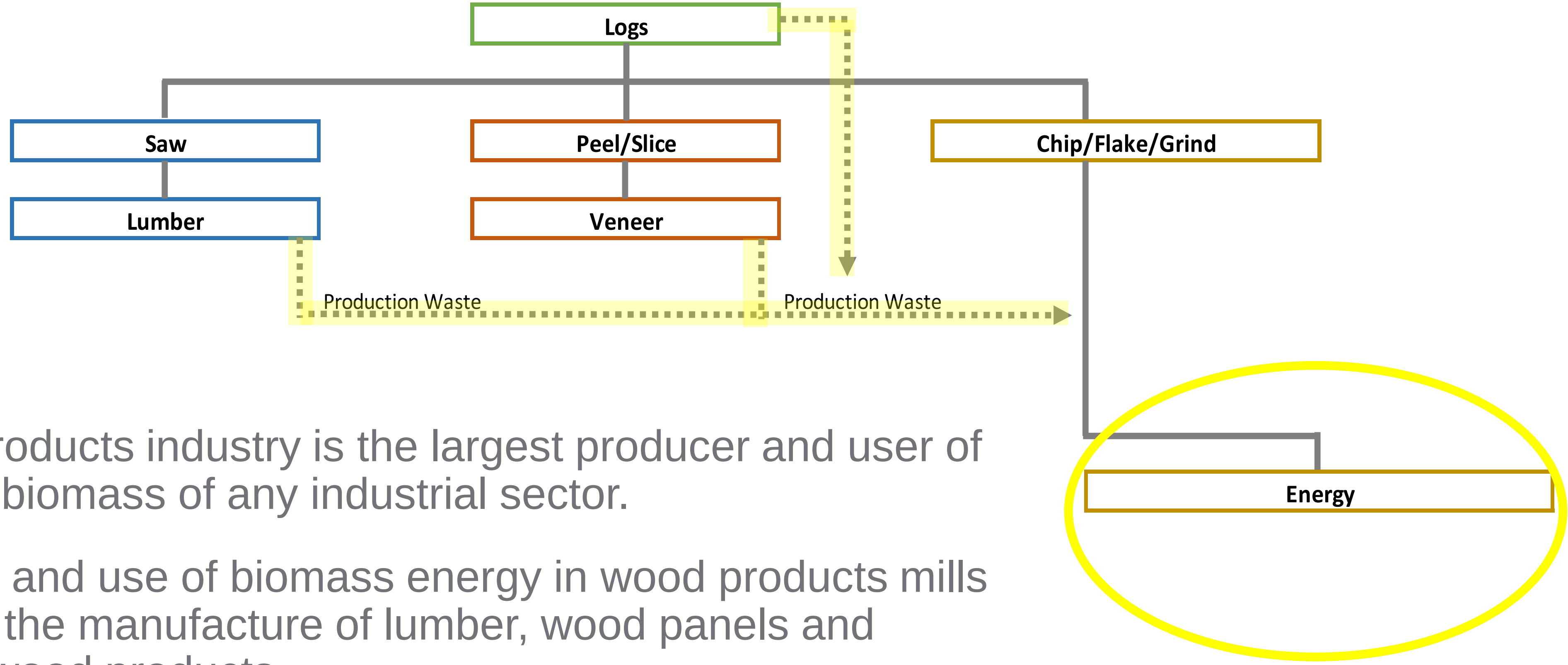
Wood Pellets

Wood Products Taxonomy



I-Joist

Wood Products Taxonomy

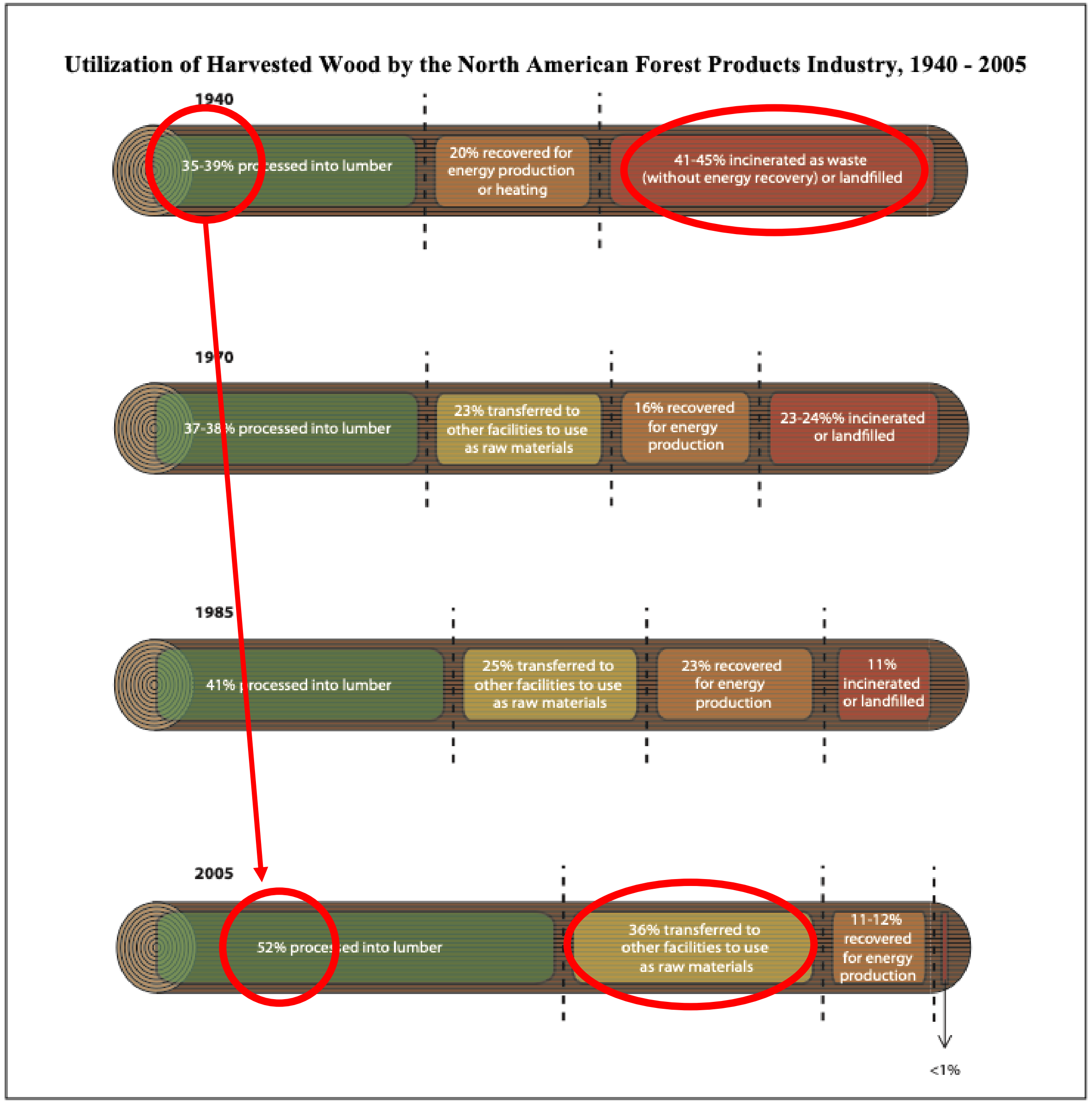


- The forest products industry is the largest producer and user of energy from biomass of any industrial sector.
- The creation and use of biomass energy in wood products mills is integral to the manufacture of lumber, wood panels and engineered wood products.
- Using forest and mill residuals for power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

Source: **American Wood Council**, https://www.awc.org/publicpolicy/biomass

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.



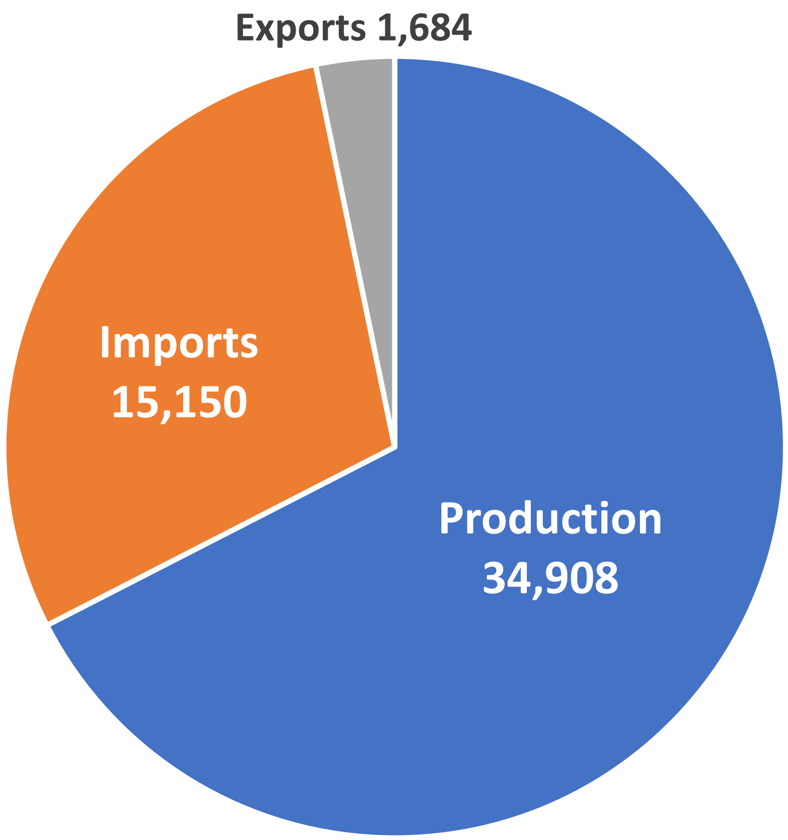
Source: **Dovetail Partners**, “Utilization of Harvested Wood by the North American Forest Products Industry,” Dr. Jim Bowyer, Dr. Steve Bratkovich, Kathryn Fernholz, October 2012, available at https://www.dovetailinc.org/upload/tmp/1581627196.pdf

U.S. Softwood Lumber Production, Imports, and Exports in 2018

Million Board Feet

Source: Western Wood Products Association

- 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.

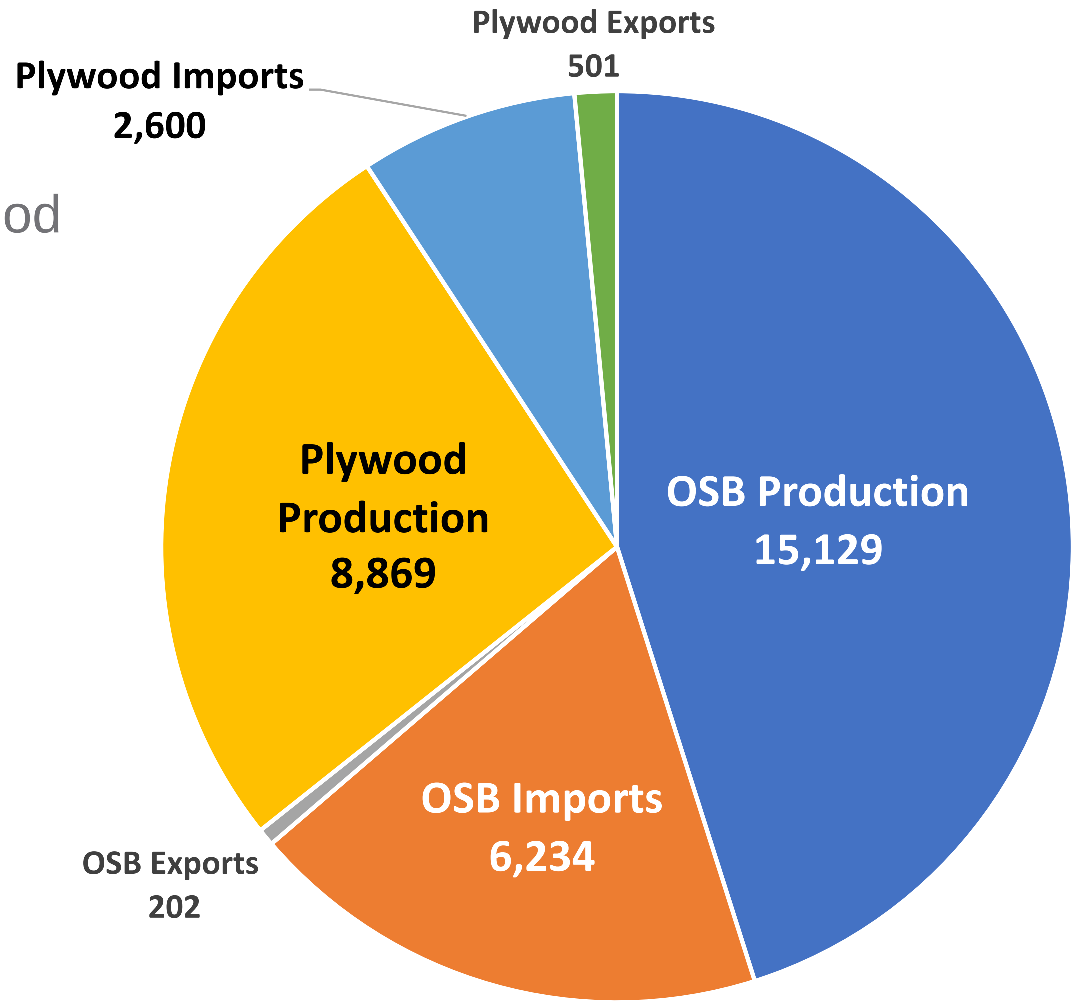


- 54% of U.S. softwood lumber production is in the South; 41% in the West.

U.S. Oriented Strand Board (OSB) and Softwood Plywood in 2018

Billion Square Feet 3/8"

Source: APA, The Engineered Wood Association



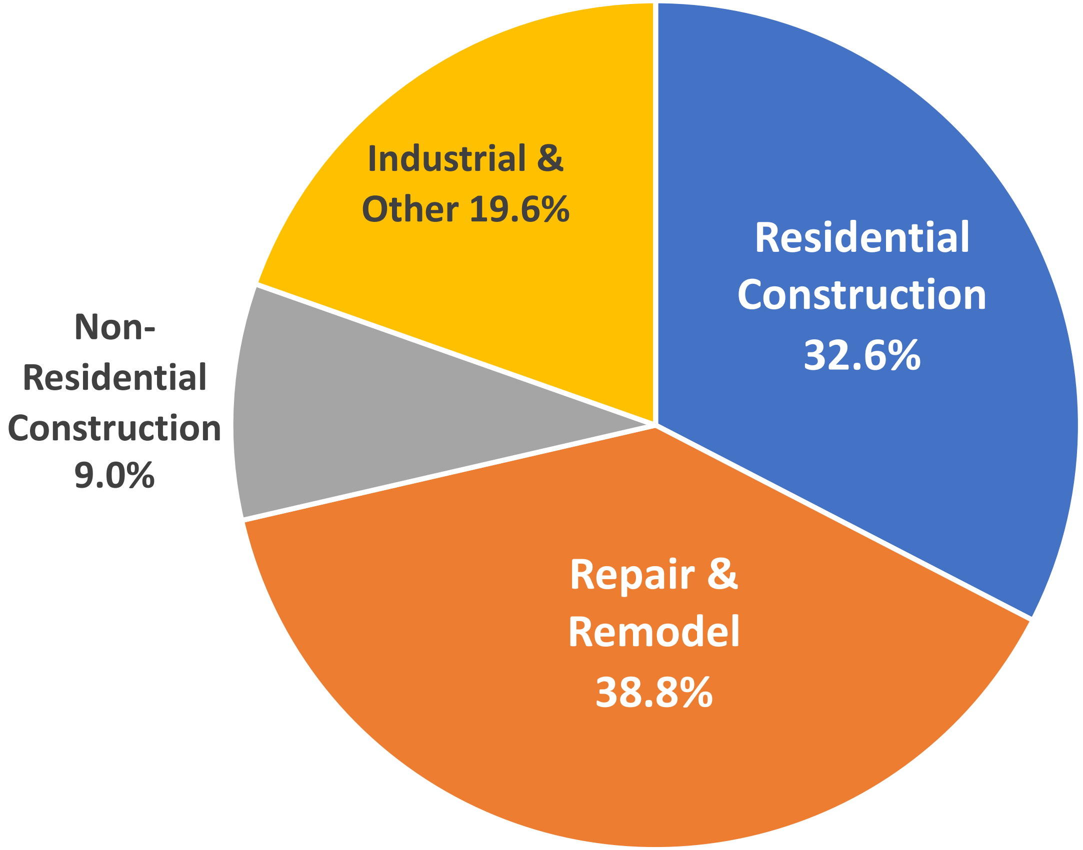
- U.S. softwood plywood imports:

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

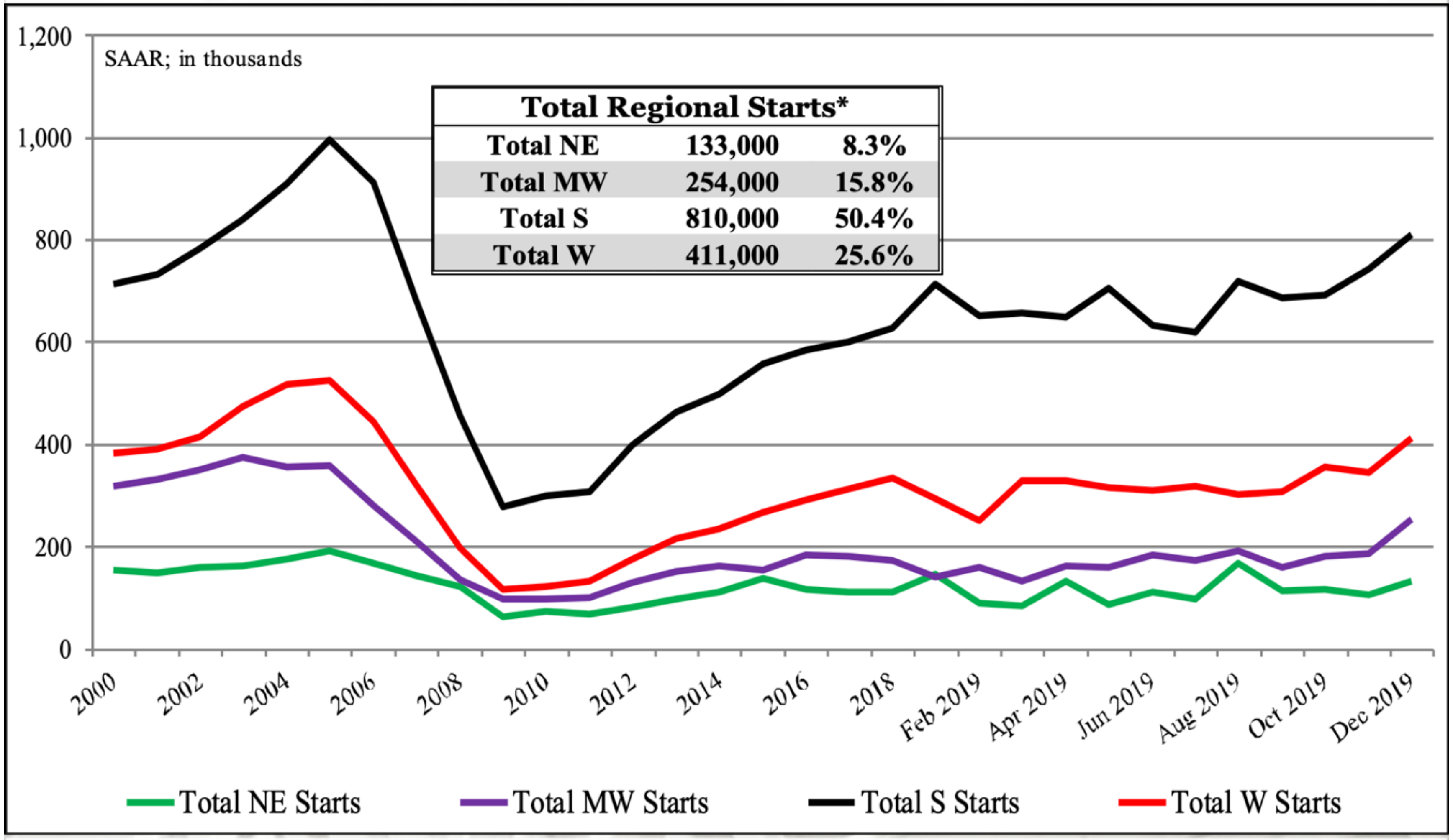
Source: Western Wood Products Association



Half-Life for Products by End Use	
End Use or Product	*Years*
New Single-Family Home	100
New Multi-Family Apartment Building	70
Residential Repair & Remodel	30
Furniture	30
Paper	3

Source: USFS Northeastern Research Station, "Methods for Calculating Forest Ecosystem and Harvested Carbon", James E. Smith, Linda S. Heath, Kenneth E. Skog, and Richard A. Birdsey, General Technical Report NE-343, December 2005

New Housing Starts by Region



Total Regional Starts*		
Total NE	133,000	8.3%
Total MW	254,000	15.8%
Total S	810,000	50.4%
Total W	411,000	25.6%

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).

* Percentage of total starts.

- 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.

Source: **Virginia Tech & USFS Housing Commentary**, https://www.woodproducts.sbio.vt.edu/housing-report/casa-2019-12a-december-main.pdf


LET
PURPLE
REIGN
AGAIN
WASHINGTON
FOOTBALL
Thank you!

Slides for Discussion Session

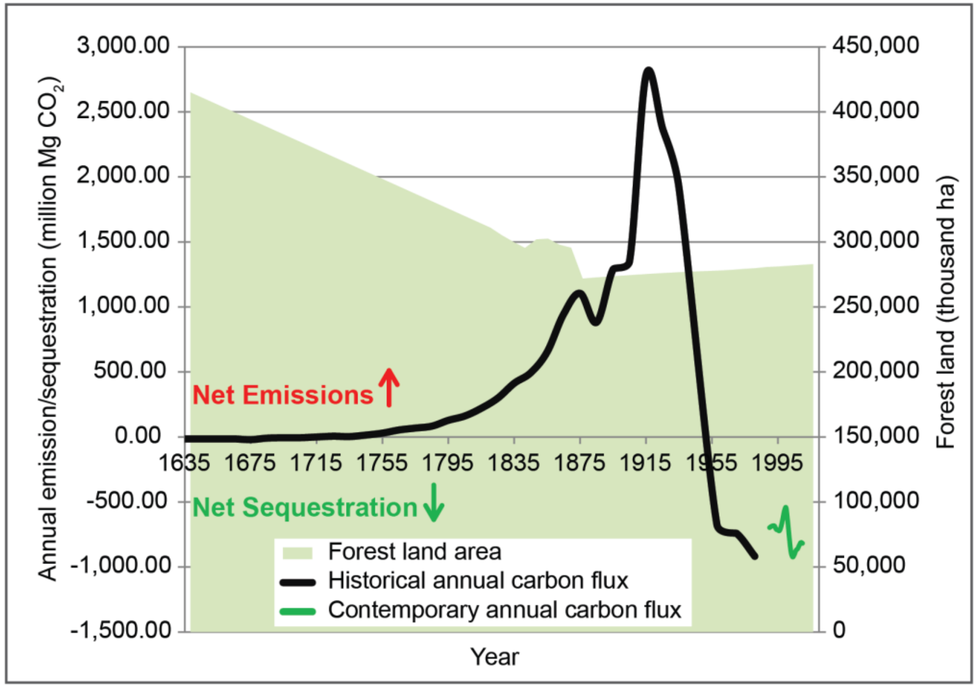
Wood Carbon Seminars

Cynthia West

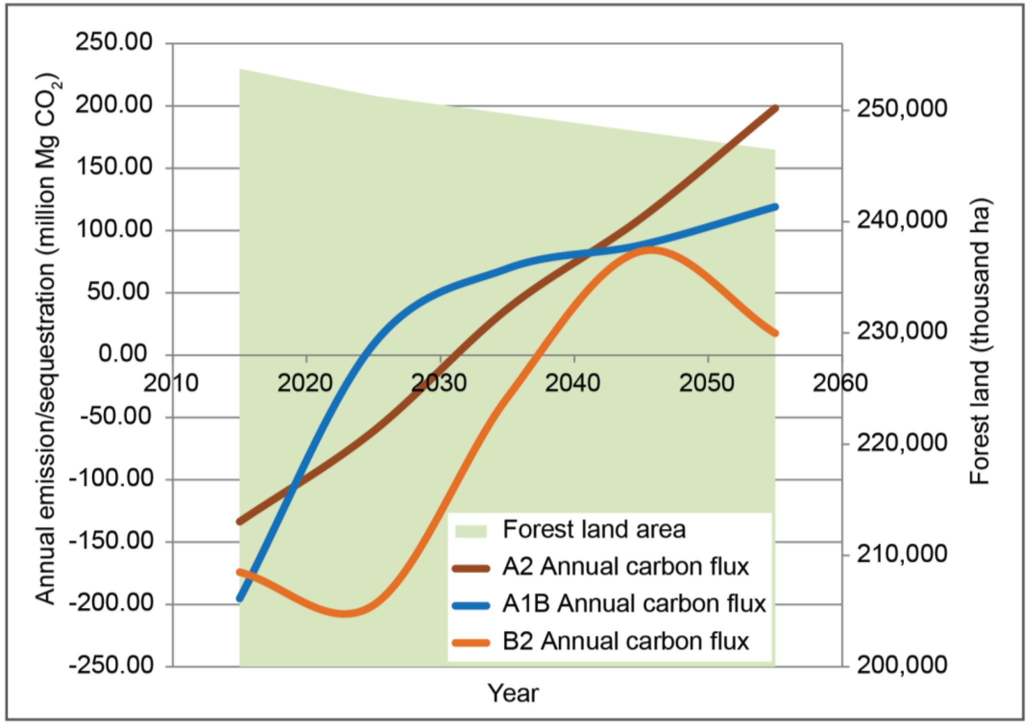
April 30, 2020

US Forests Net Carbon Flux Over Time

Forests and Carbon



Net Carbon Flux of US forests 1635-2000

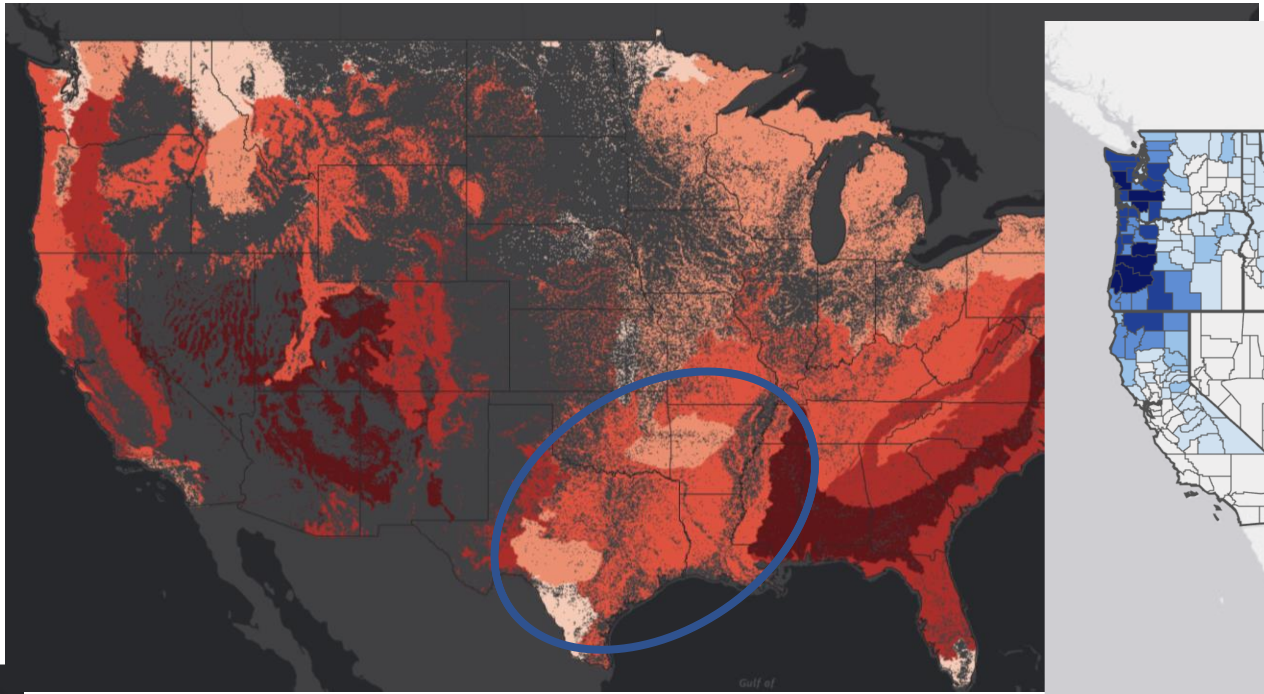


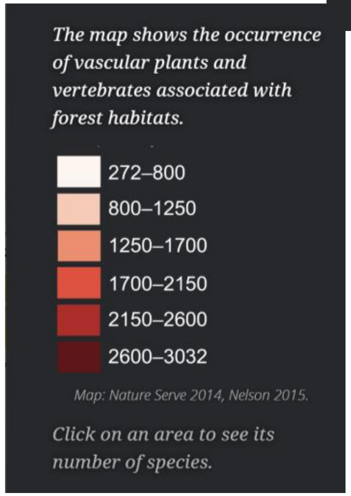
USFS prediction of net carbon flux under different scenarios through 2060

From: USFS, 2012: Future of America's forest and rangelands: 2010 Resources Planning Act assessment. General Technical Report WO-87. 198 pp., U.S. Department of Agriculture, U.S. Forest Service, Washington, D.C. URL

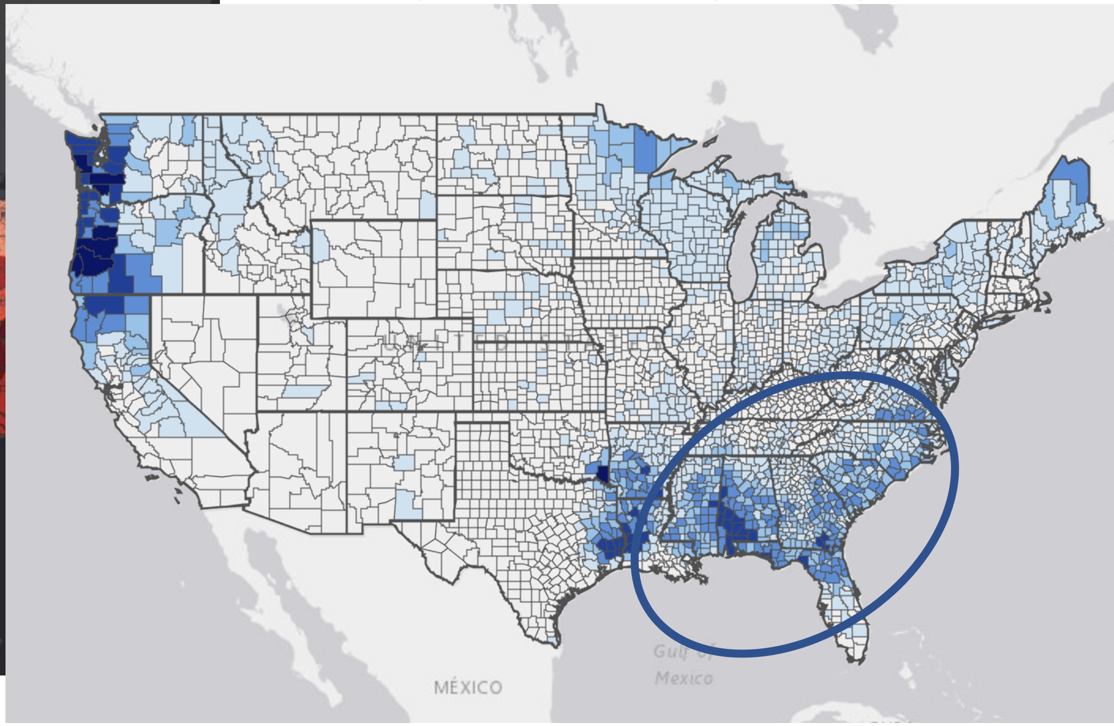
Southeastern plantation forests and biodiversity

Species Richness in US Forests





Acres of planted trees by county



Source: State of America's Forests. 2019. https://usaforests.org/

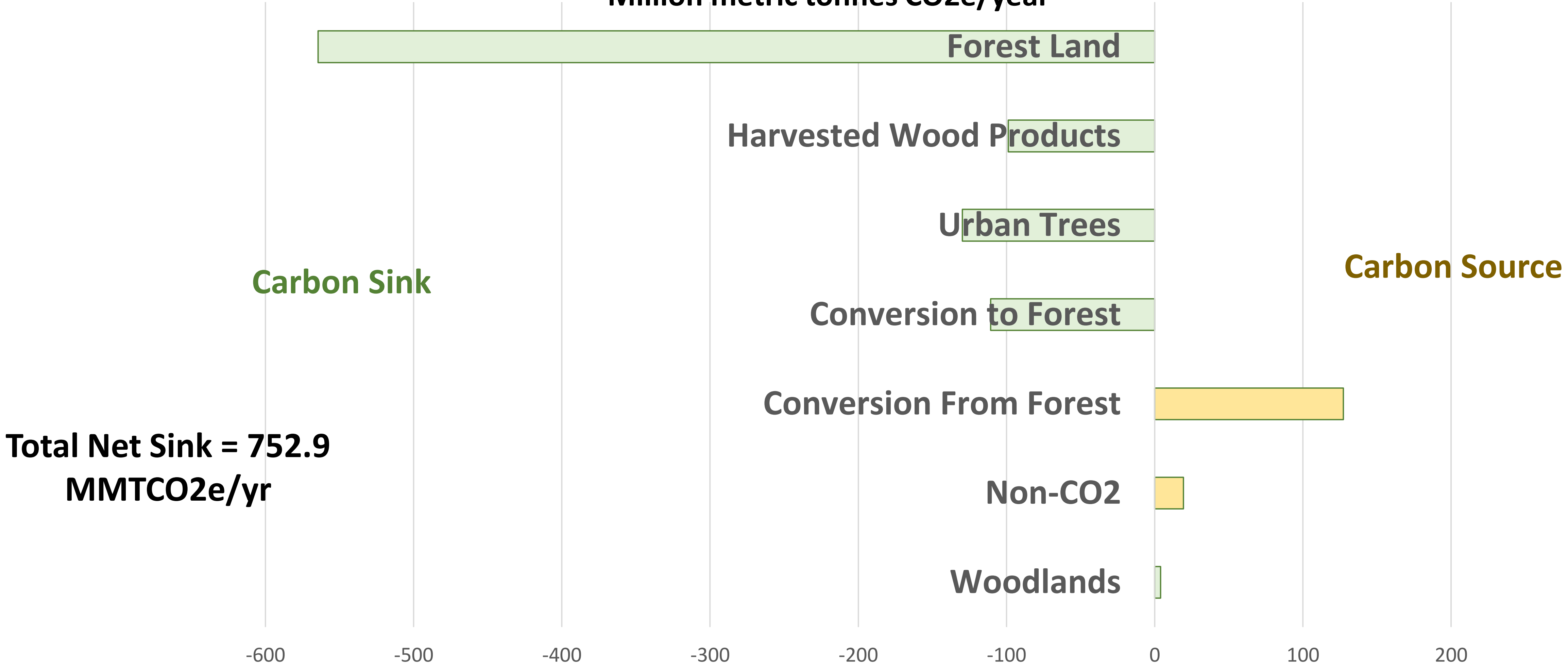
Articles:

Greene et al (2016) A meta-analysis of biodiversity responses to management of southeastern pine forests- opportunities for open pine conservation. *Forest Ecology and Management*

Loehle et al (2009) Achieving conservation goals in managed forests of the Southeastern Coastal Plain *Environmental Management*

Demarais et al (2017) Tamm Review: Terrestrial vertebrate biodiversity and intensive forest management in the U.S. *Forest Ecology and Management.*

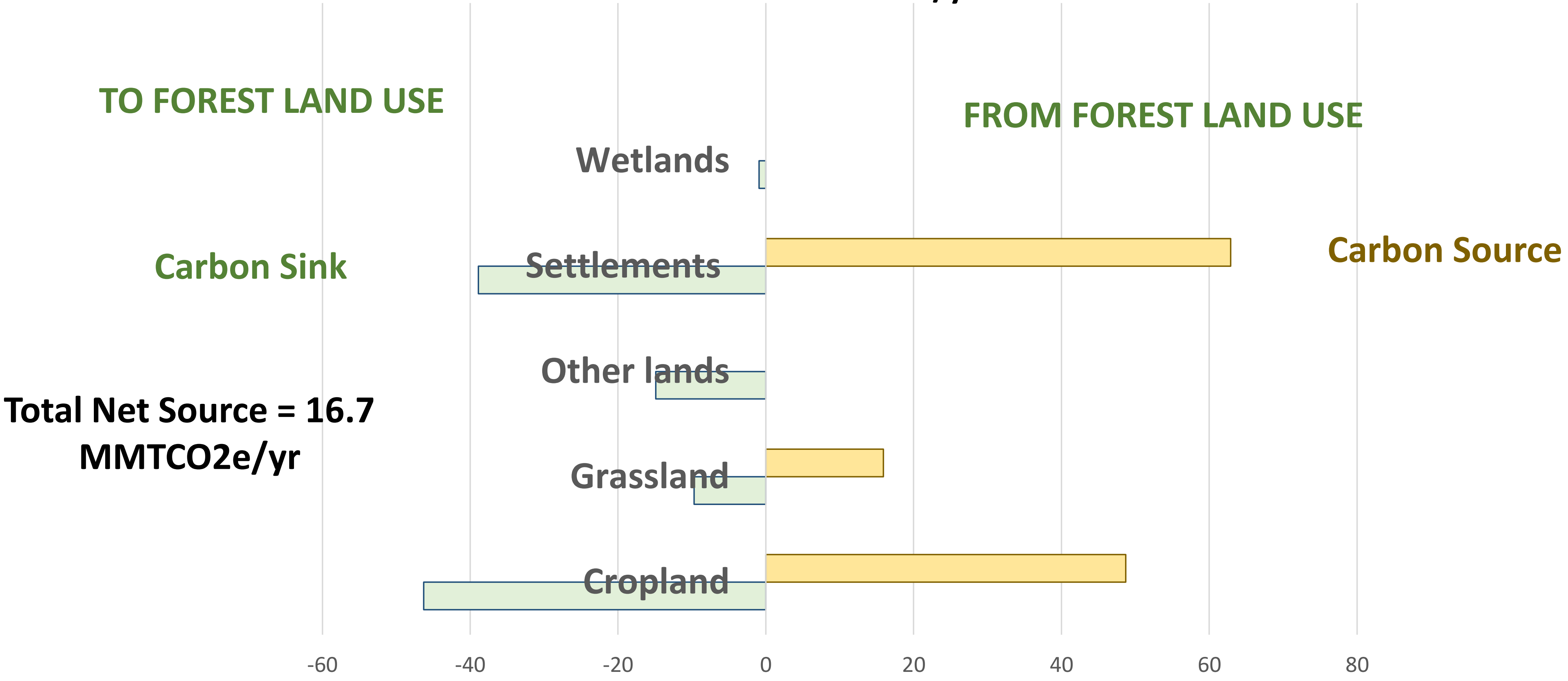
Components of the Nation's Forest Sink
EPA 2020 GHG Inventory (2018 data)
Million metric tonnes CO2e/year



	Woodlands	Non-CO2	Conversion From Forest	Conversion to Forest	Urban Trees	Harvested Wood Products	Forest Land
Emissions	4	19.4	127.4	-110.6	-129.8	-98.8	-564.5

Land Use Conversion
Nation’s Forest Sink
EPA 2020 GHG Inventory (2017 data)

Million metric tonnes CO2e/year

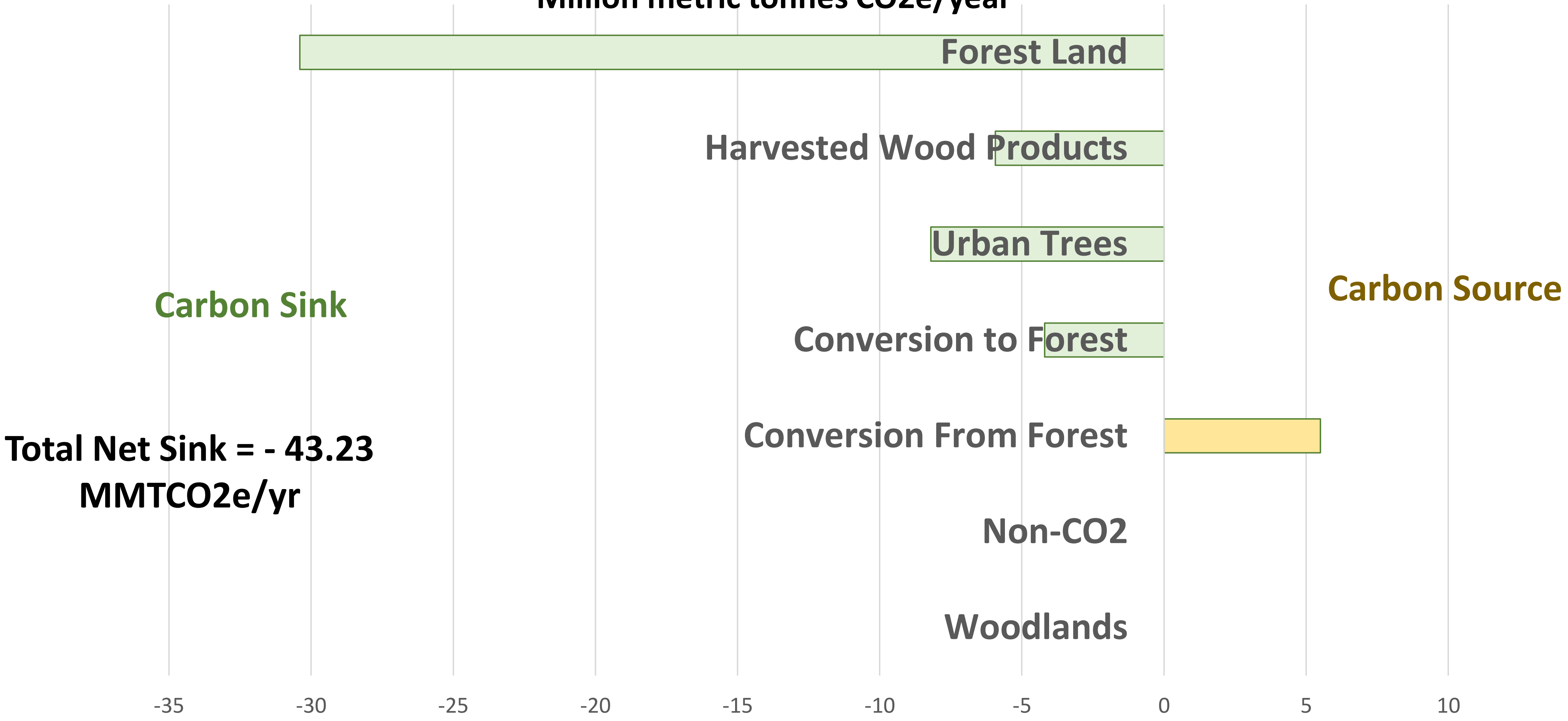


	Cropland	Grassland	Other lands	Settlements	Wetlands	
From Forests	48.7	15.9		62.9		
To Forests	-46.3	-9.7	-14.9	-38.9	-0.9	

Components of North Carolina's Forest Sink

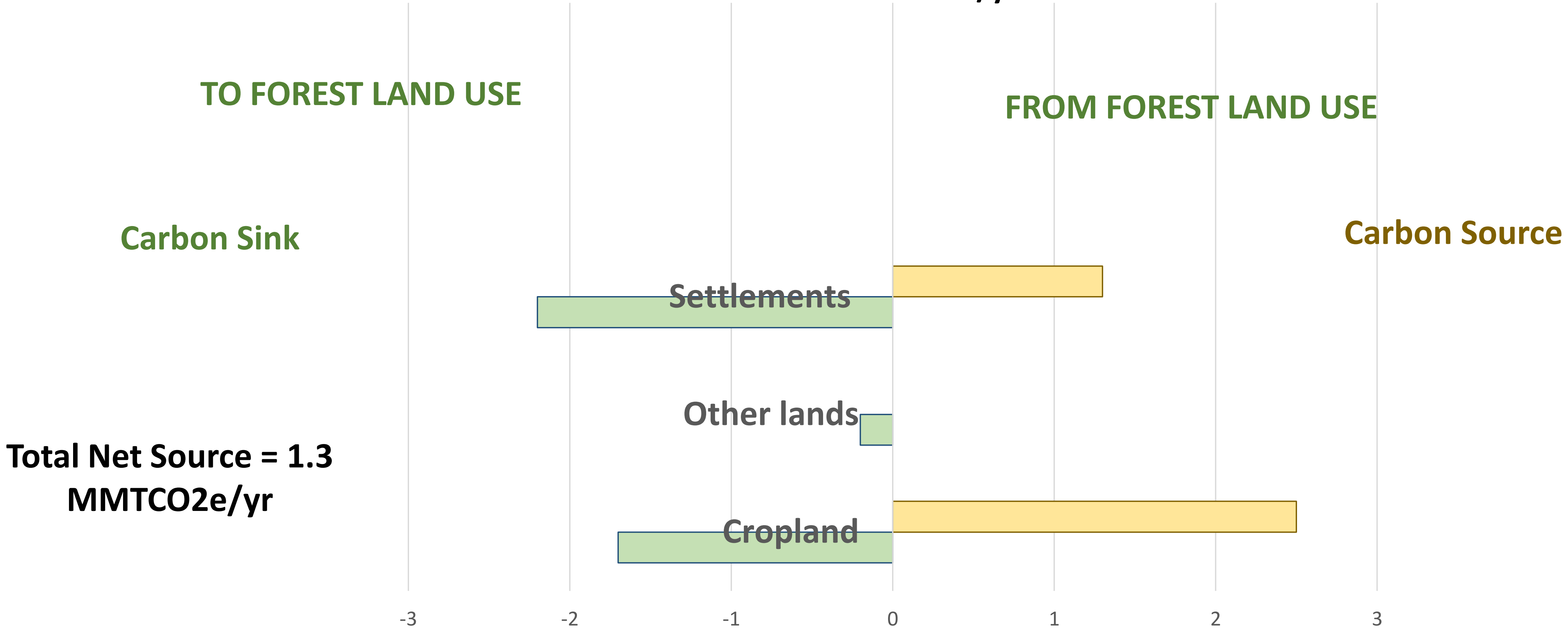
EPA 2020 GHG Inventory (2018 data)

Million metric tonnes CO2e/year



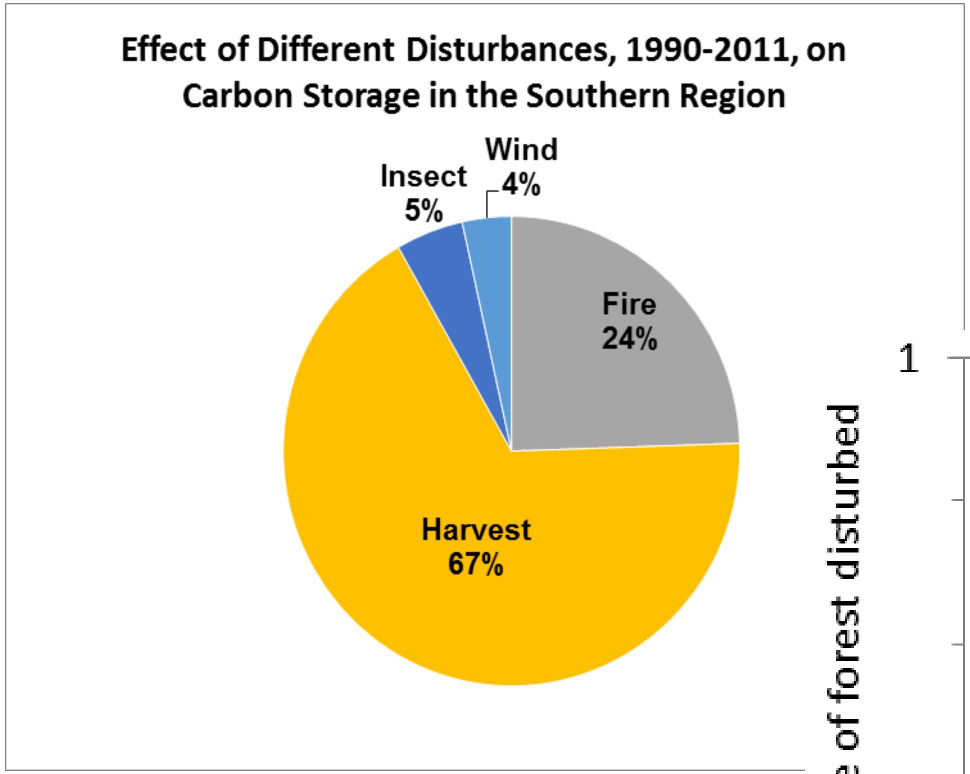
	Woodlands	Non-CO2	Conversion From Forest	Conversion to Forest	Urban Trees	Harvested Wood Products	Forest Land
Emissions	0	0	5.5	-4.2	-8.2	-5.93	-30.4

Land Use Conversion
North Carolina's Forest Sink
EPA 2020 GHG Inventory (2017 data)
Million metric tonnes CO2e/year

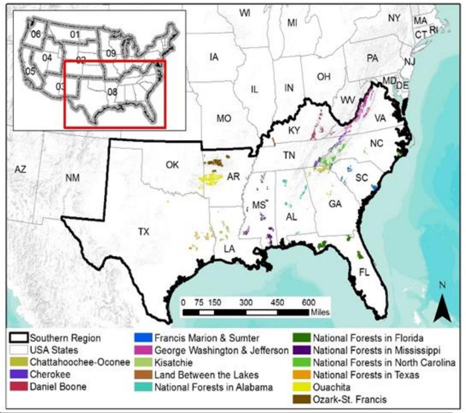


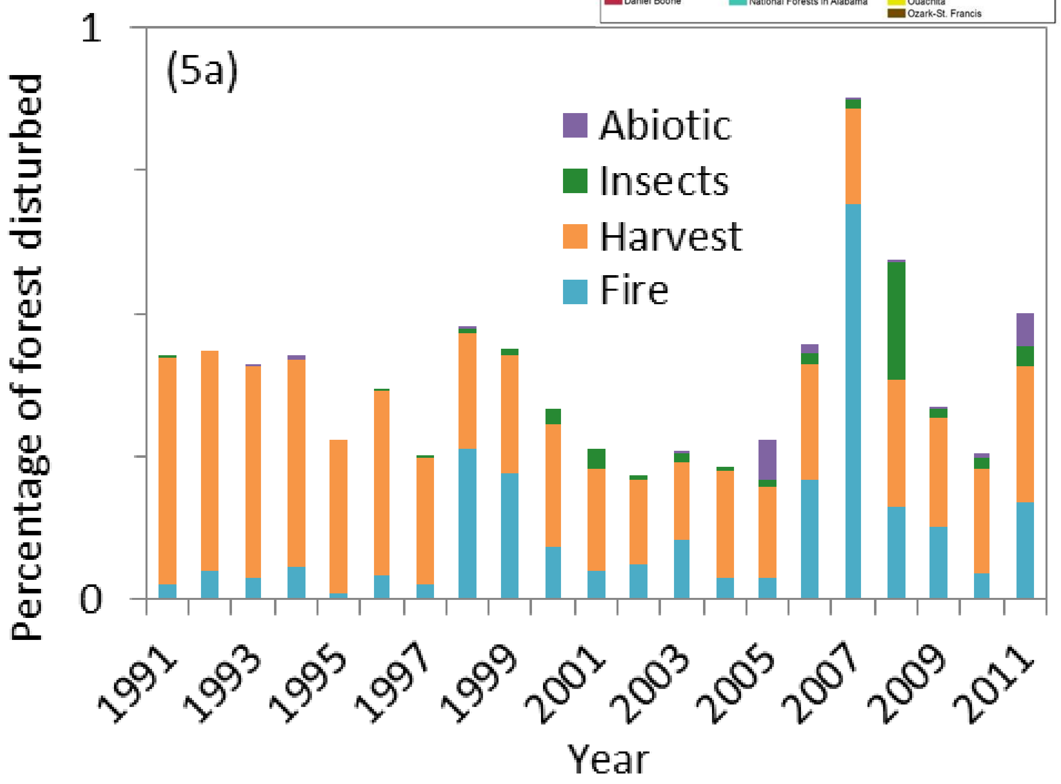
	Cropland	Other lands	Settlements		
From Forests	2.5	0	1.3		
To Forests	-1.7	-0.2	-2.2		

Disturbances in regional context: management dominated



14 National forests

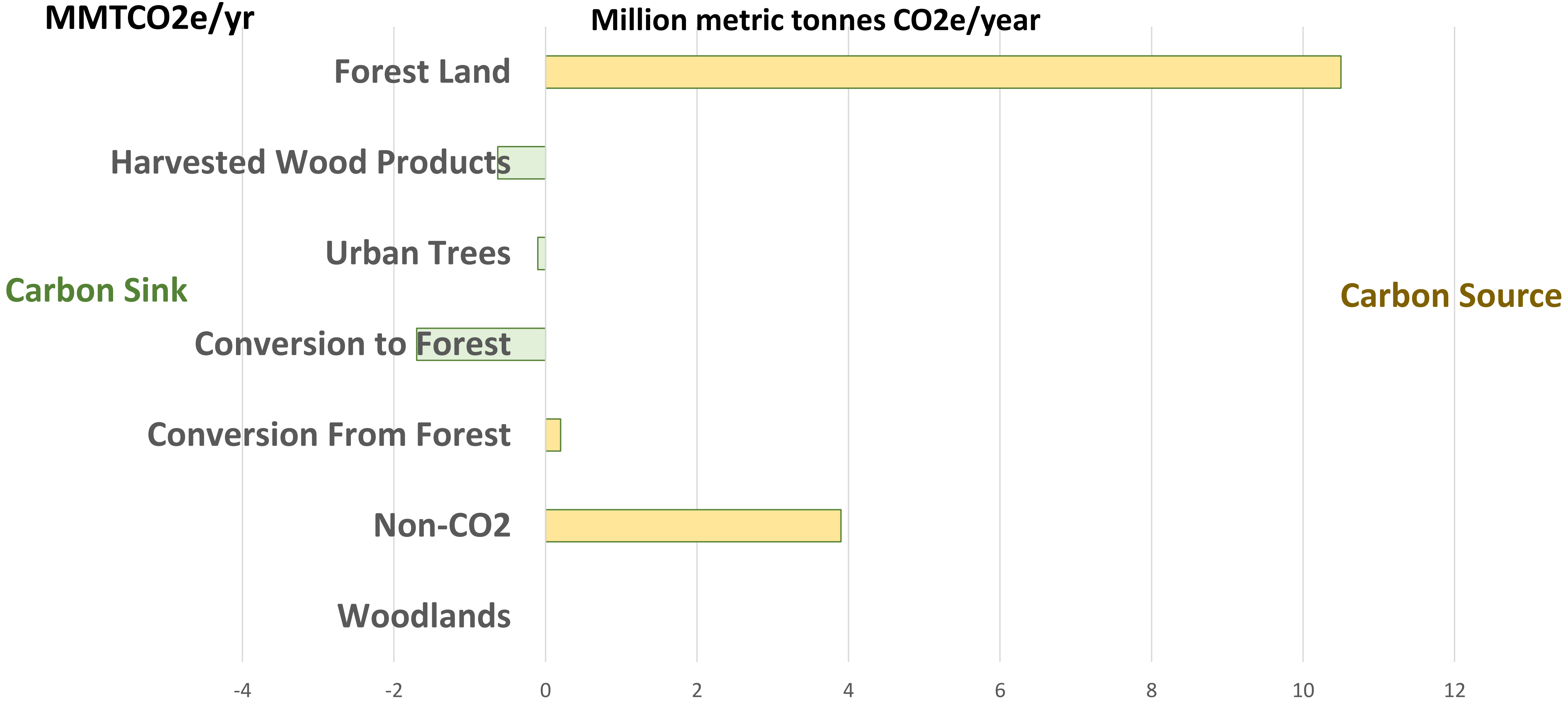




Healey et al. in review

Components of Montana's Forest Sink
EPA 2020 GHG Inventory (2018 data)

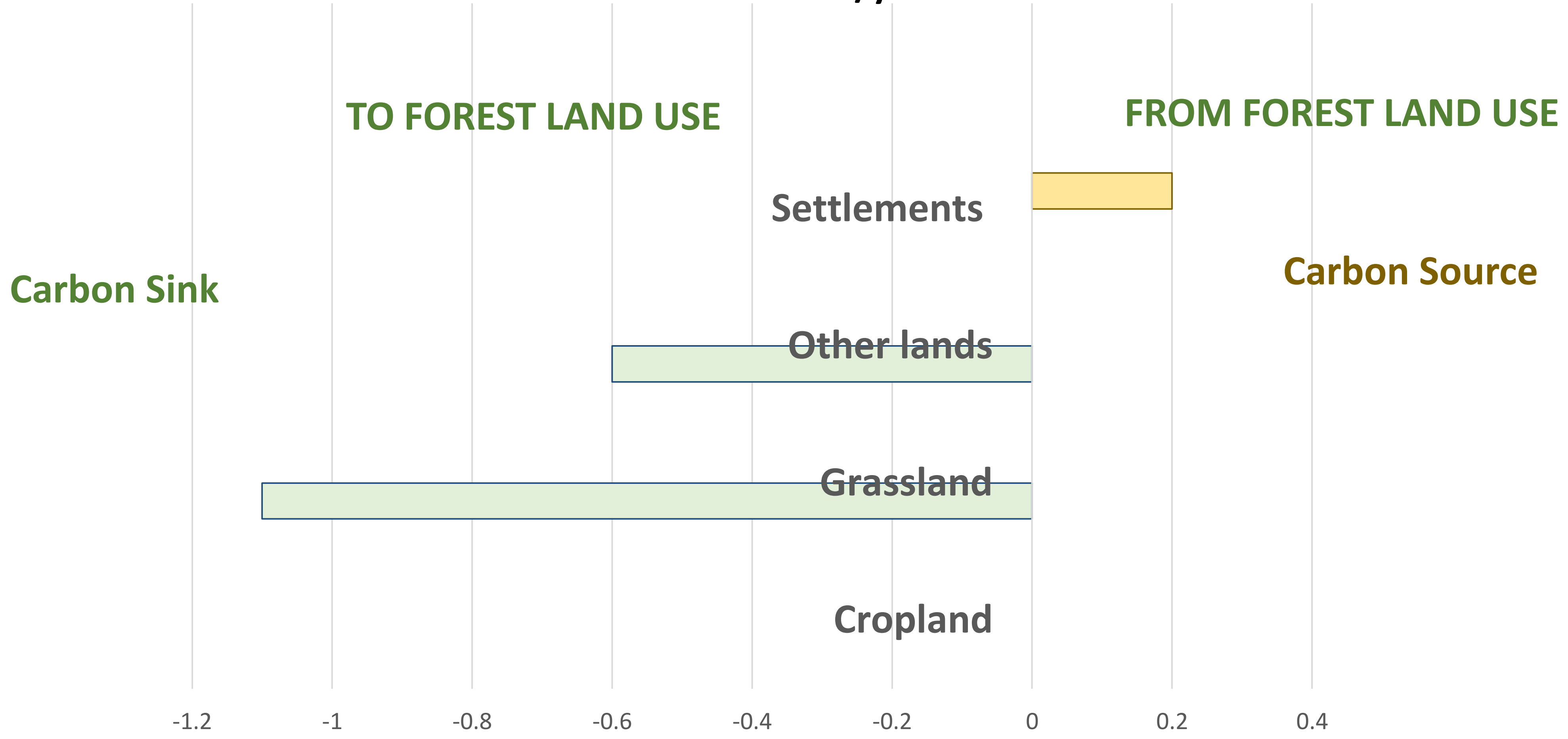
Total Net Source = 12.17 MMTCO2e/yr



	Woodlands	Non-CO2	Conversion From Forest	Conversion to Forest	Urban Trees	Harvested Wood Products	Forest Land
Emissions	0	3.9	0.2	-1.7	-0.1	-0.63	10.5

Land Use Conversion
Montana's Forest Sink
EPA 2020 GHG Inventory (2017 data)
Million metric tonnes CO2e/year

Total Net Sink = -1.5 MMTCO2e/yr

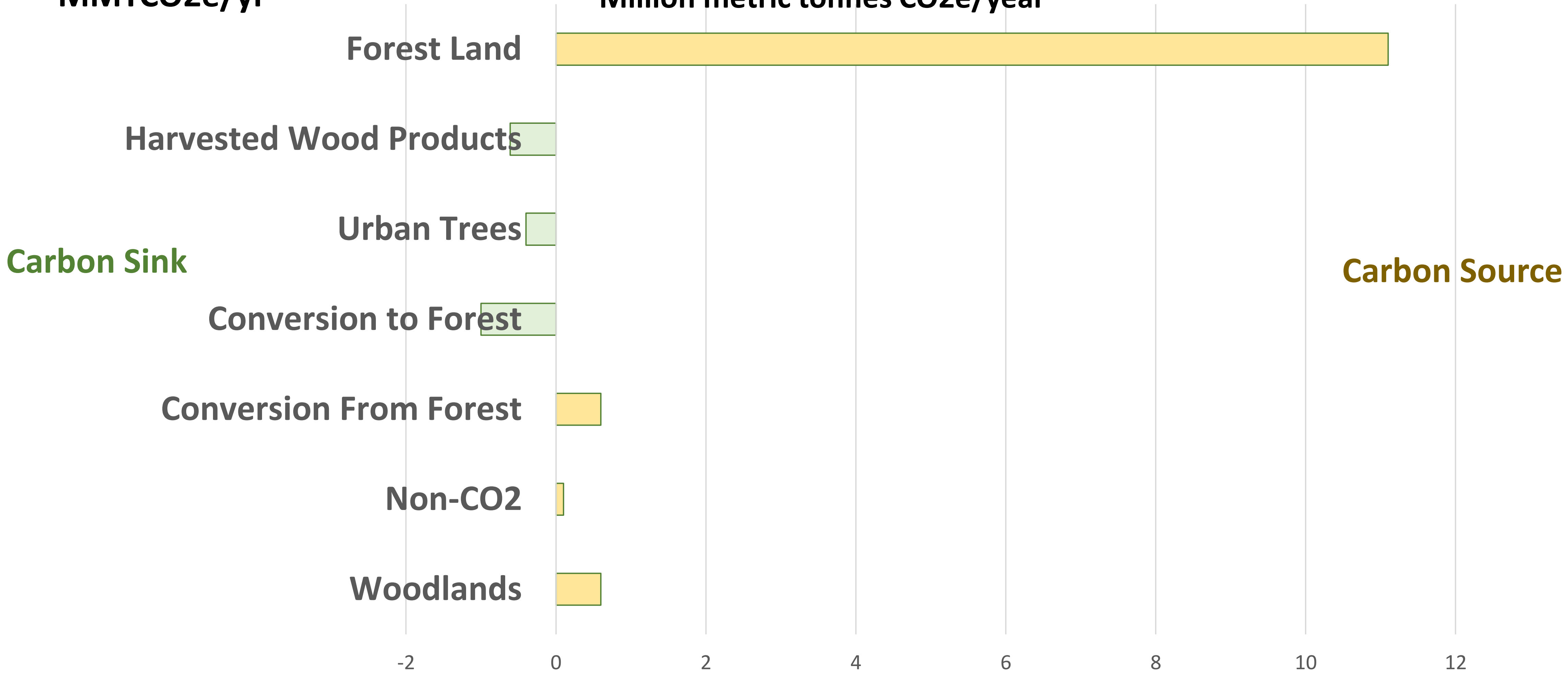


	Cropland	Grassland	Other lands	Settlements	
From Forests	0	0	0	0.2	
To Forests	0	-1.1	-0.6	0	

Components of Colorado's Forest Sink
EPA 2020 GHG Inventory (2018 data)

Total Net Source = 10.39 MMTCO2e/yr

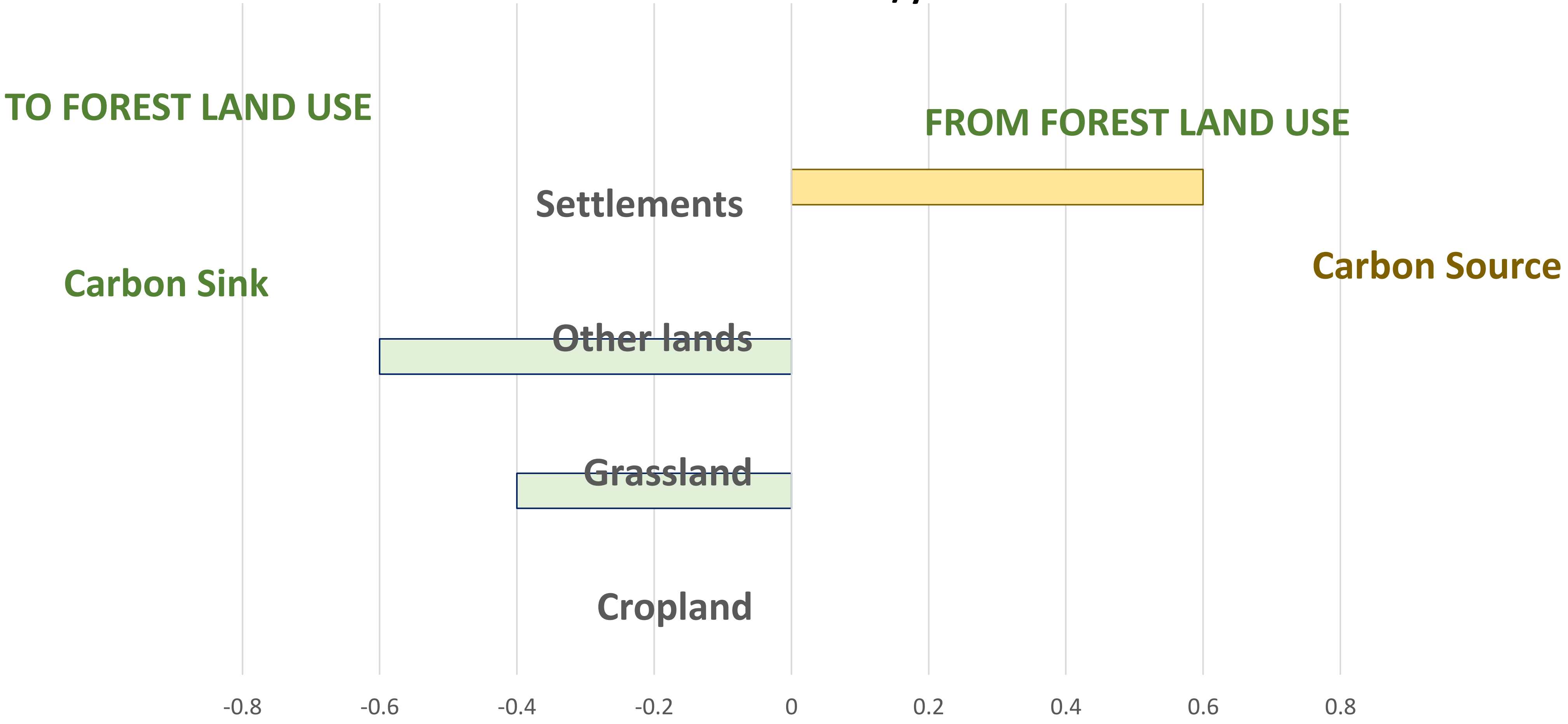
Million metric tonnes CO2e/year



	Woodlands	Non-CO2	Conversion From Forest	Conversion to Forest	Urban Trees	Harvested Wood Products	Forest Land
Emissions	0.6	0.1	0.6	-1	-0.4	-0.61	11.1

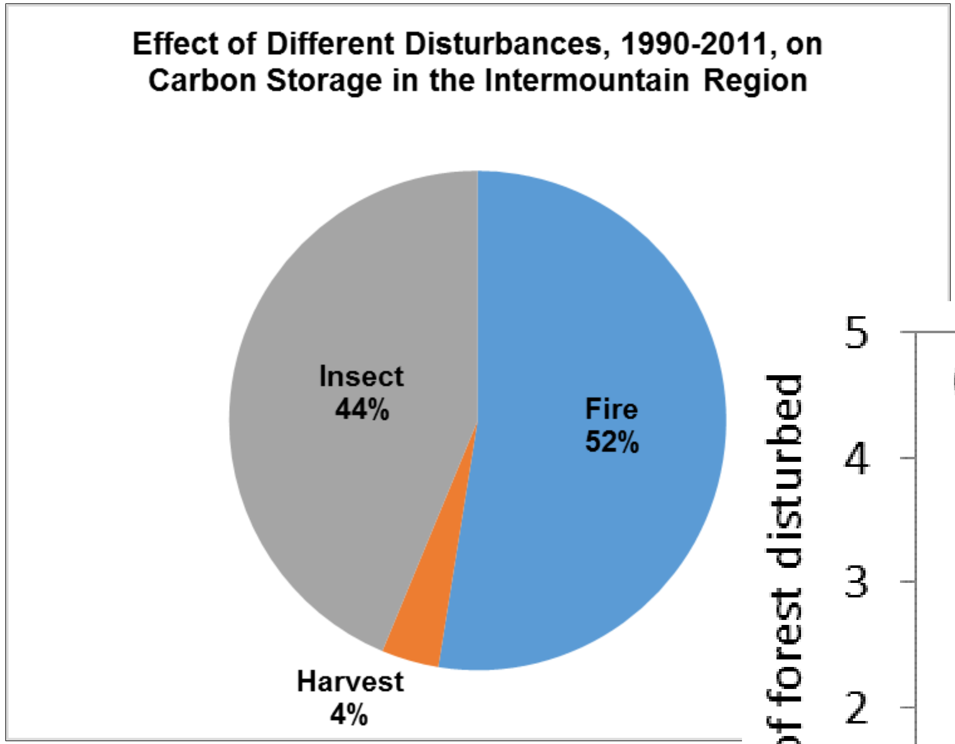
Land Use Conversion
Colorado's Forest Sink
EPA 2020 GHG Inventory (2017 data)
Million metric tonnes CO2e/year

Total Net Sink = -0.45 MMTCO2e/yr

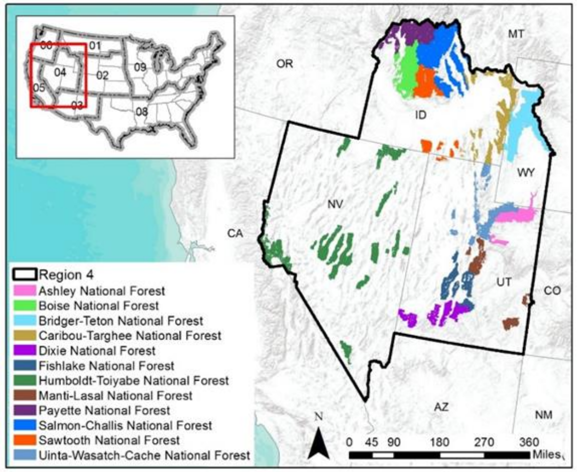


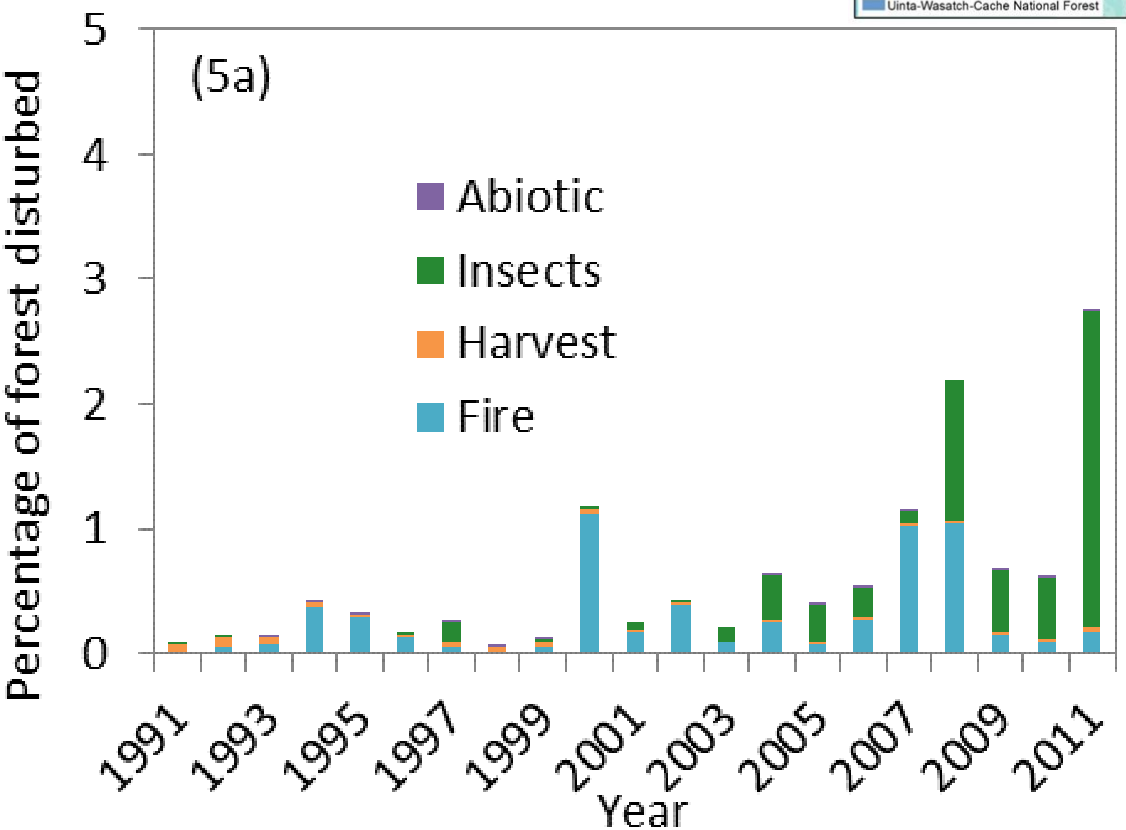
	Cropland	Grassland	Other lands	Settlements	
From Forests	0	0	0	0.6	
To Forests	0	-0.4	-0.6	0	

Disturbances in regional context: natural disturbance dominated



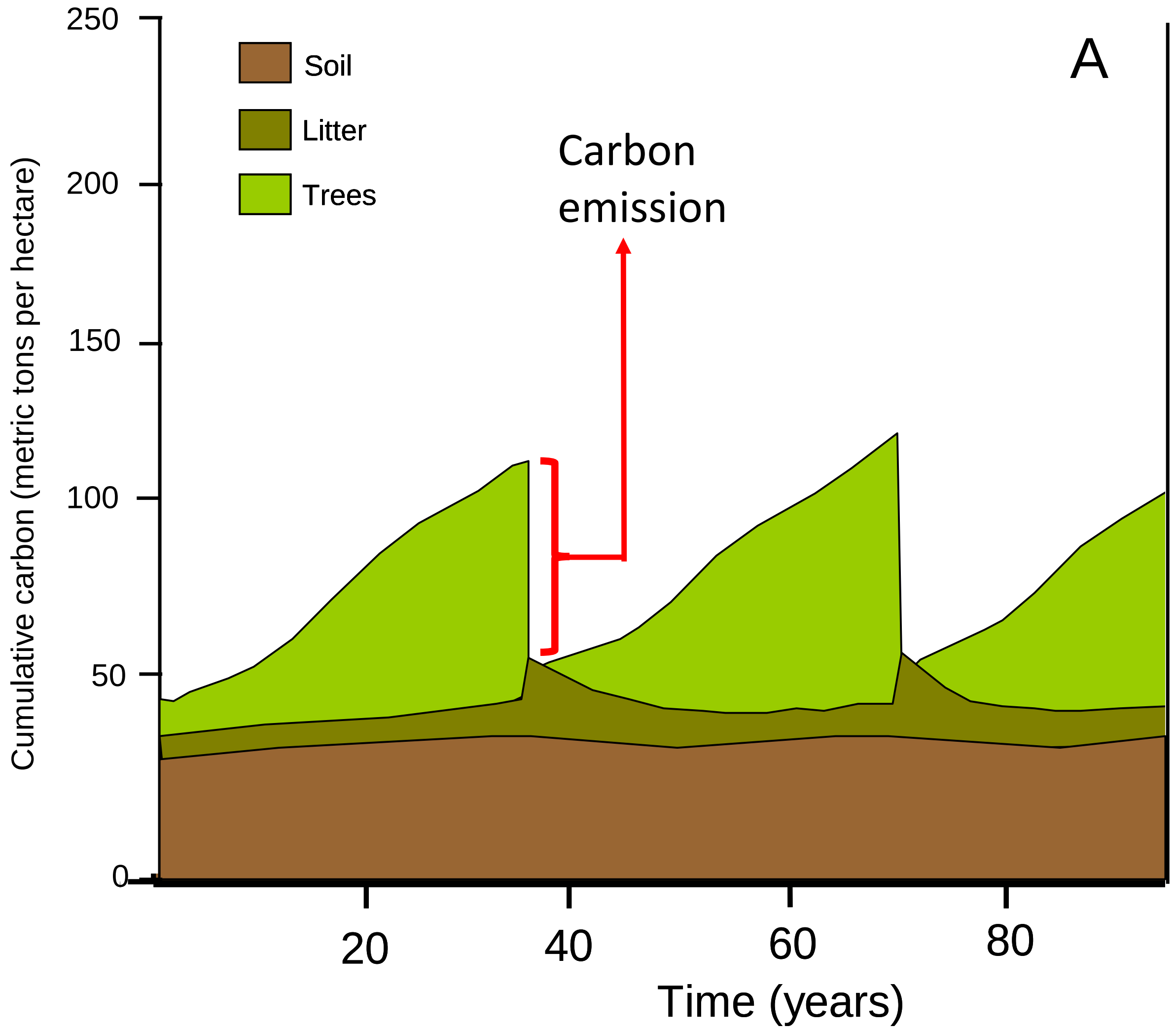
12 National forests





Healey et al. in review

Narrow view of the forest system

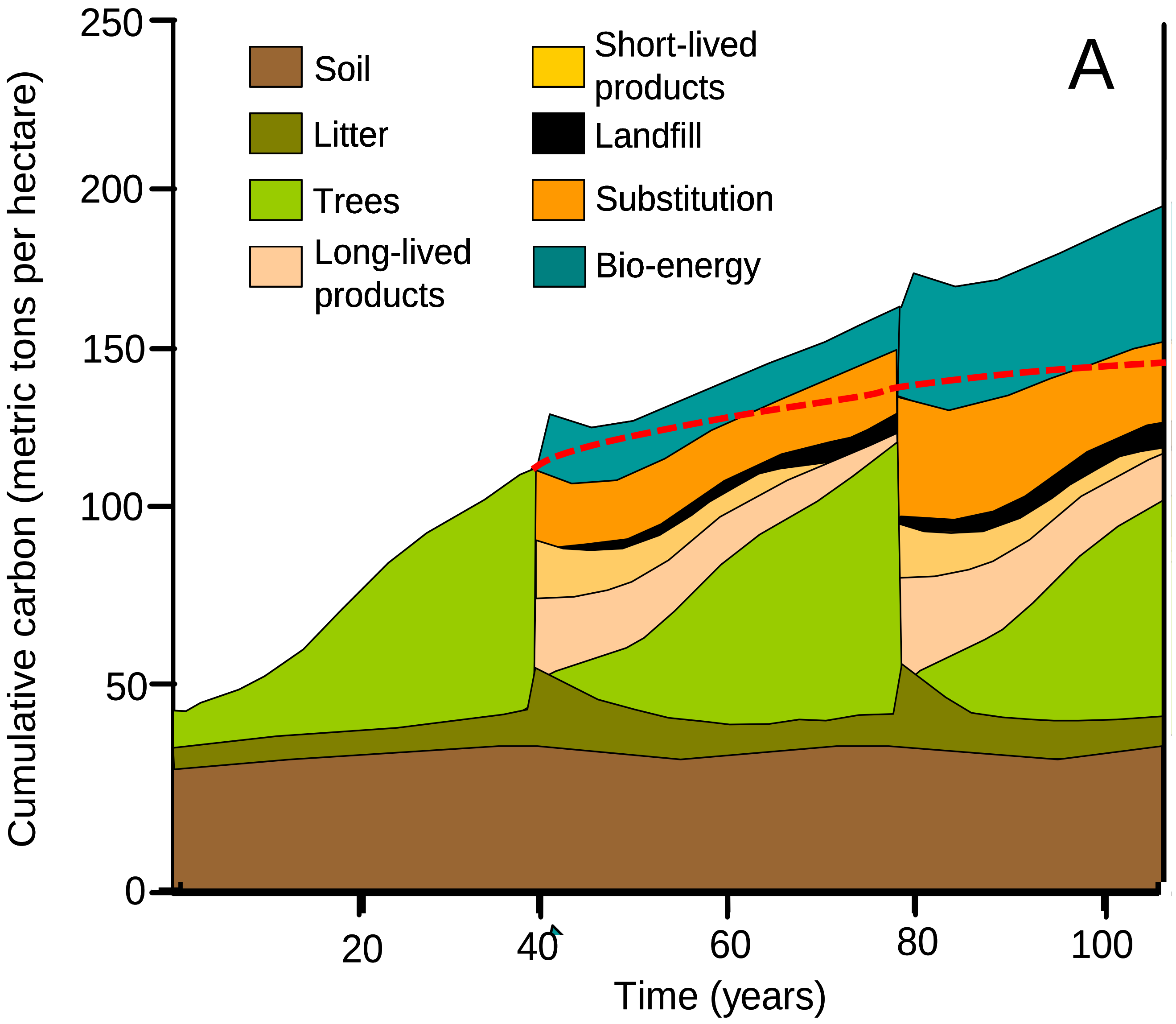


- Concerned with emissions on shorter time scales and limited geographical extent
- Source/sink trends main way to view impacts of management activates
- Considers narrower range of activities that influence carbon positively

E.g., timber harvesting would have an immediate negative impact.

McKinley et al. 2011

Complete View of the Forest System



- 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 Leadership Forum

Carbon neutrality and its connection to the substitution effects of forest products

(5/21/2020 version)

Reid Miner, Retired NCASI

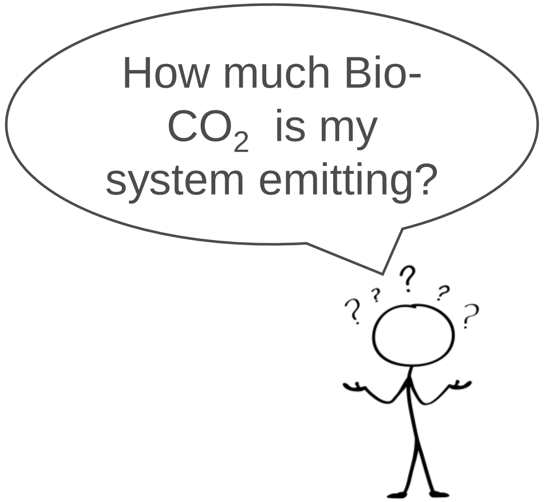
Some of the following material was developed by the author while an employee of NCASI. The material is used here with the permission of NCASI.

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)

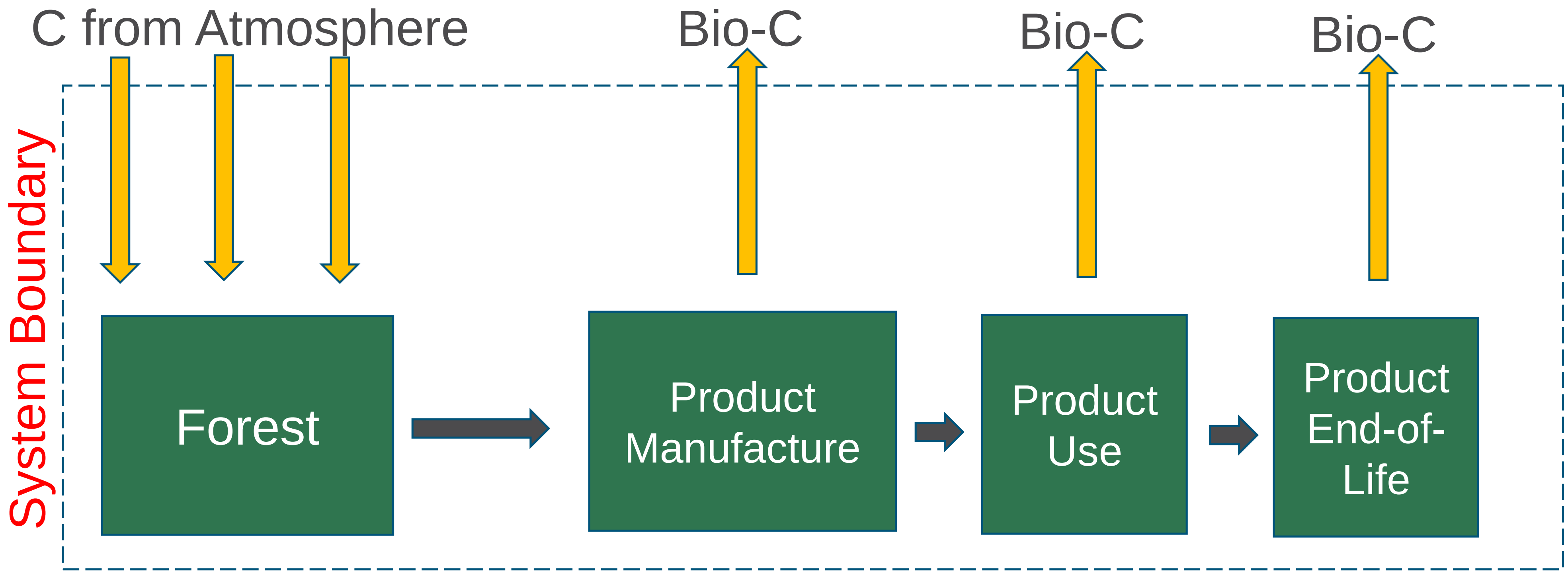
We will describe 4 general approaches to the calculations:

These are not comprehensive but are intended to capture some of the key elements of the debate about how to characterize biogenic carbon fluxes

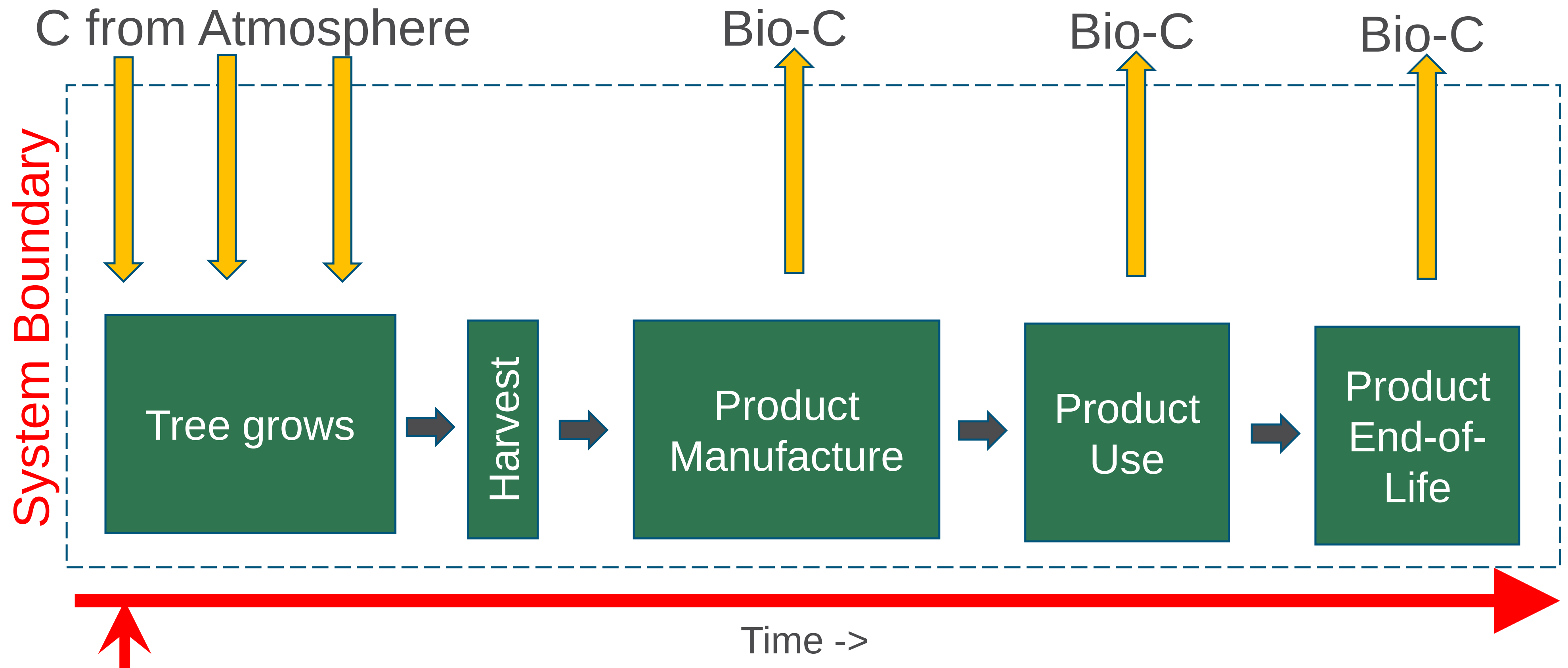


- Approach 1: CO_2 is removed from the atmosphere before harvesting while the tree is growing
- Approach 2: CO_2 is removed from the atmosphere after harvest by the trees that replace the tree that was harvested
- Approach 3: CO_2 is removed from the atmosphere in the year of harvest by non-harvested 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



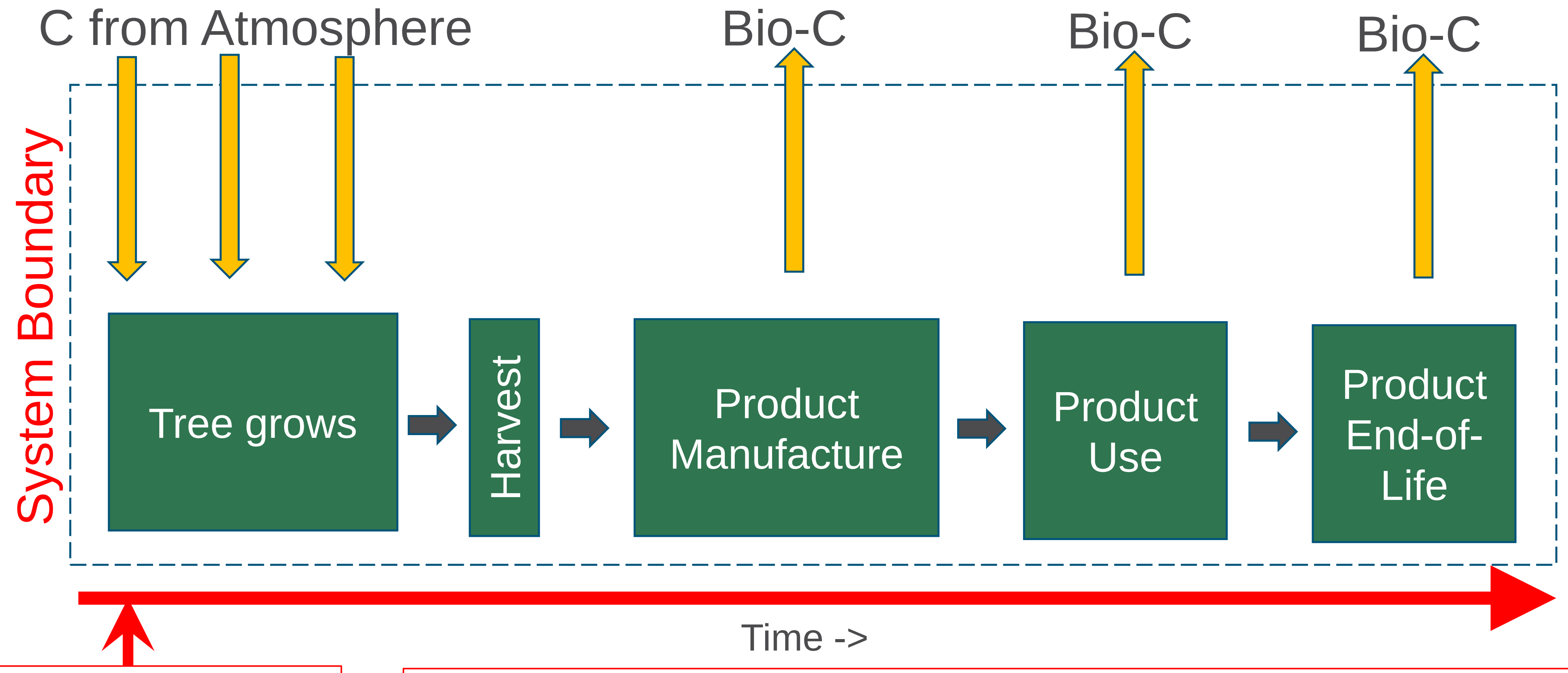
Approach 1: CO_2 is removed from atmosphere by the growing tree before it is harvested



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?)

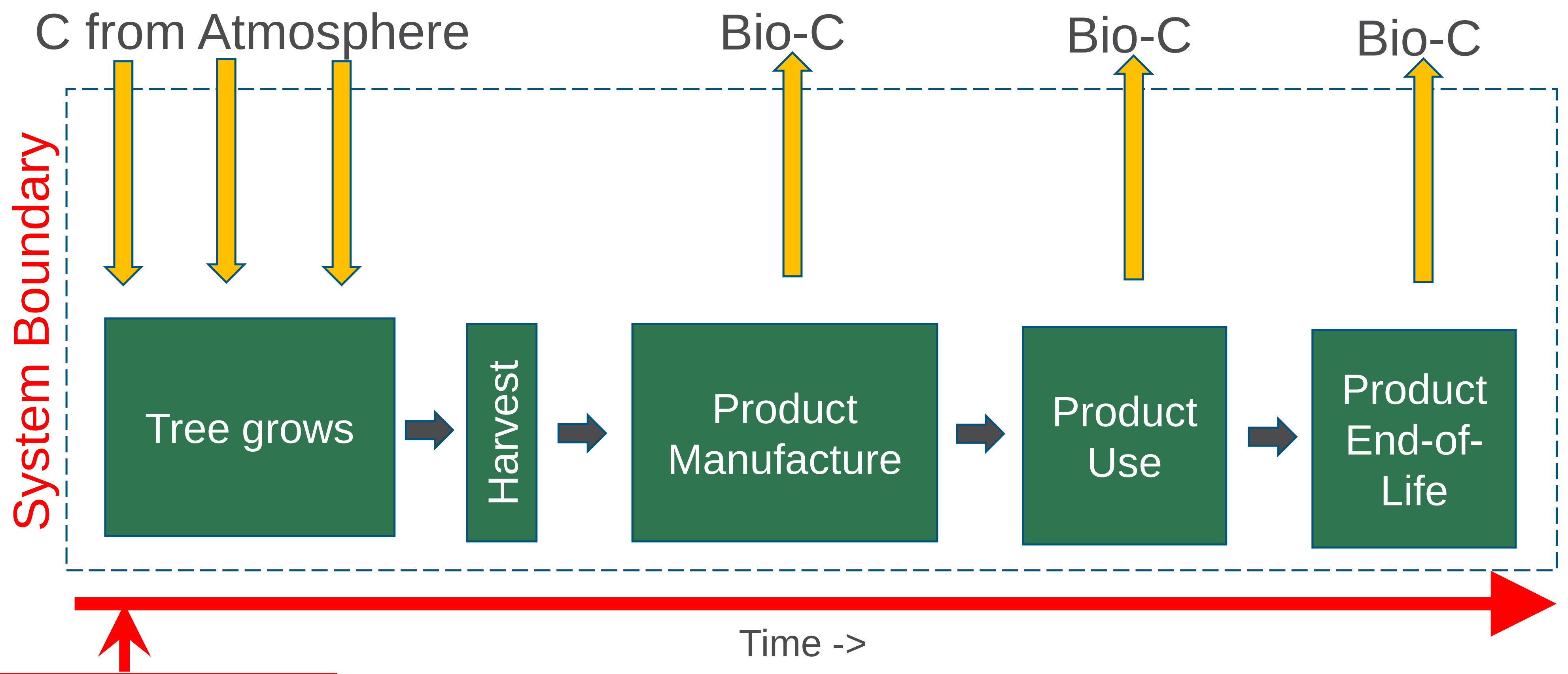
Approach 1: CO_2 is removed from atmosphere by the growing tree before it is harvested



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

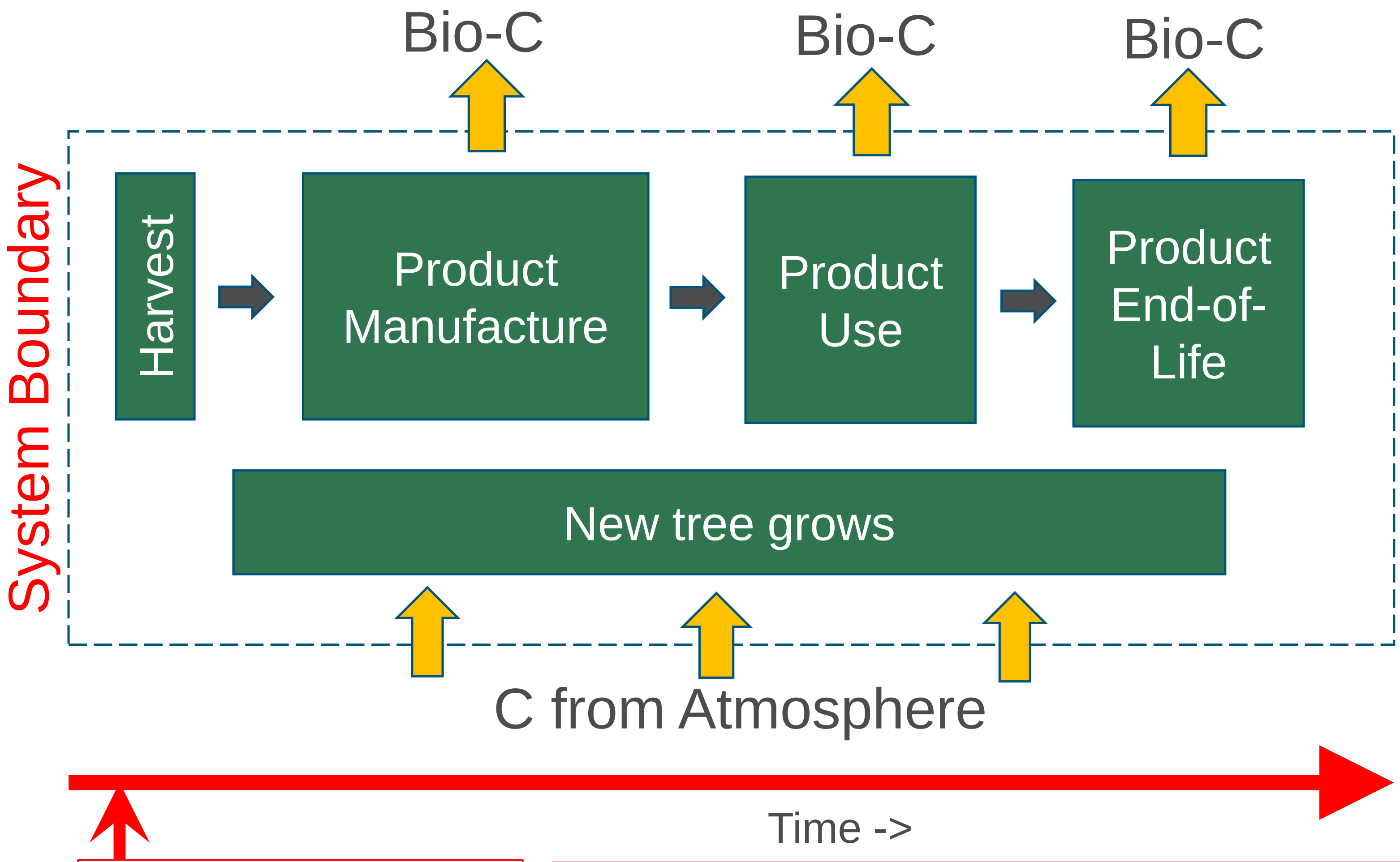
Approach 1: CO_2 is removed from atmosphere by the growing tree before it is harvested



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.

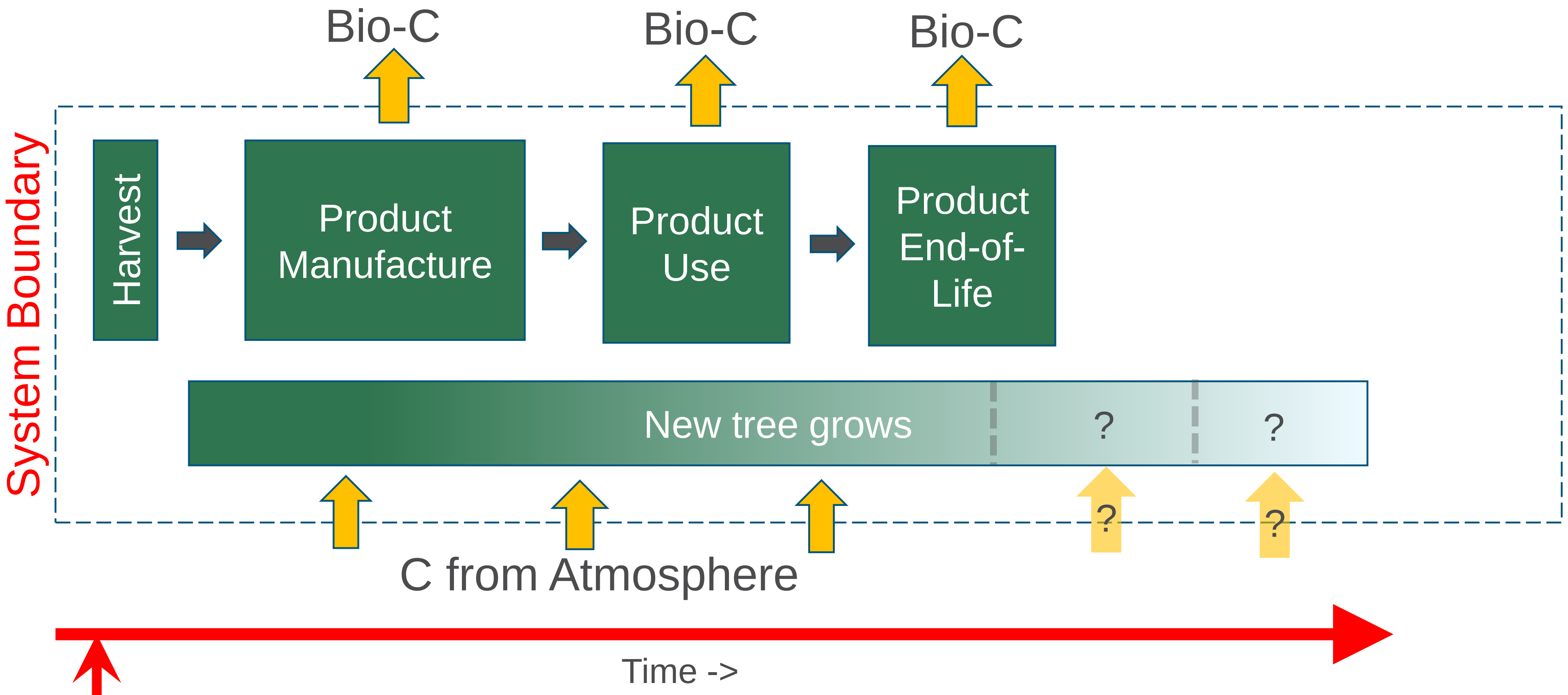
Approach 2: CO_2 is removed from atmosphere by a growing tree that replaces the tree that was harvested



Start accounting at harvest

Note: If the new tree grows to same size as harvested tree, biogenic CO_2 = zero (neutral?)

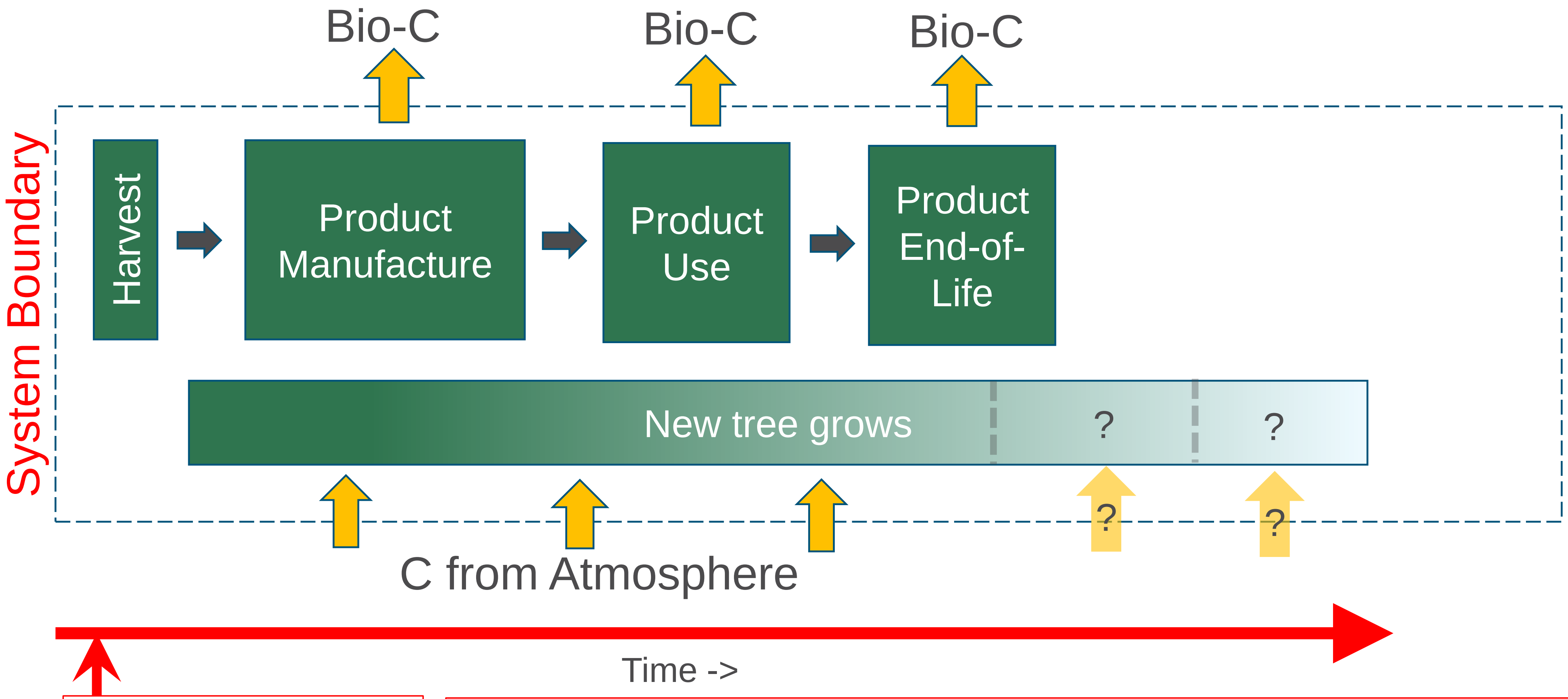
Approach 2: CO_2 is removed from atmosphere by a growing tree that replaces the tree that was harvested



Start accounting at harvest

Note: Biogenic CO_2 emissions depend on time selected, growth rate of new tree, etc.

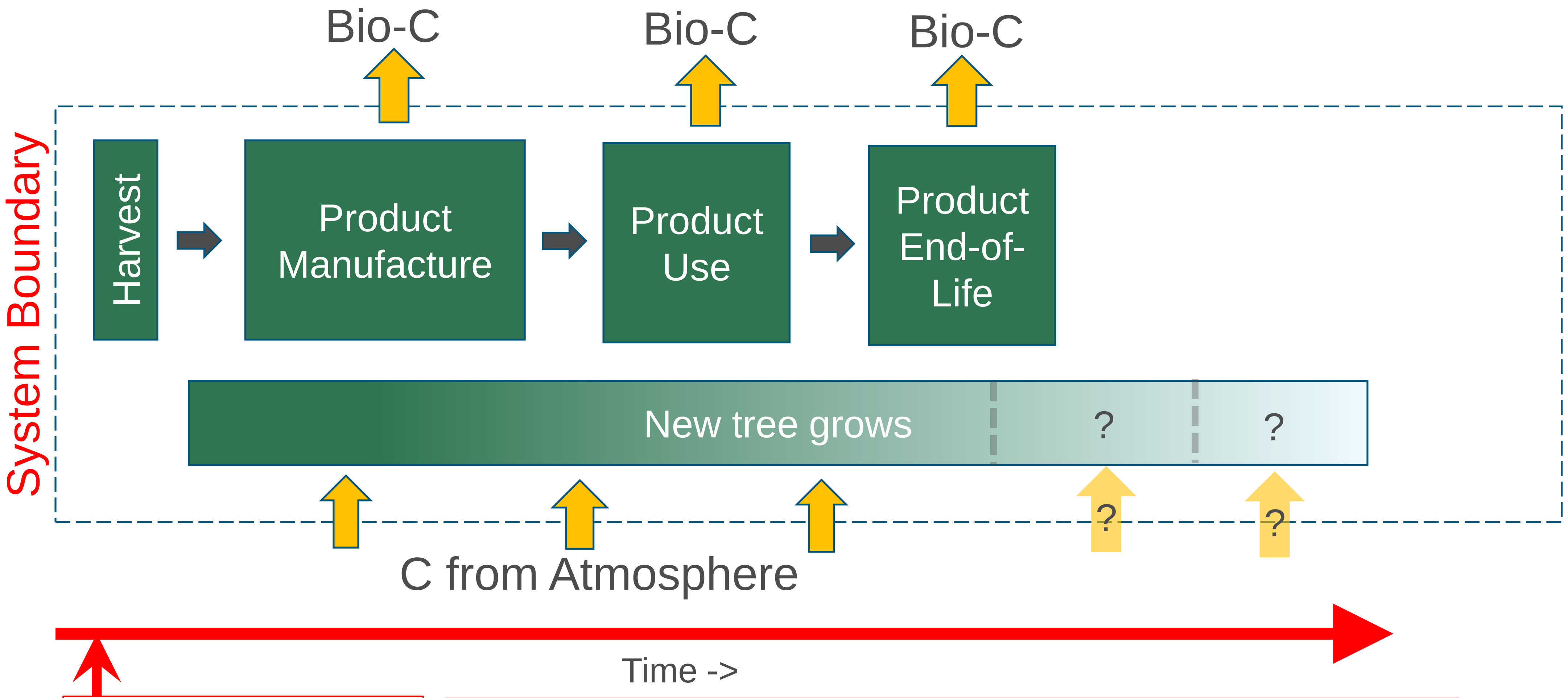
Approach 2: CO_2 is removed from atmosphere by a growing tree that replaces the tree that was harvested



Start accounting at harvest

Also Note: System boundaries include a new tree that is not connected by flows of material or energy to our product

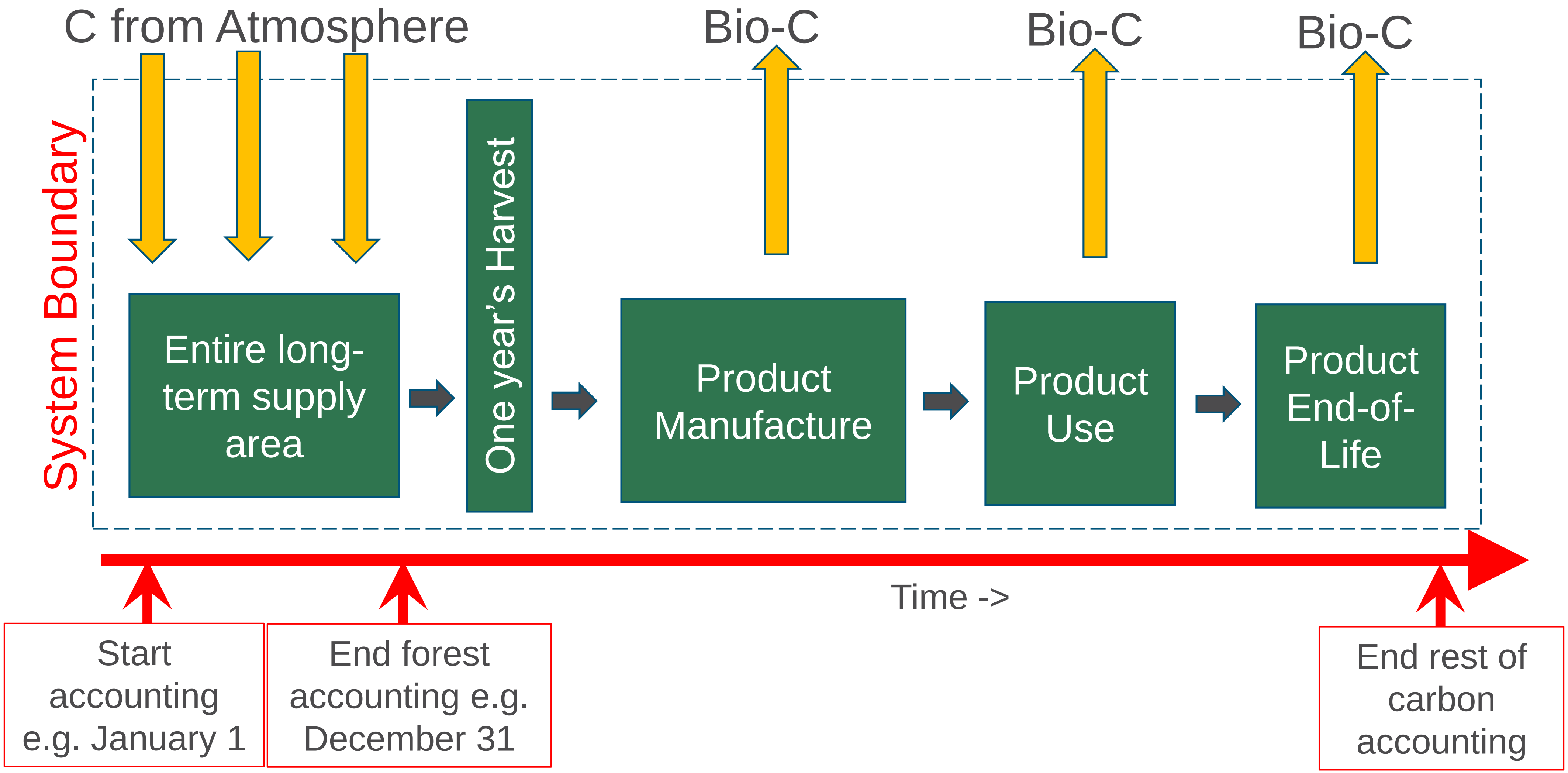
Approach 2: CO_2 is removed from atmosphere by a growing tree that replaces the tree that was harvested



Start accounting at harvest

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



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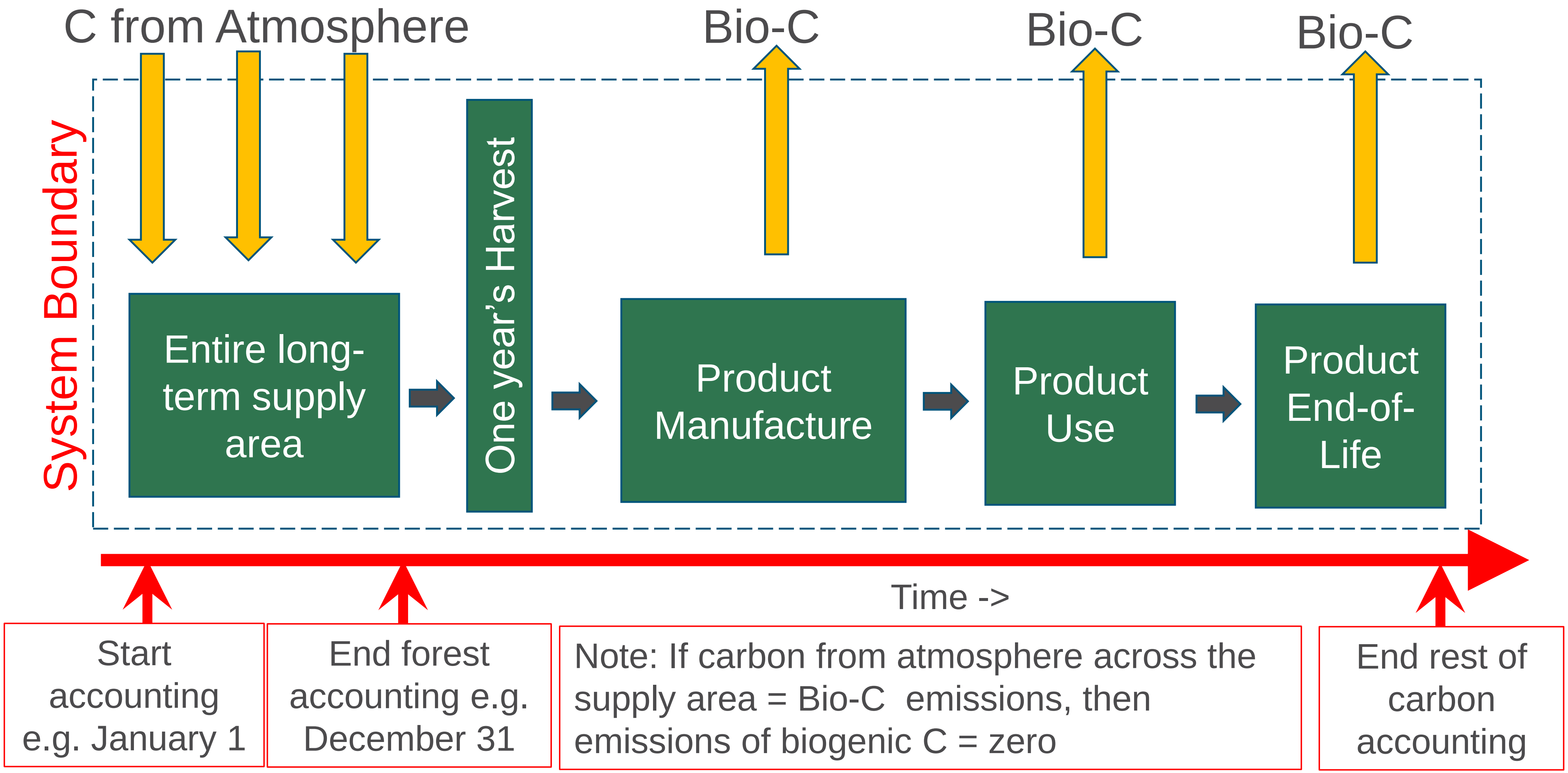

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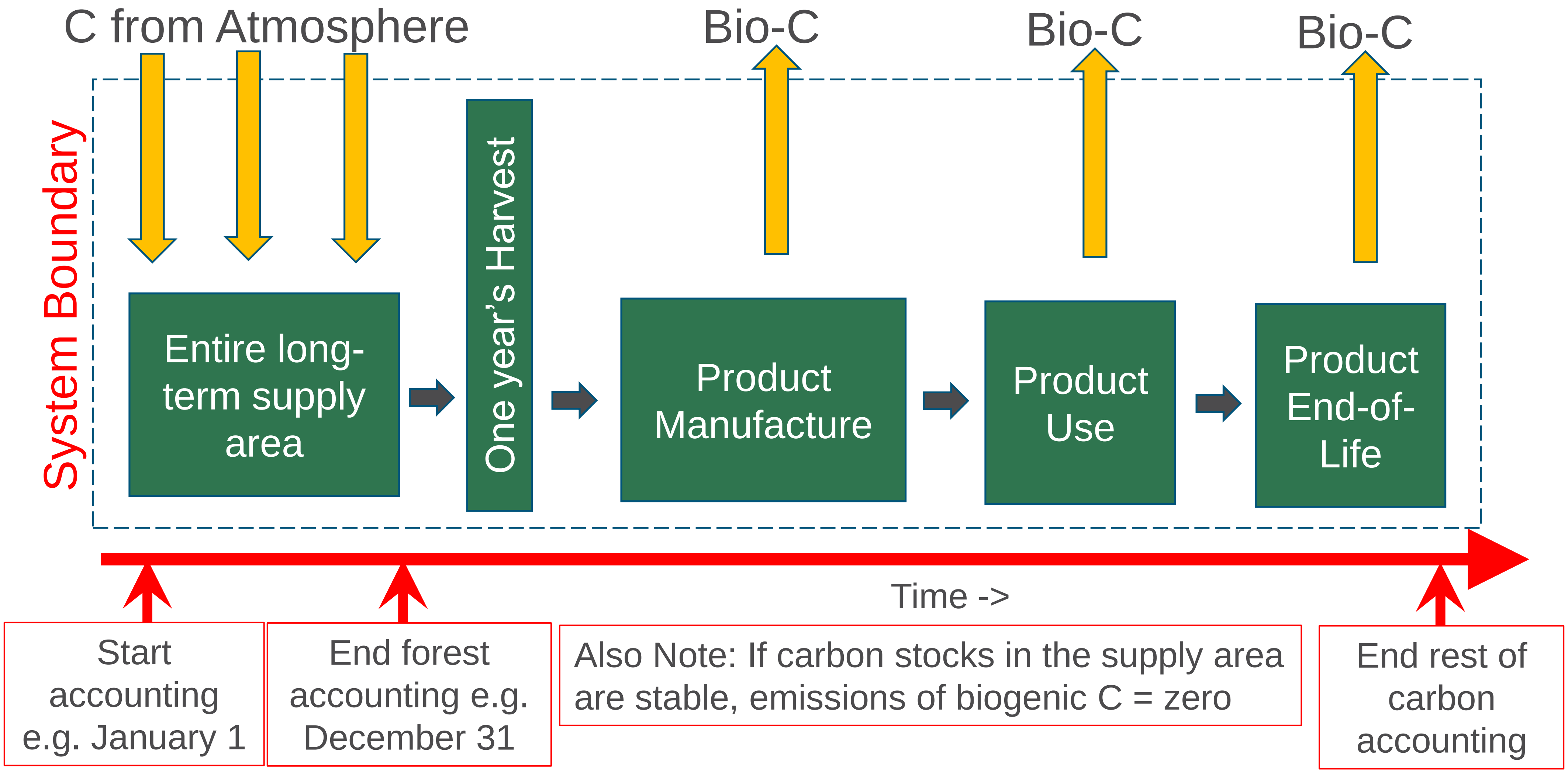
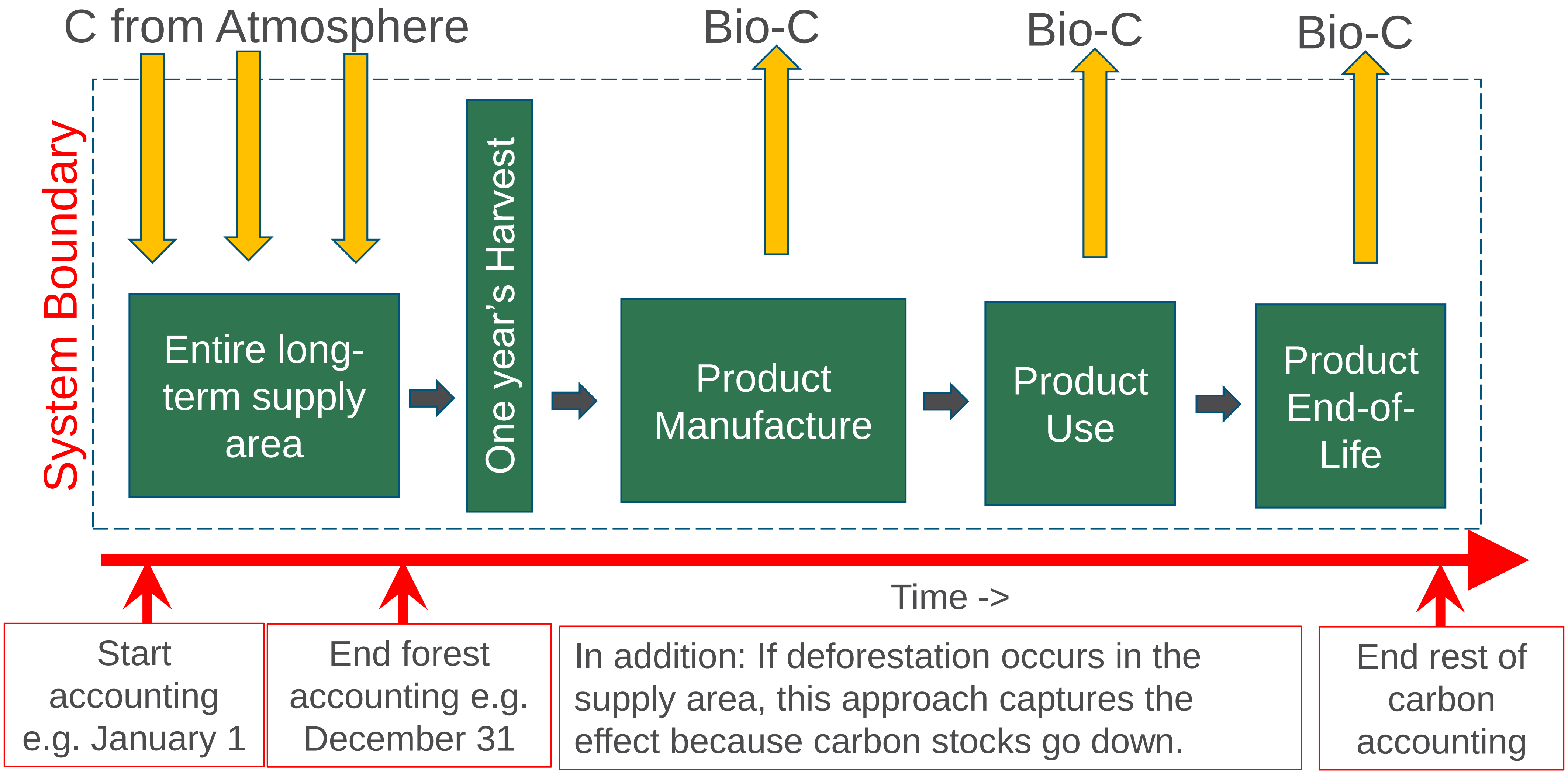
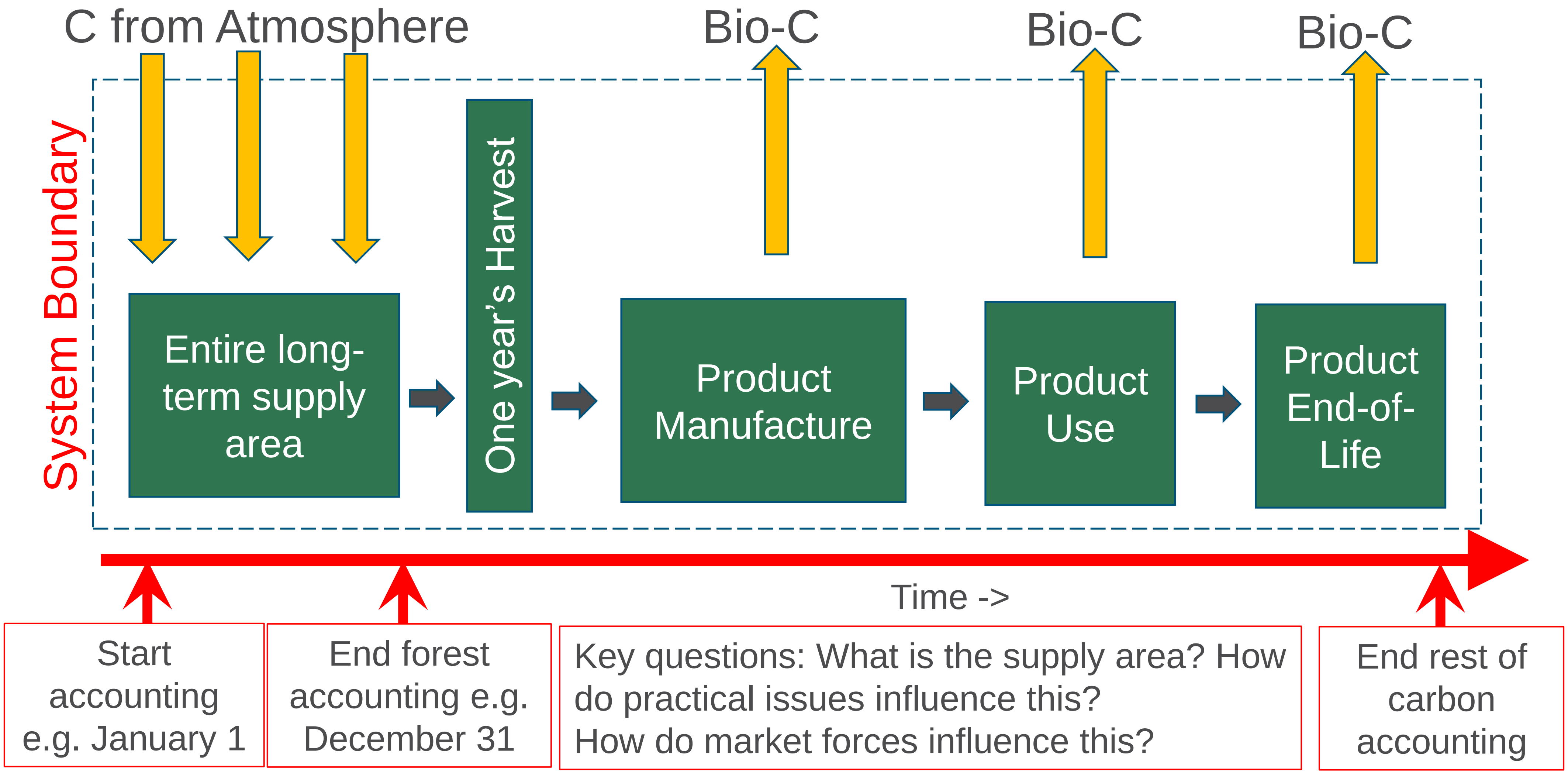


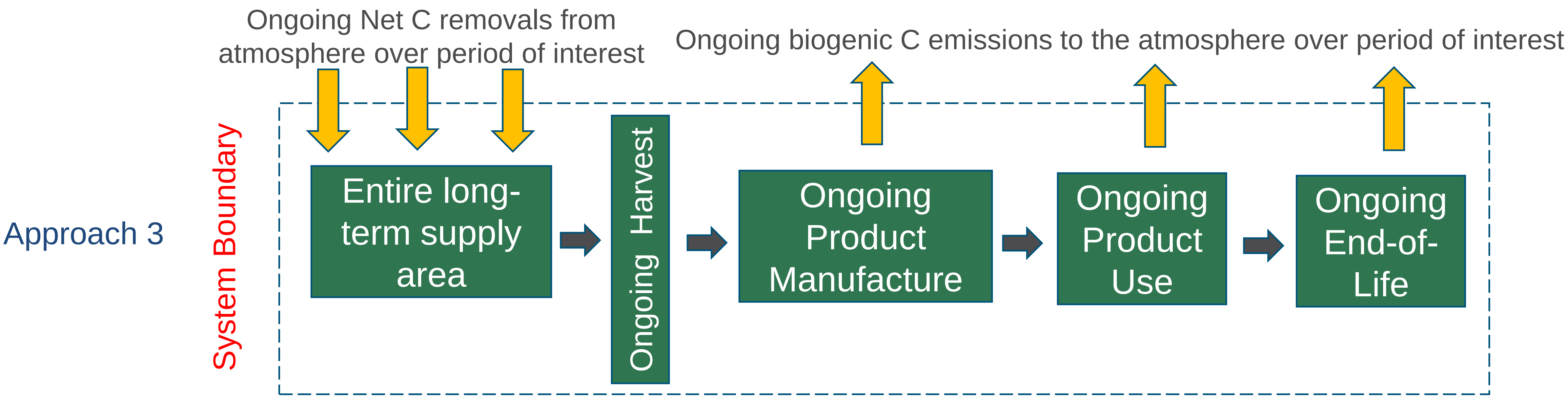
Approach 3: CO_2 is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area



Approach 3: 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



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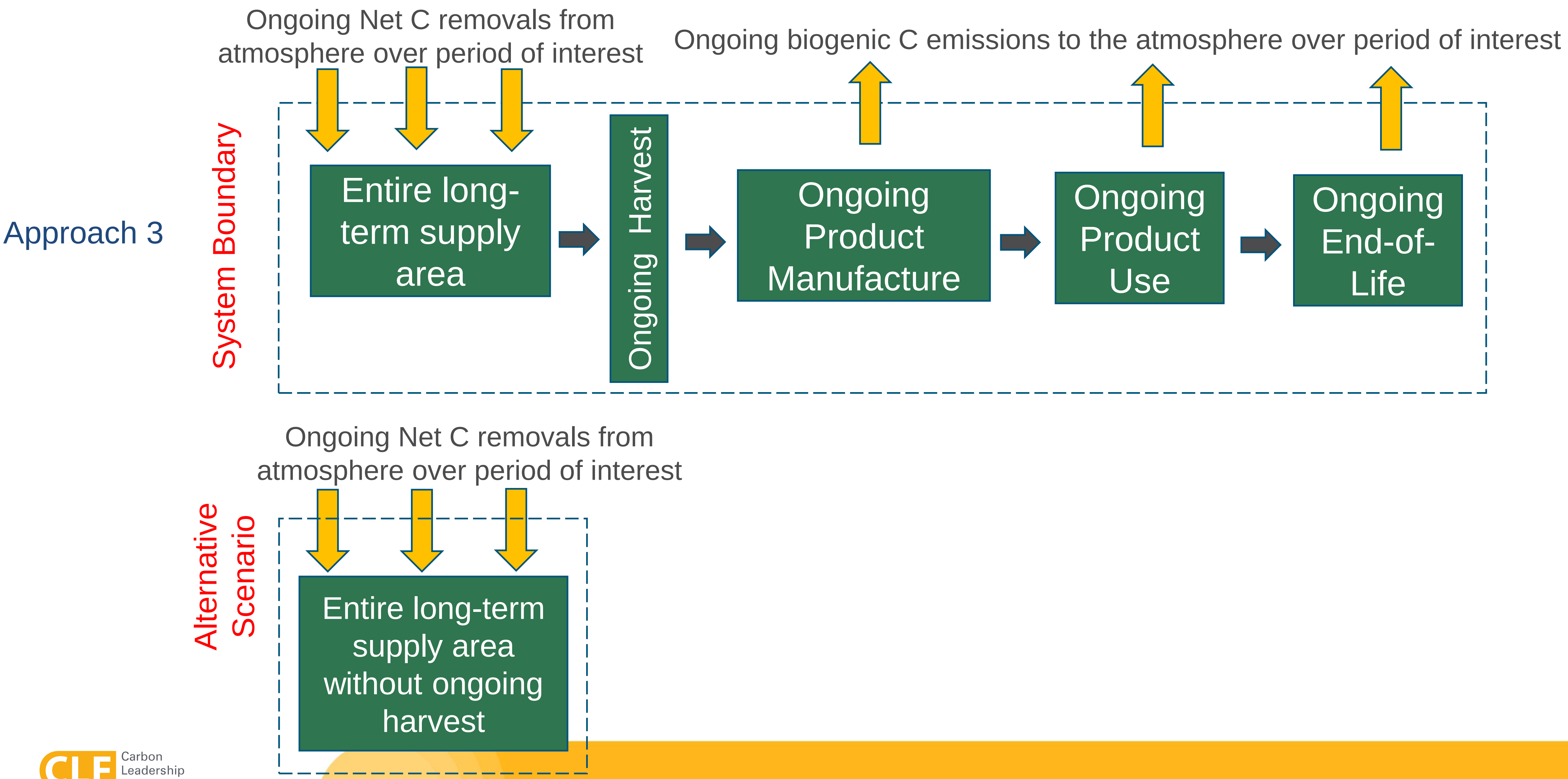

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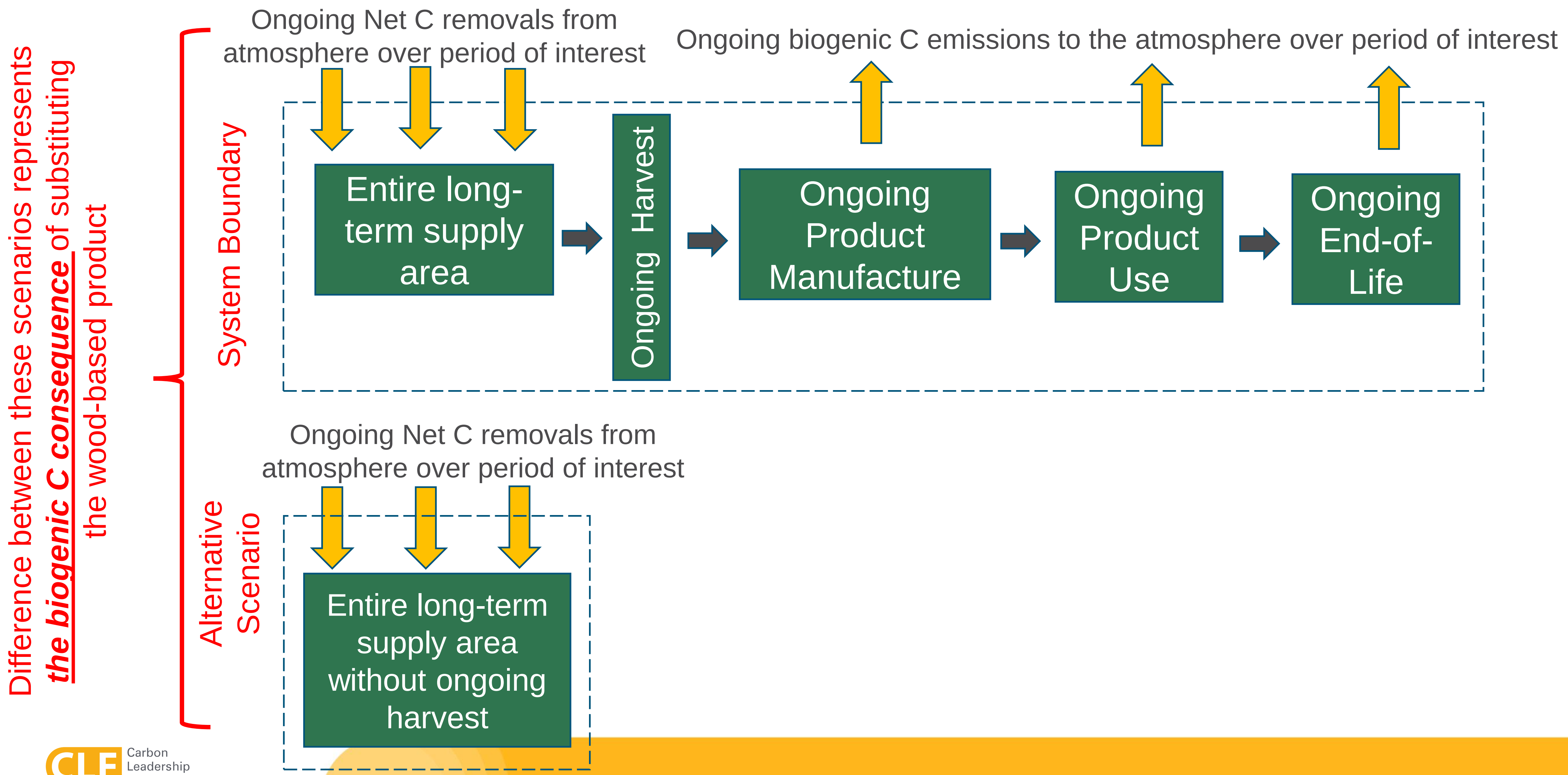
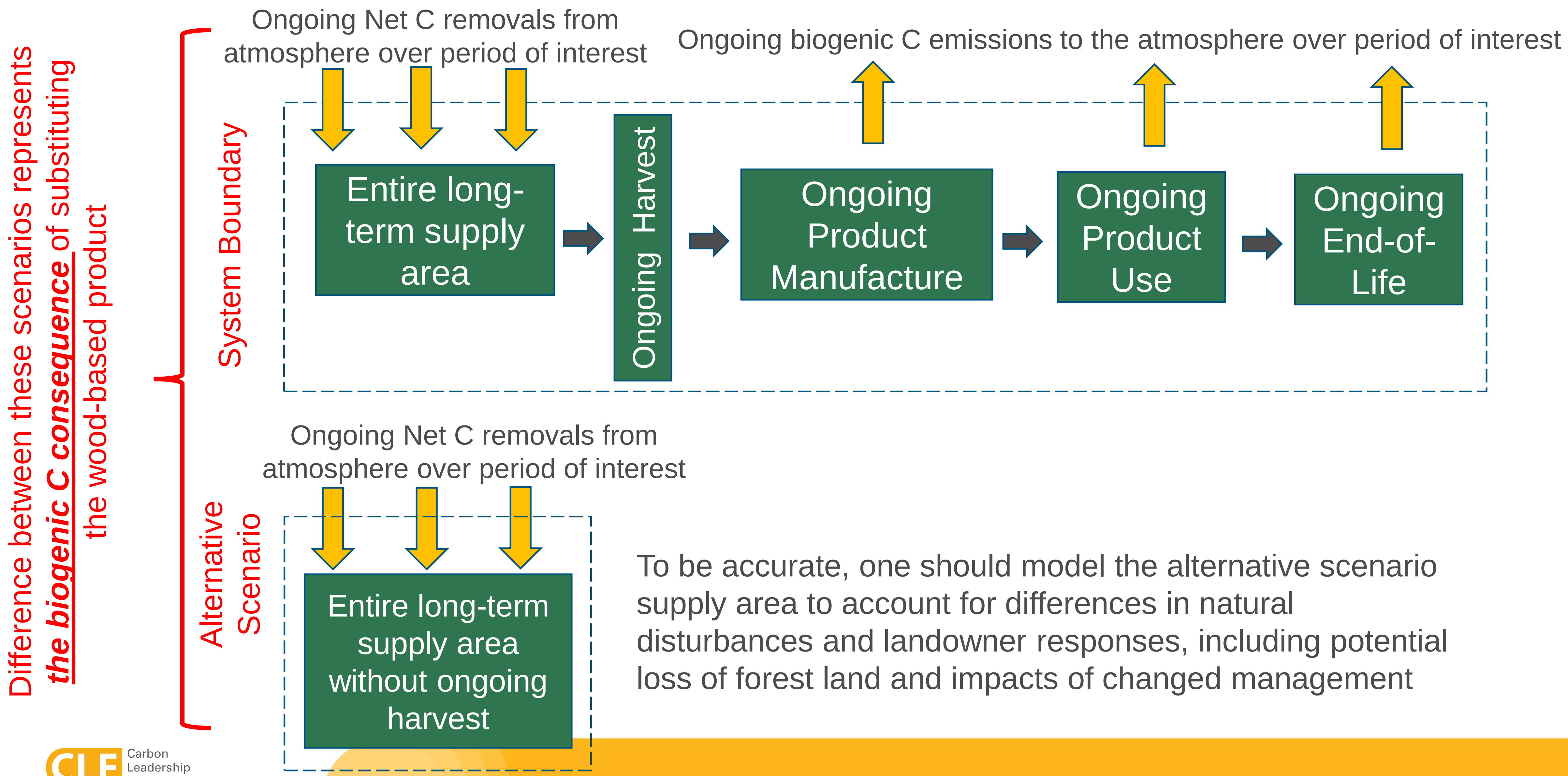


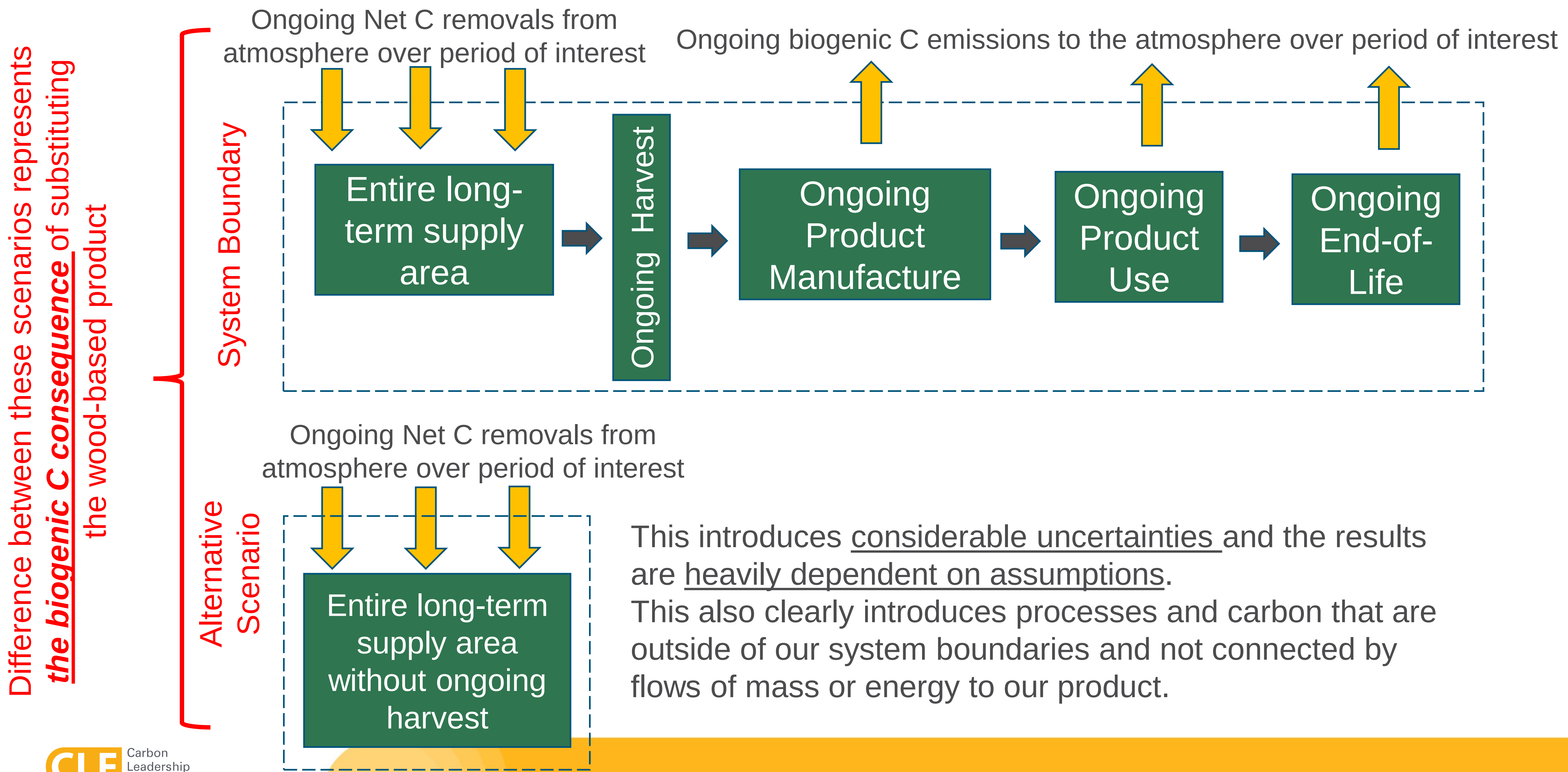
CLF Carbon Leadership Forum

Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3



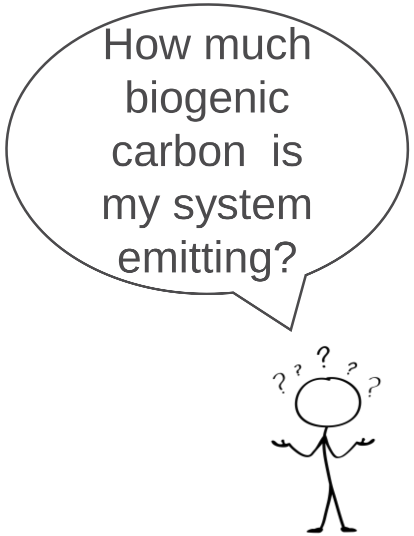
To be accurate, one should model the alternative scenario supply area to account for differences in natural disturbances and landowner responses, including potential loss of forest land and impacts of changed management

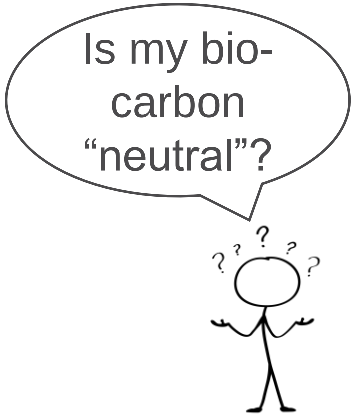
Approach 4: Include foregone sequestration. In this example, include foregone sequestration in Approach 3



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

*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 **)*

- 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

**What Drives Land-Use Change in the United States? A National Analysis of Landowner Decisions*, Land Economics

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

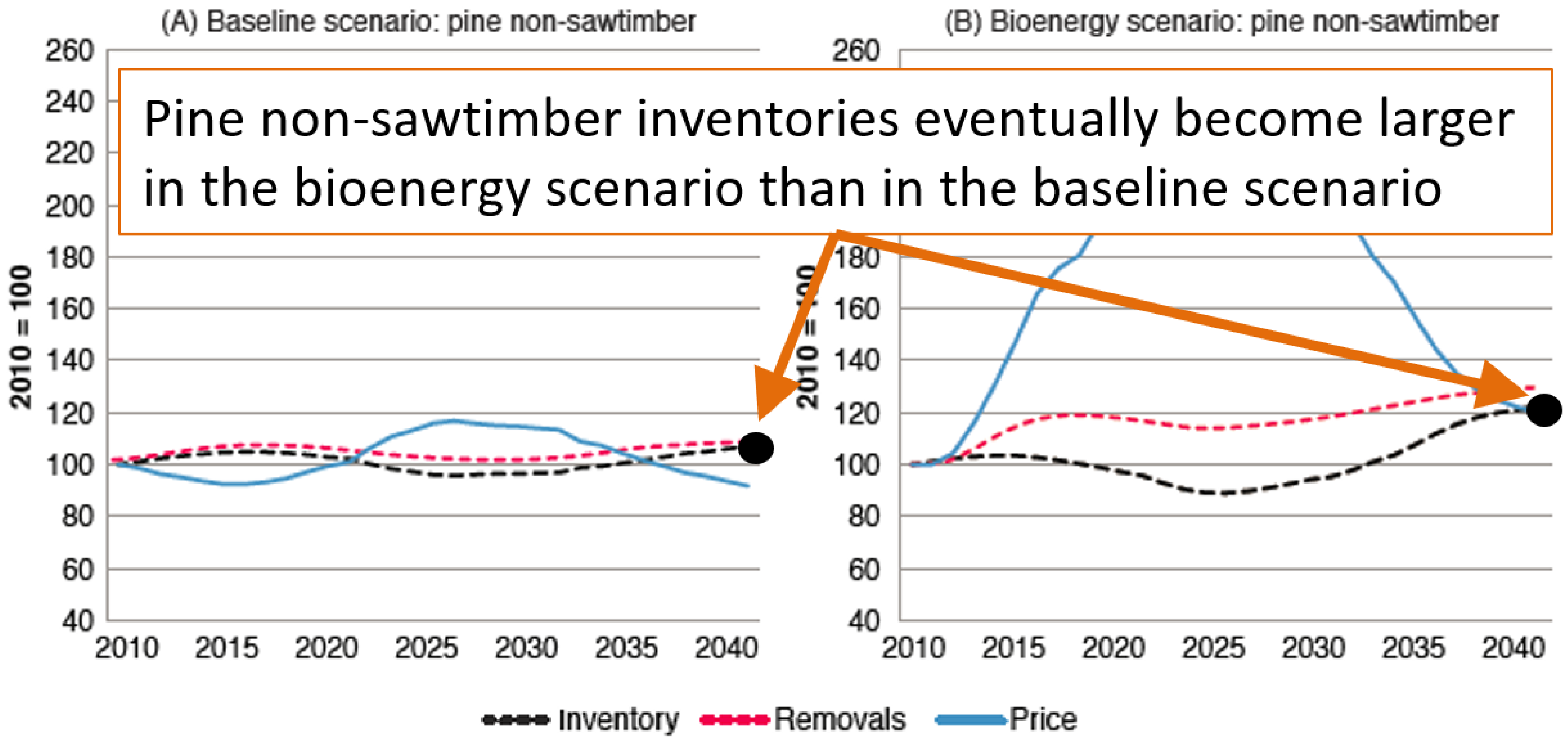
Landowner response and carbon

- 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

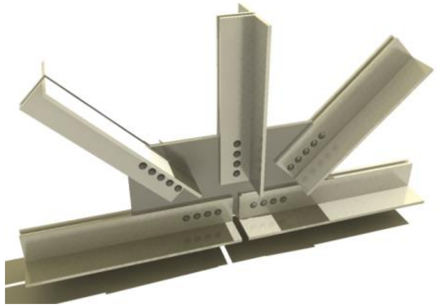
Results for pine non-sawtimber from one study of increased demand for pellets*
Other examples will look different depending on the specifics.



* Abt, et al. 2014. Effect of policies on pellet production and forests in the US South: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-202. U.S. Forest Service.

Substitution effects vs. carbon neutrality

Vs.



Substitution effects vary depending on the products being considered

Vs.

- 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”)

- Thank you

Carbon Leadership Forum

How LCA Handles Wood

James Salazar
Coldstream Consulting

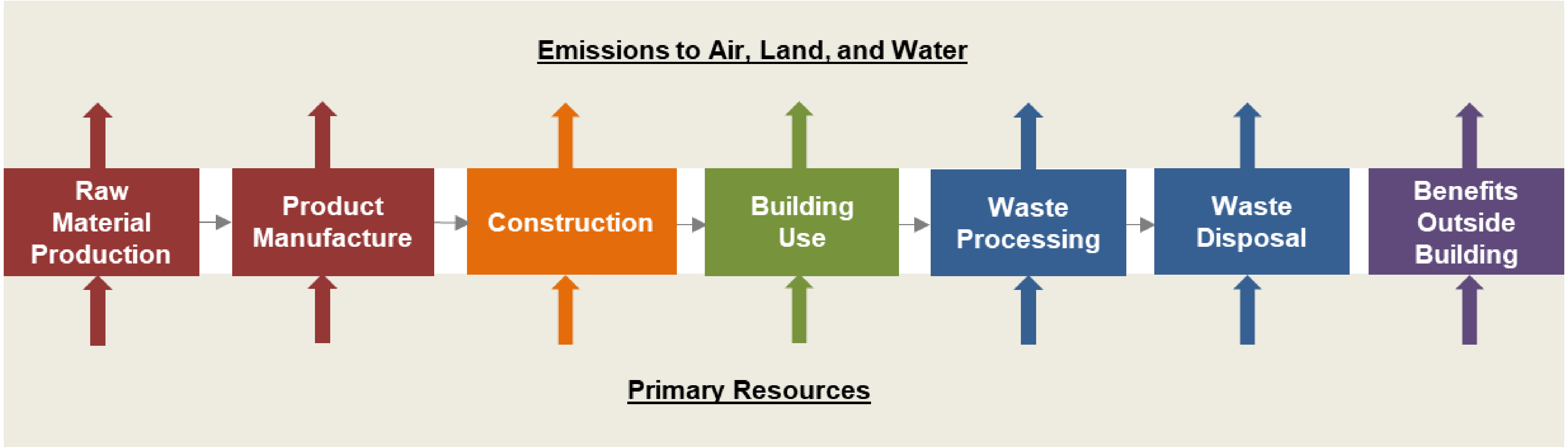
May 7, 2020

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



LCA Calculation

Activity Data

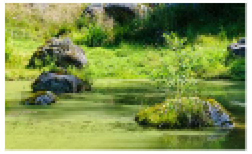
LCI Data	Characterization Factors	Impacts
100 kg CO2	*1	= 100 kg CO2eq
1 kg CH4	*25	= 25 kg CO2eq
.1 kg N2O	*298	= 29.8 kg CO2eq
		154.8 kg CO2eq

Total Global Warming Potential is 154.8 kg CO2eq

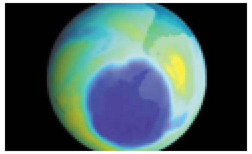
LCA Results

Global warming

Acidification



Eutrophication

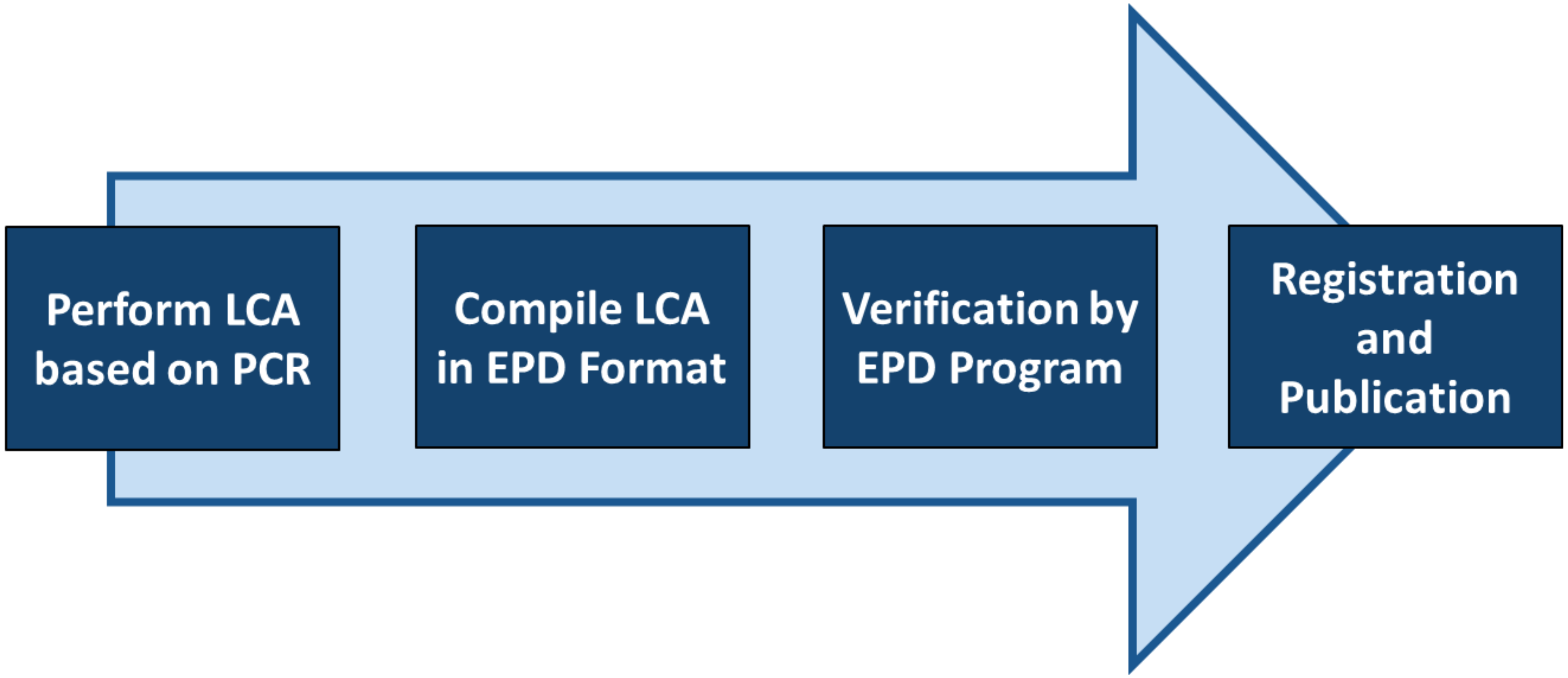


Ozone depletion

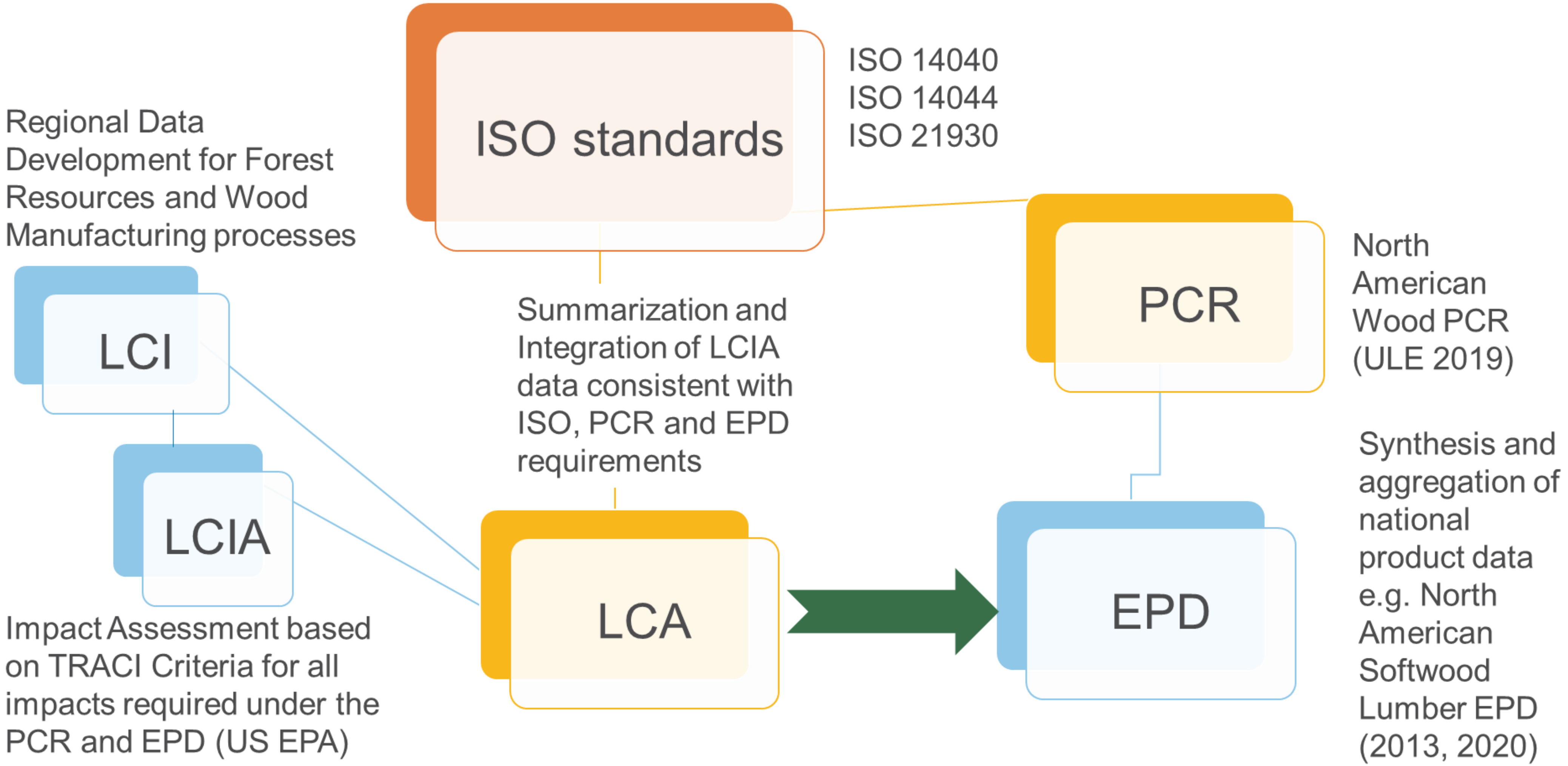
Smog

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



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” <u>for Biogenic C</u> 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
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  - Stable or Increasing Forest Stocks

UNFCC USA

Table 6-1: Net CO_2 Flux from Land Use, Land-Use Change, and Forestry (MMT CO_2 Eq.)

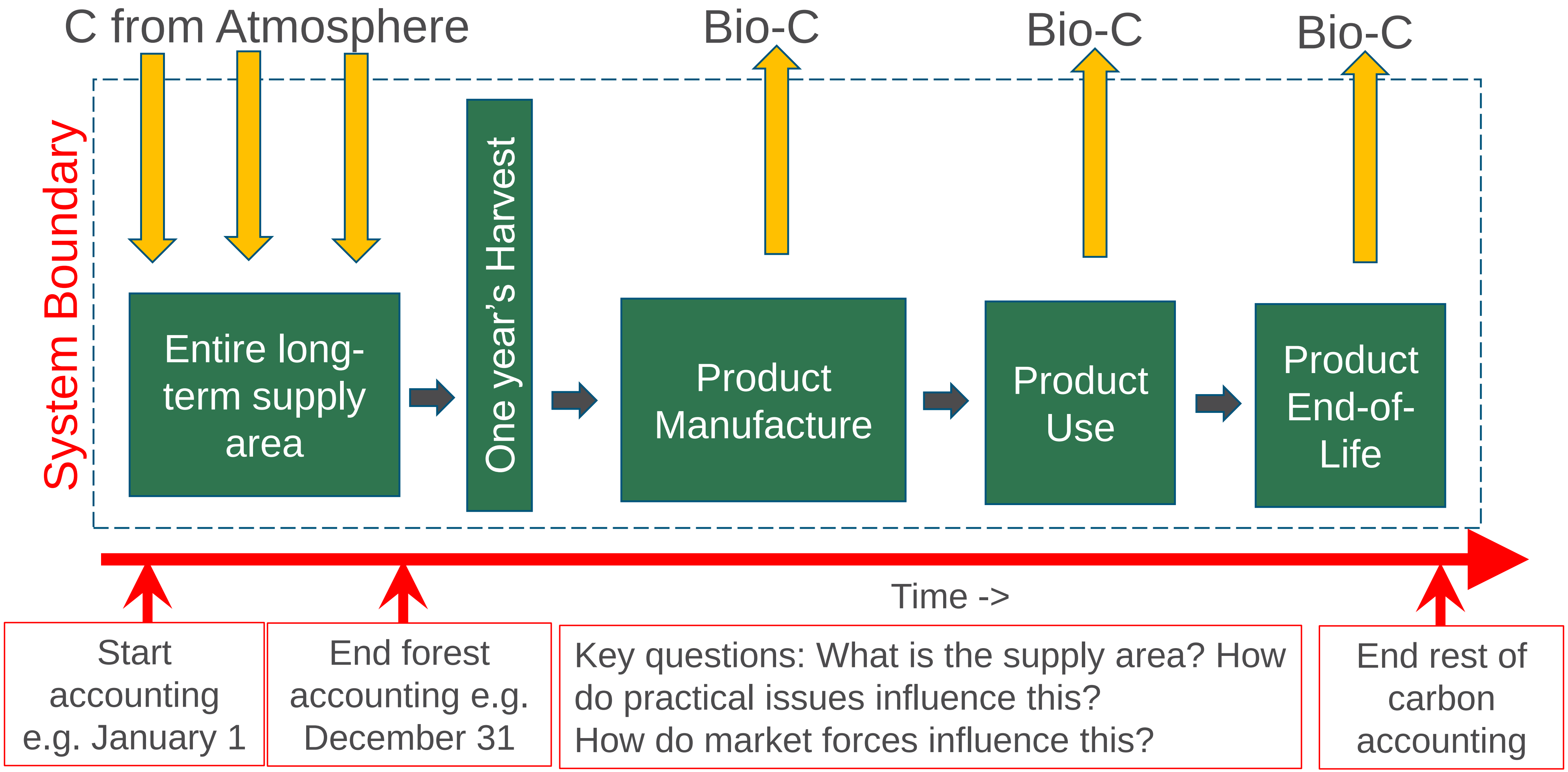
Land-Use Category	1990	2005	2014	2015	2016	2017	2018
Forest Land Remaining Forest Land	**(733.9)**	**(678.6)**	**(618.8)**	**(676.1)**	**(657.9)**	**(647.7)**	**(663.2)**
Changes in Forest Carbon Stocks[a]	(733.9)	(678.6)	(618.8)	(676.1)	(657.9)	(647.7)	(663.2)
Land Converted to Forest Land	**(109.4)**	**(110.2)**	**(110.5)**	**(110.6)**	**(110.6)**	**(110.6)**	**(110.6)**
Changes in Forest Carbon Stocks[b]	(109.4)	(110.2)	(110.5)	(110.6)	(110.6)	(110.6)	(110.6)
Cropland Remaining Cropland	**(23.2)**	**(29.0)**	**(12.2)**	**(12.8)**	**(22.7)**	**(22.3)**	**(16.6)**
Changes in Mineral and Organic Soil Carbon Stocks	(23.2)	(29.0)	(12.2)	(12.8)	(22.7)	(22.3)	(16.6)
LULUCF Carbon Stock Change	**(860.7)**	**(831.0)**	**(739.6)**	**(802.9)**	**(801.7)**	**(790.0)**	**(799.6)**

UNFCC Canada

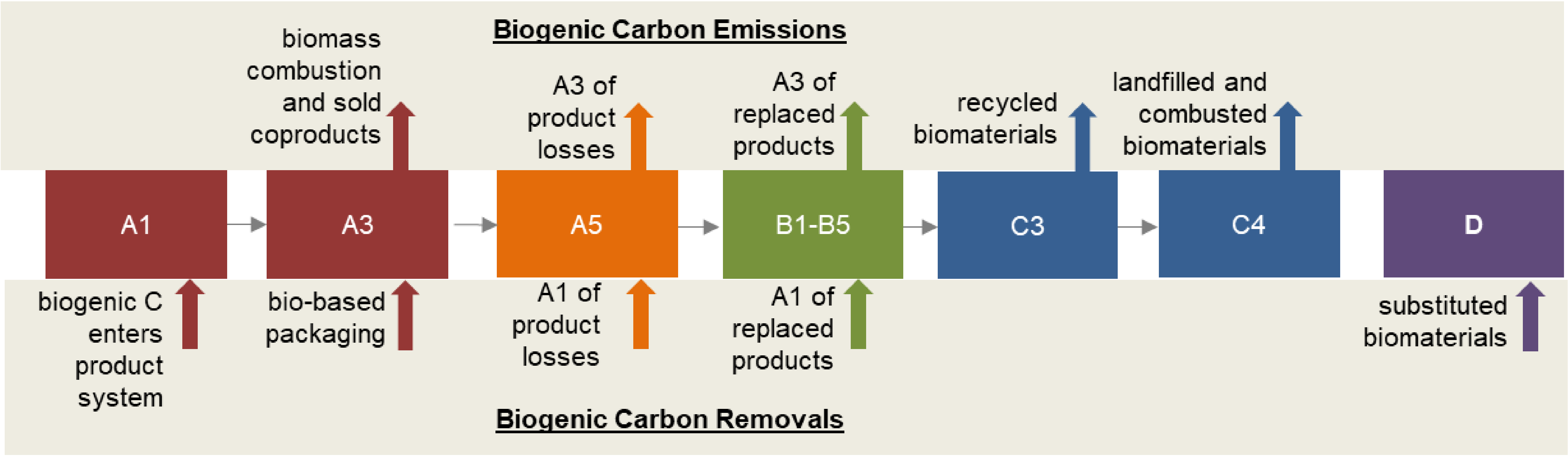
Table 6–1 **LULUCF Sector Net GHG Flux Estimates, Selected Years**

Sectoral Category		Net GHG Flux (kt CO_2 eq)[b]							
		1990	2005	2013	2014	2015	2016	2017	2018
Land Use, Land-Use Change and Forestry TOTAL[a]		**-60 000**	**-13 000**	**-25 000**	**-25 000**	**-18 000**	**-19 000**	**-16 000**	**-13 000**
a.	**Forest Land**	**-200 000**	**-150 000**	**-150 000**	**-150 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**
	Forest Land remaining Forest Land	-200 000	-140 000	-150 000	-150 000	-140 000	-140 000	-140 000	-140 000
	Land converted to Forest Land	-1 100	- 950	- 590	- 540	- 500	- 440	- 390	- 330
b.	**Cropland**	**8 100**	**-11 000**	**-10 000**	**-9 500**	**-8 600**	**-7 700**	**-6 800**	**-6 200**
	Cropland remaining Cropland	-1 300	-15 000	-13 000	-12 000	-11 000	-10 000	-9 700	-8 800
	Land converted to Cropland	9 500	3 900	2 700	2 800	2 700	2 800	2 900	2 700
c.	**Grassland**	**0.6**	**0.9**	**1.9**	**0.8**	**1.2**	**1.2**	**1.2**	**1.2**
	Grassland remaining Grassland	0.6	0.9	1.9	0.8	1.2	1.2	1.2	1.2
	Land converted to Grassland	NO	NO	NO	NO	NO	NO	NO	NO
d.	**Wetlands**	**5 300**	**3 100**	**3 100**	**3 100**	**2 900**	**2 900**	**3 000**	**2 600**
	Wetlands remaining Wetlands	1 500	2 600	2 400	2 400	2 500	2 600	2 600	2 400
	Land converted to Wetlands	3 800	480	670	710	410	330	350	210
e.	**Settlements**	**2 100**	**2 100**	**2 300**	**2 300**	**2 200**	**2 100**	**1 900**	**1 800**
	Settlements remaining Settlements	-3 900	-4 100	-4 100	-4 100	-4 100	-4 100	-4 100	-4 100
	Land converted to Settlements	6 000	6 100	6 400	6 400	6 400	6 200	6 000	5 900
f.	**Other Land**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
g.	**Harvested Wood Products**	**130 000**	**140 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**
	Forest Conversion[c]	*21 000*	*16 000*	*15 000*	*15 000*	*15 000*	*15 000*	*14 000*	*14 000*
	Indirect CO_2[d]	*790*	*820*	*630*	*560*	*570*	*530*	*510*	*490*
	Natural Disturbances[e]	*-22 000*	*46 000*	*43 000*	*160 000*	*240 000*	*120 000*	*220 000*	*250 000*

Approach 3: CO_2 is removed from the atmosphere in the year of harvest by non-harvested trees growing across the supply area

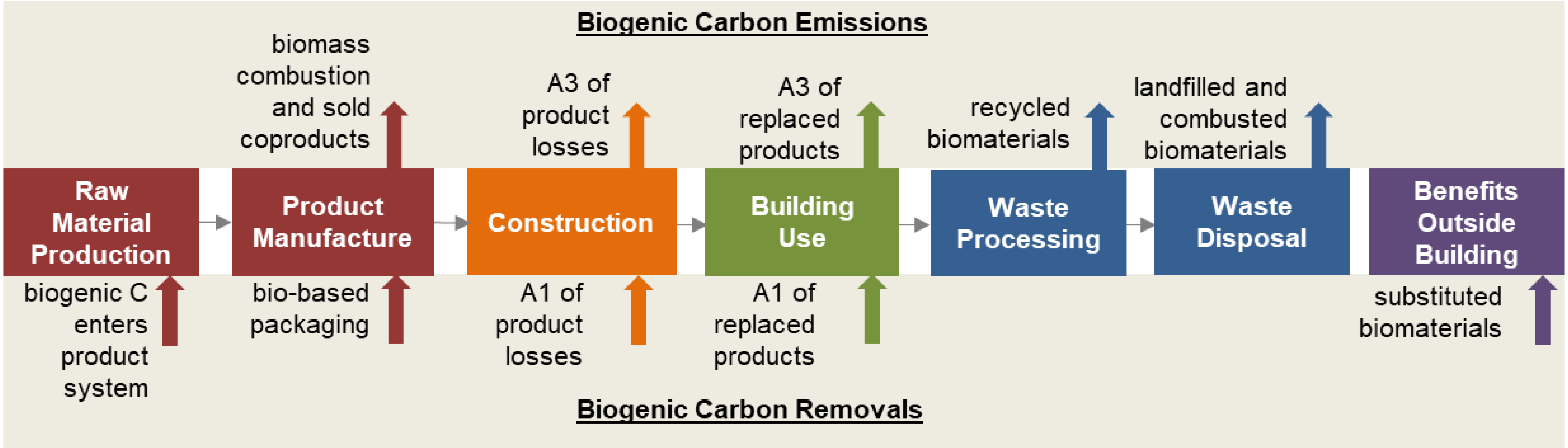


Biogenic Carbon Accounting per ISO 21930

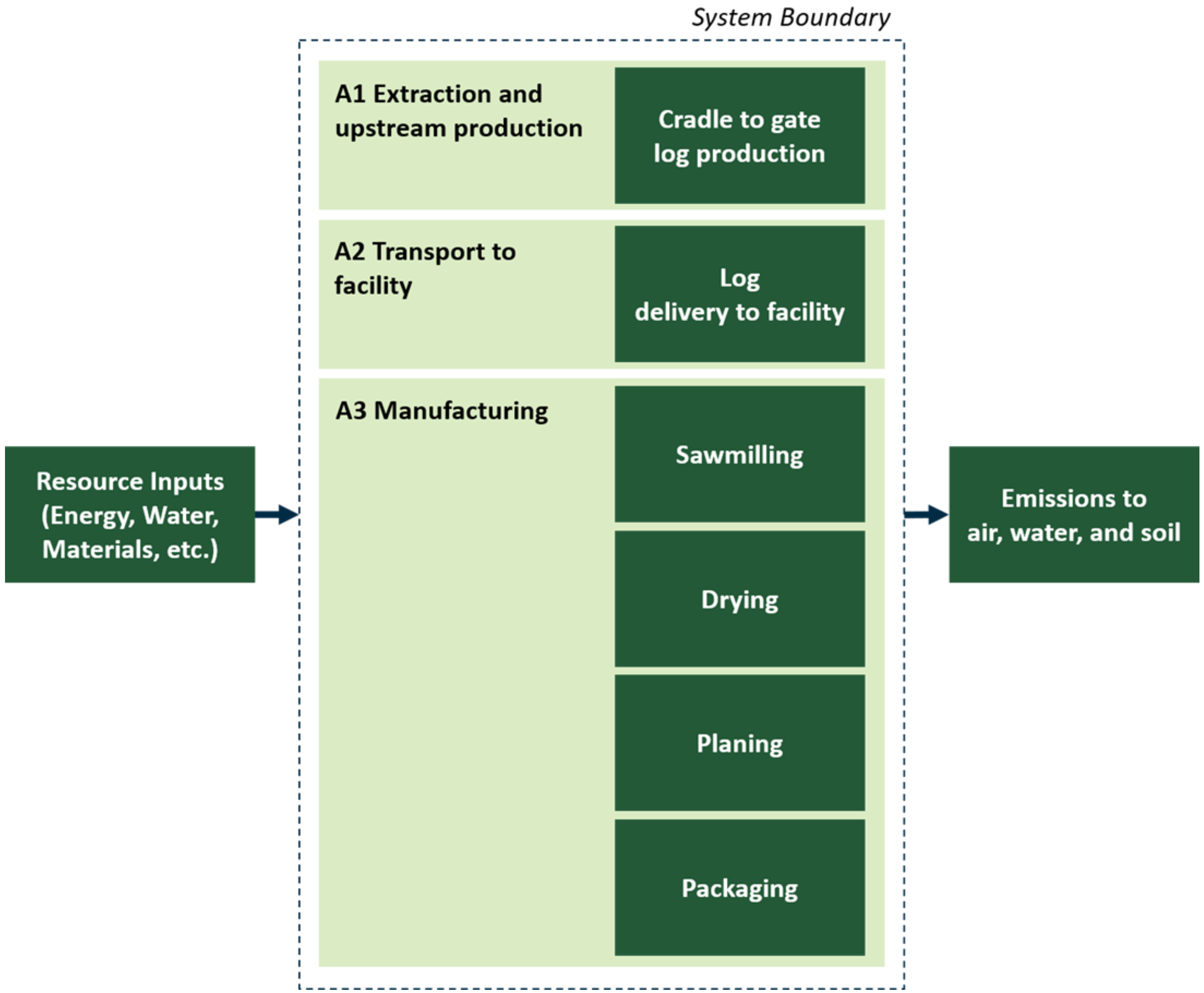


Biogenic Carbon in LCA & EPD

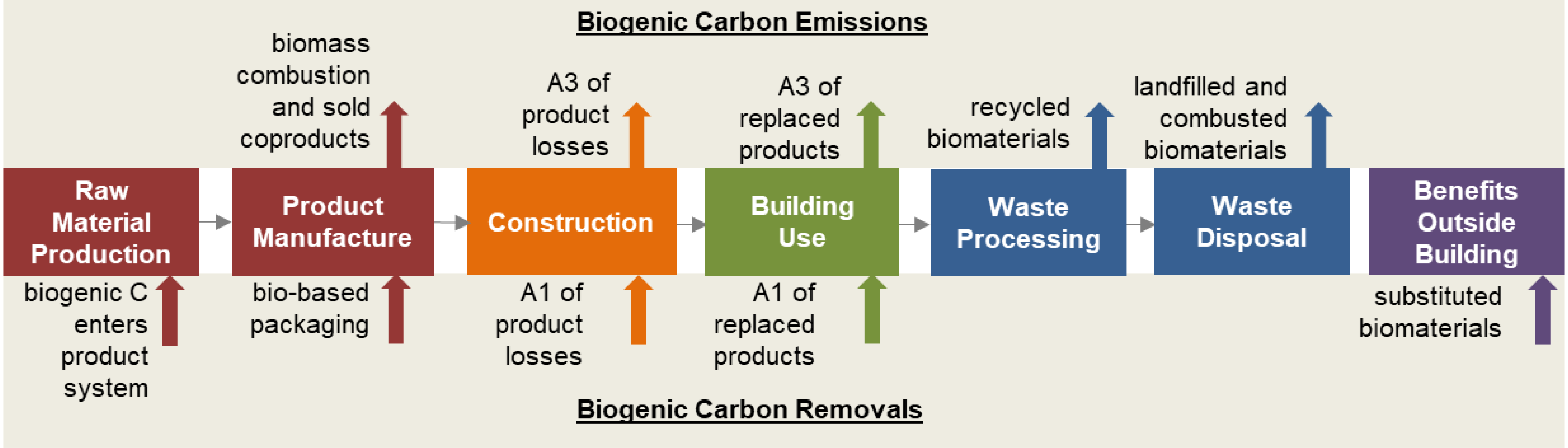
Cradle-to-Gate Biogenic Carbon Accounting



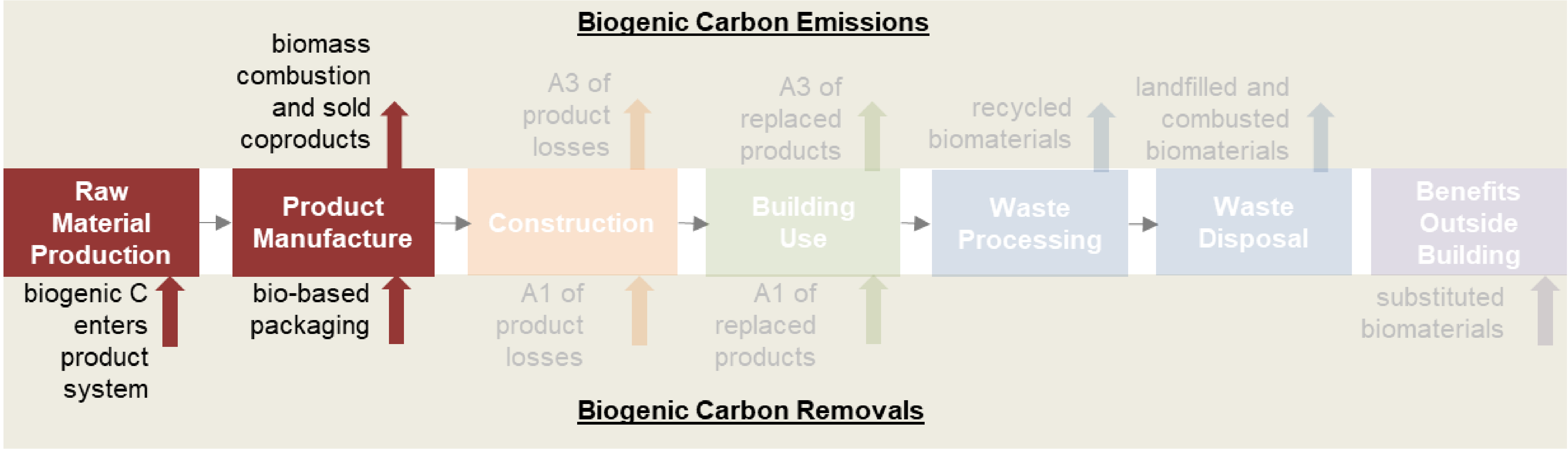
Cradle-to-Gate Wood Product System



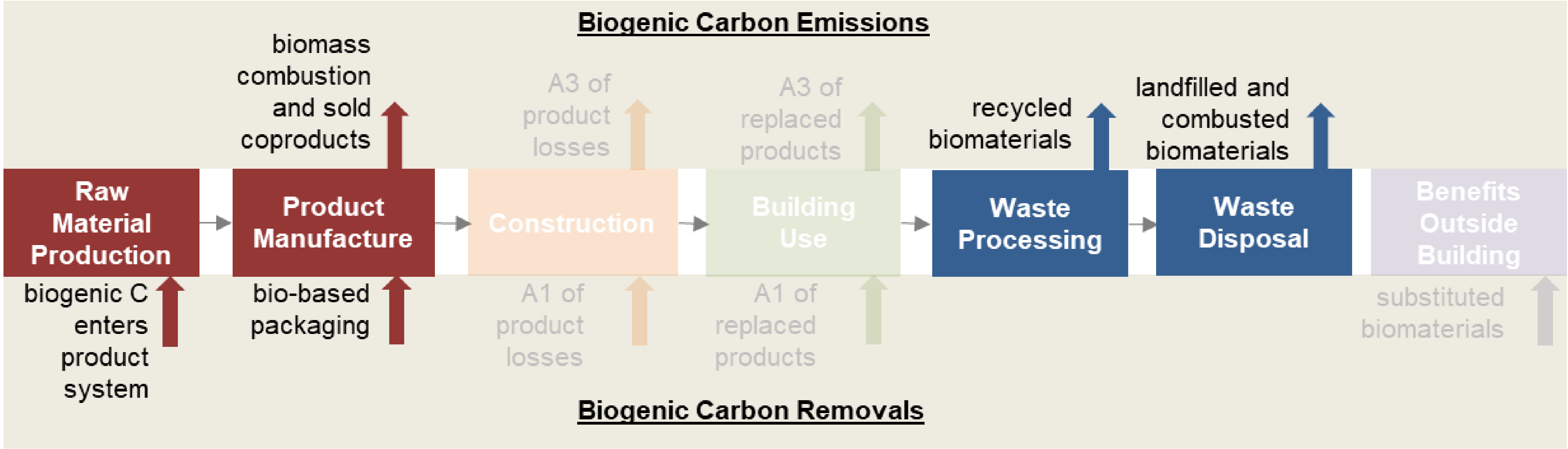
Cradle-to-Gate Biogenic Carbon Accounting



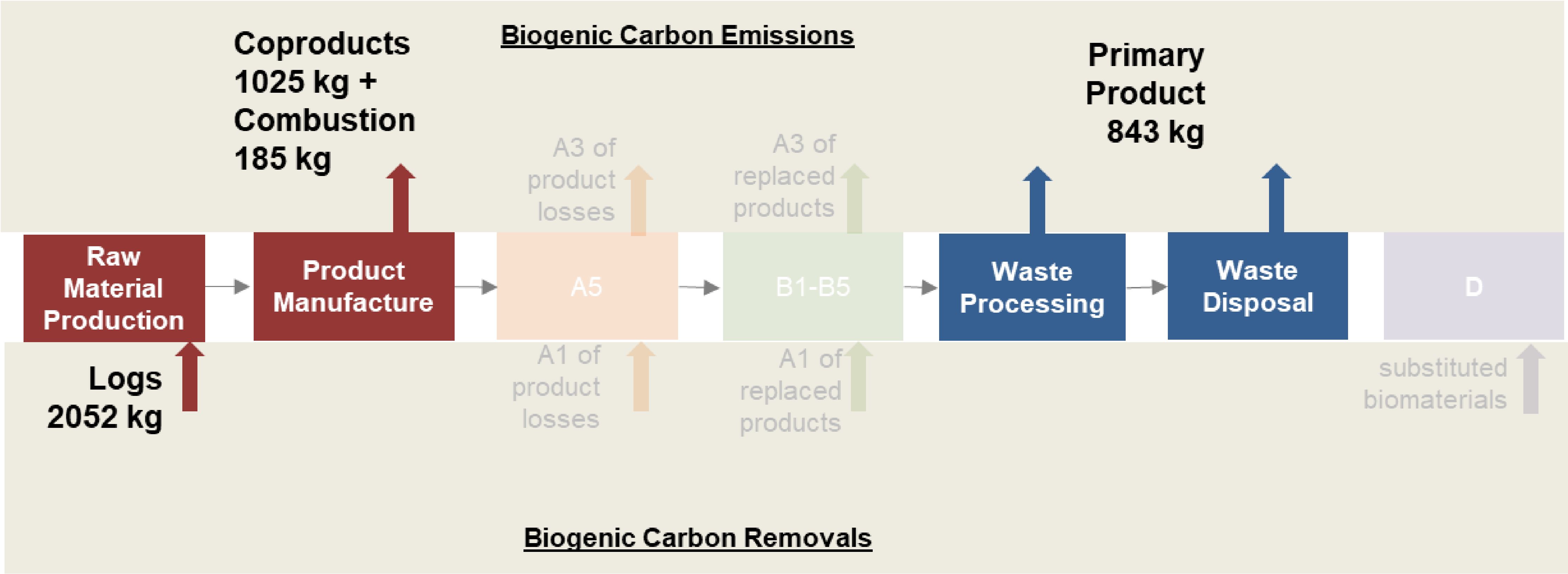
Cradle-to-Gate Biogenic Carbon Accounting



Cradle-to-Gate Biogenic Carbon Accounting



Cradle-to-Gate Biogenic Carbon Accounting



Cradle-to-Gate Biogenic Carbon Results

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

Zero Net Biogenic Carbon Sequestration in Cradle-to-Gate LCA

CLF Carbon Leadership Forum

A Deeper Dive into Wood Product LCA Forest Resource Accounting

CLF Wood Seminar Series

May 7, 2020

by

Elaine Oneil, 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

CORRIM

Well Established International Framework and Hierarchy

Regional Data Development

Regional Data Development for Forest Resources and Wood Manufacturing processes

ISO standards

ISO 14040
ISO 14044
ISO 21930

ISO 21930

PCR

North American Wood PCR (ULE 2019)

LCI

LCIA

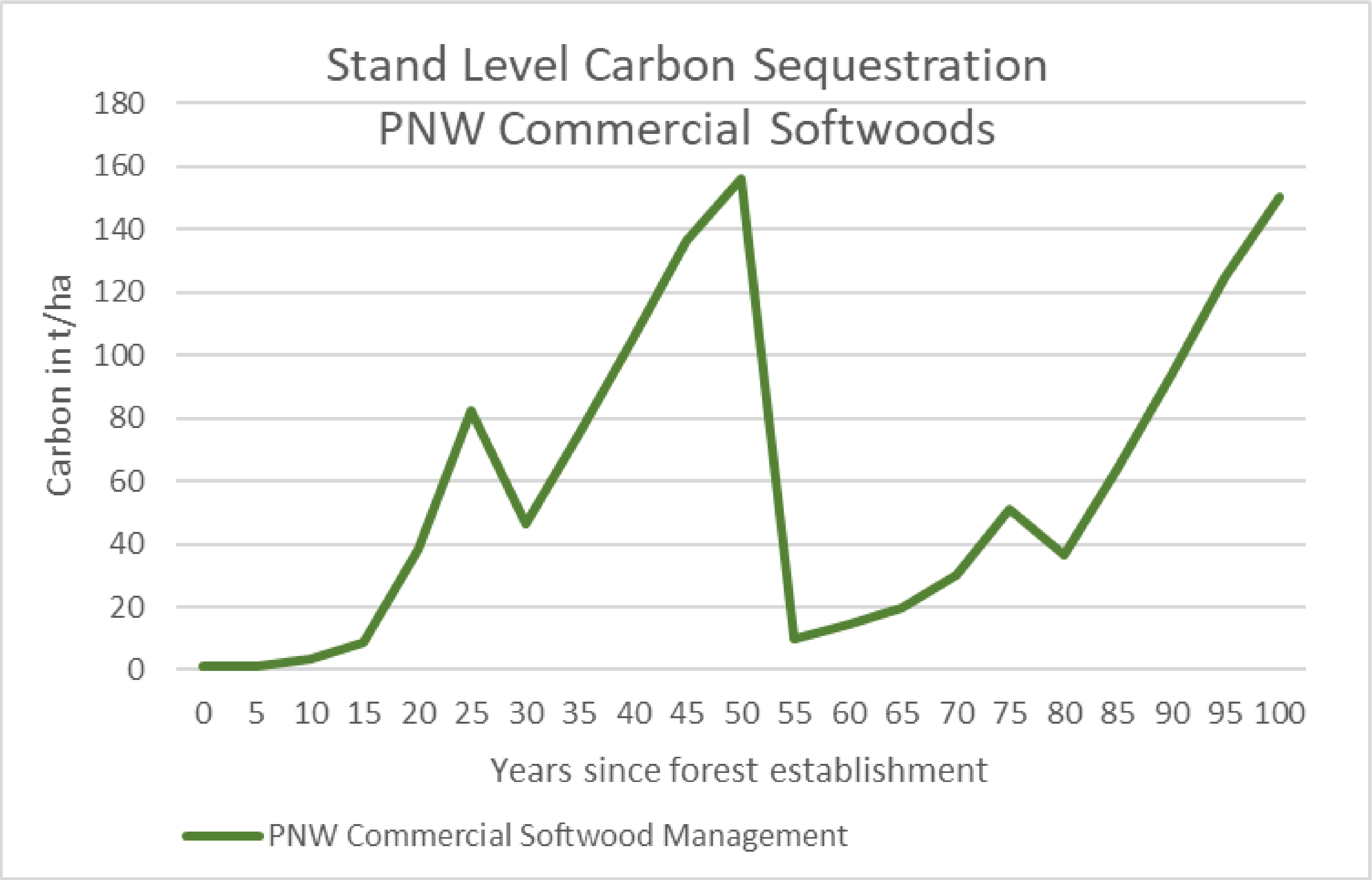
Summarization and Integration of LCI and LCIA consistent with ISO, PCR and EPD requirements

LCA

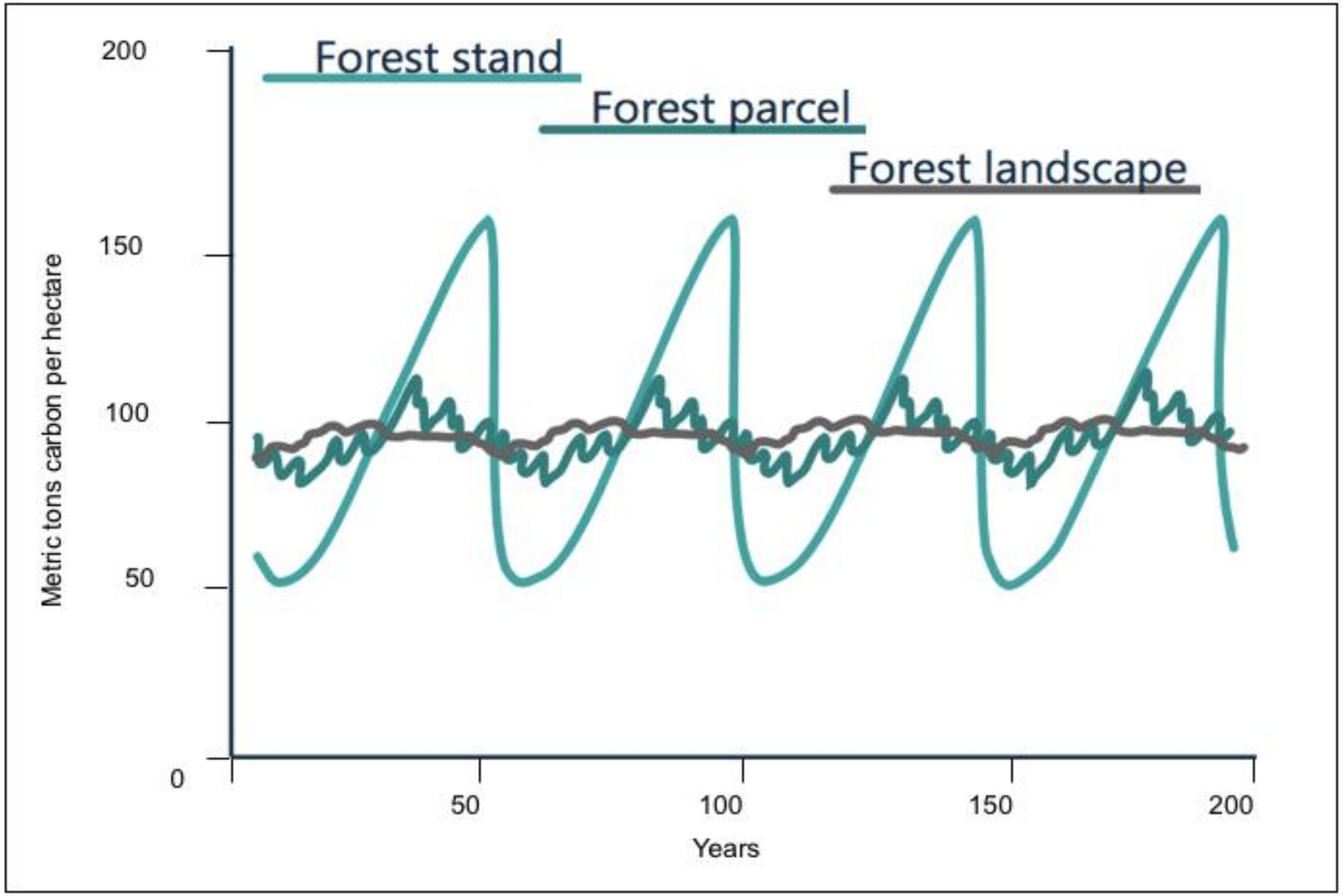
EPD

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

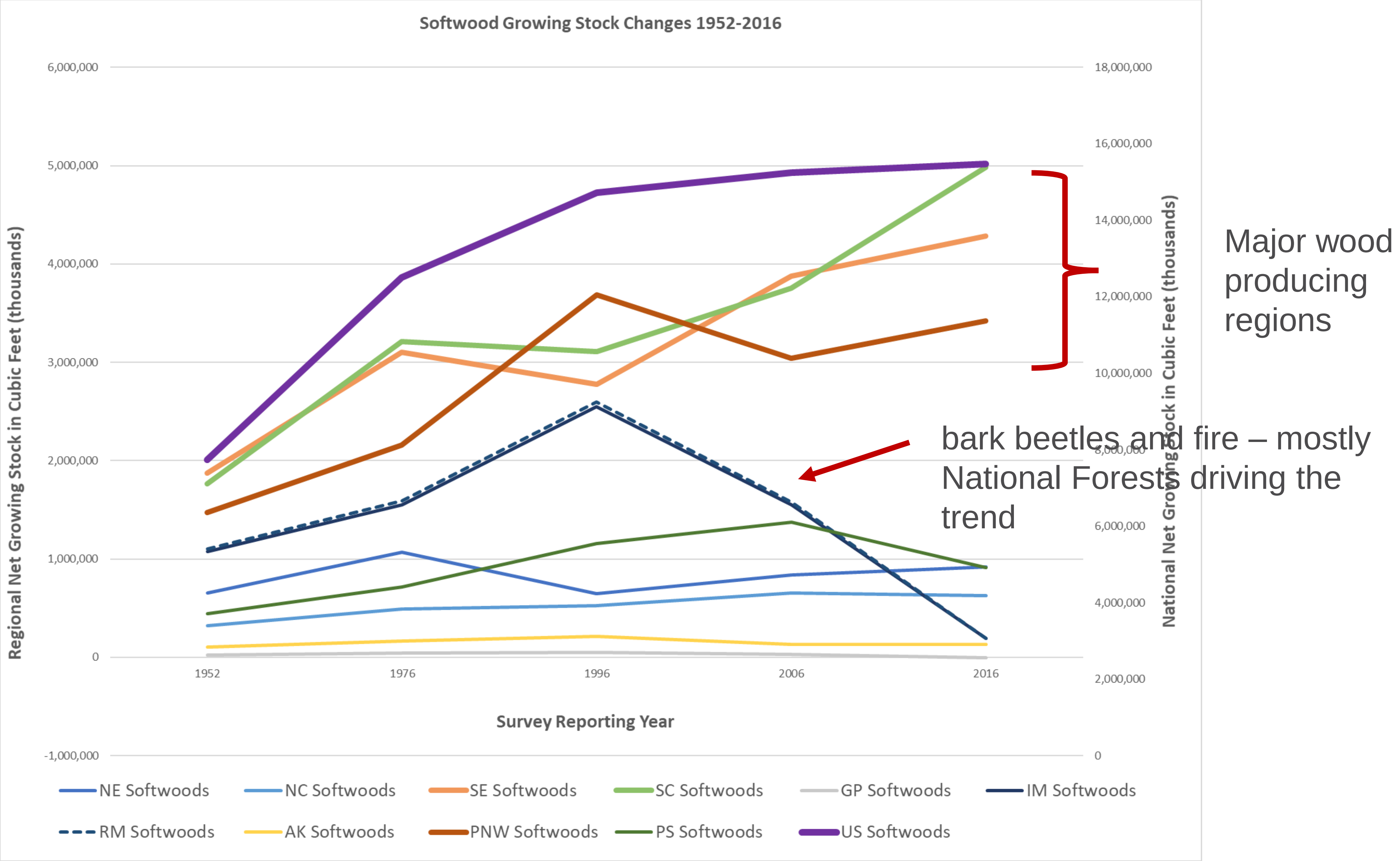
Impact Assessment based on TRACI Criteria for all impacts required under the PCR and EPD (US EPA)


Stand Level Carbon Sequestration
PNW Commercial Softwoods
Carbon in t/ha
180
160
140
120
100
80
60
40
20
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Years since forest establishment
PNW Commercial Softwood Management

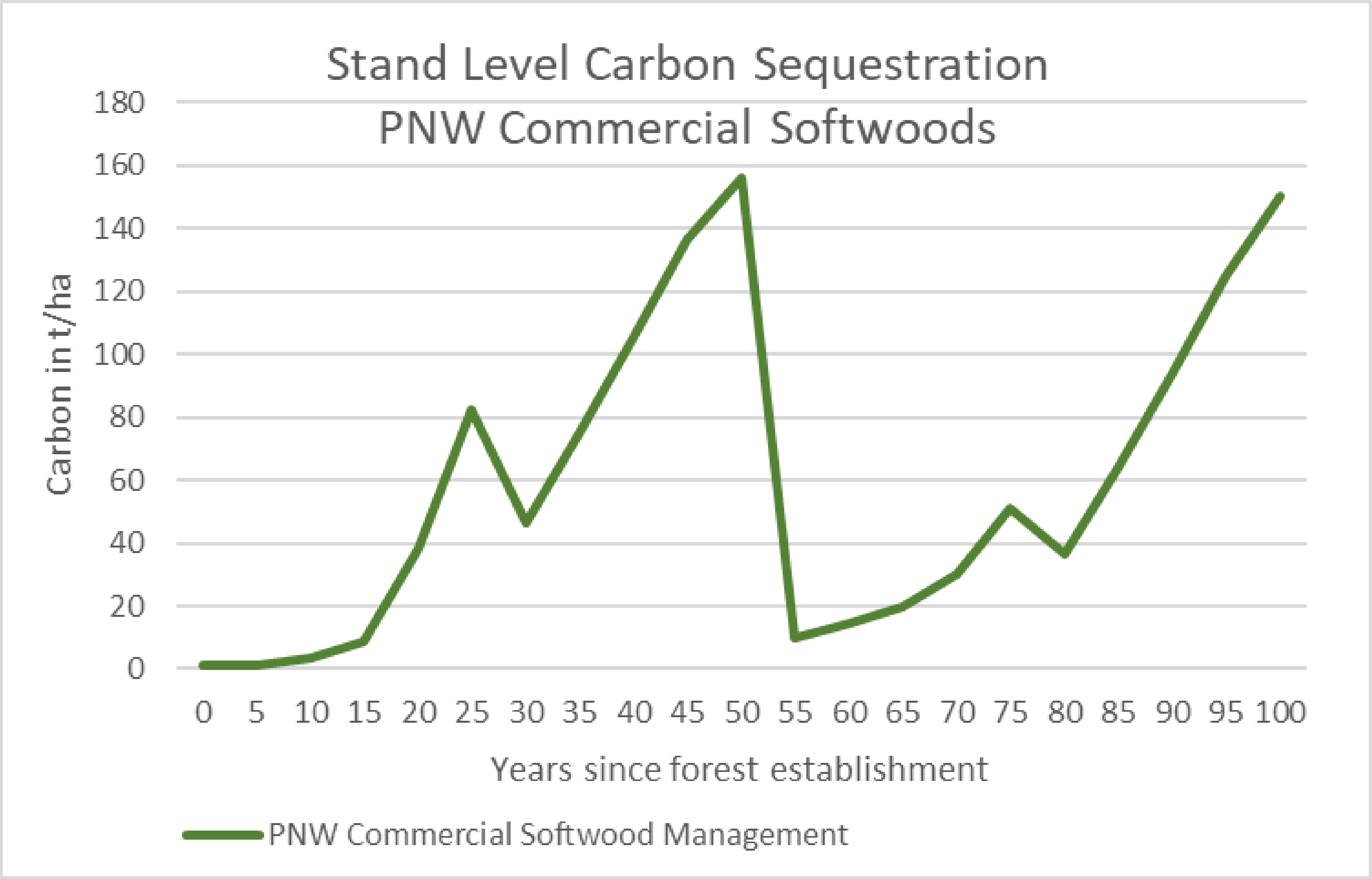
Scale Matters

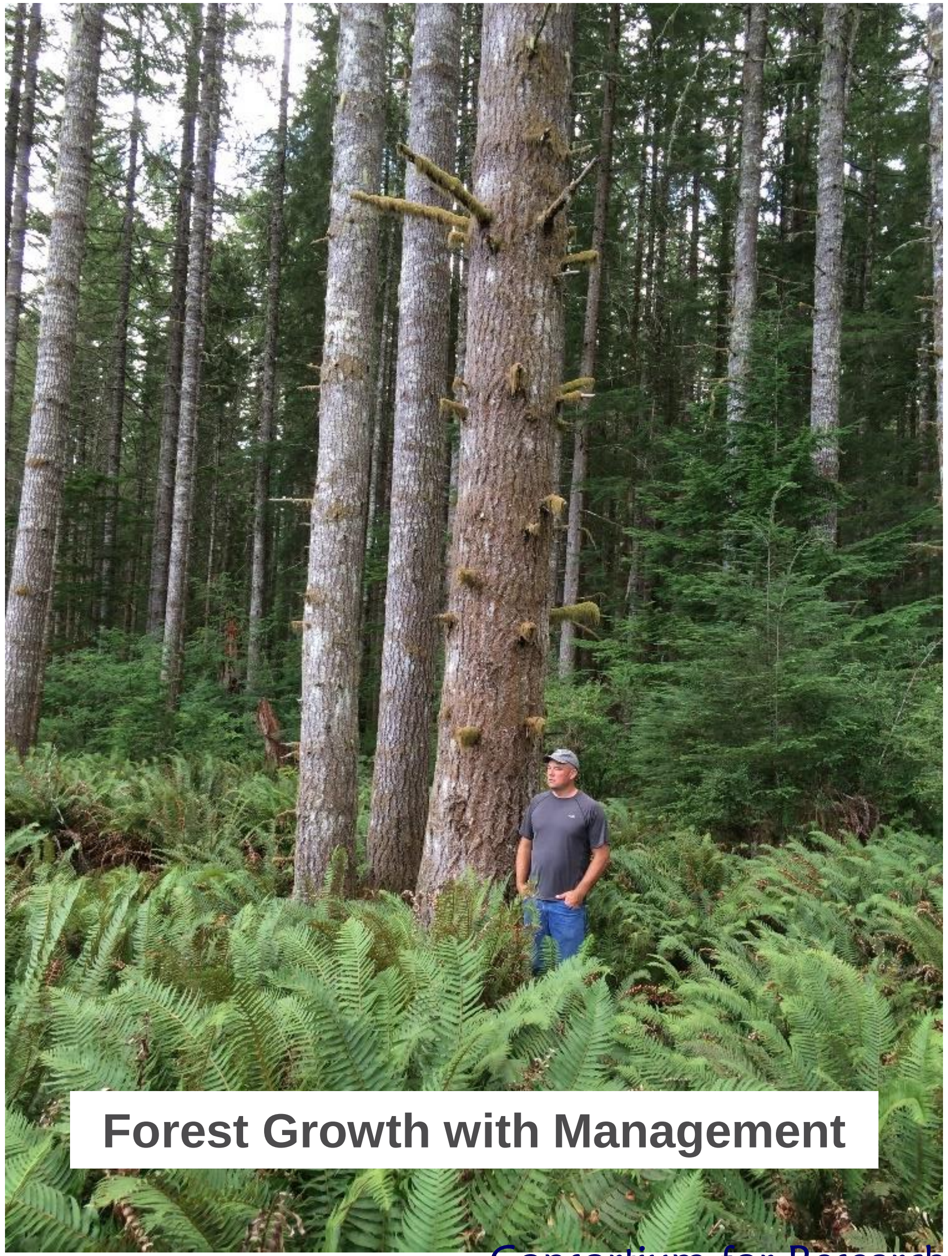


Graphic representation of the spatial and temporal dynamics of C storage for a typical PNW forest managed on 45-year rotations presented as: the growth and harvest cycles of **one forest stand** (in **turquoise**), an average per ha for **10 forest stands** harvested in sequential intervals (in **teal**), 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.

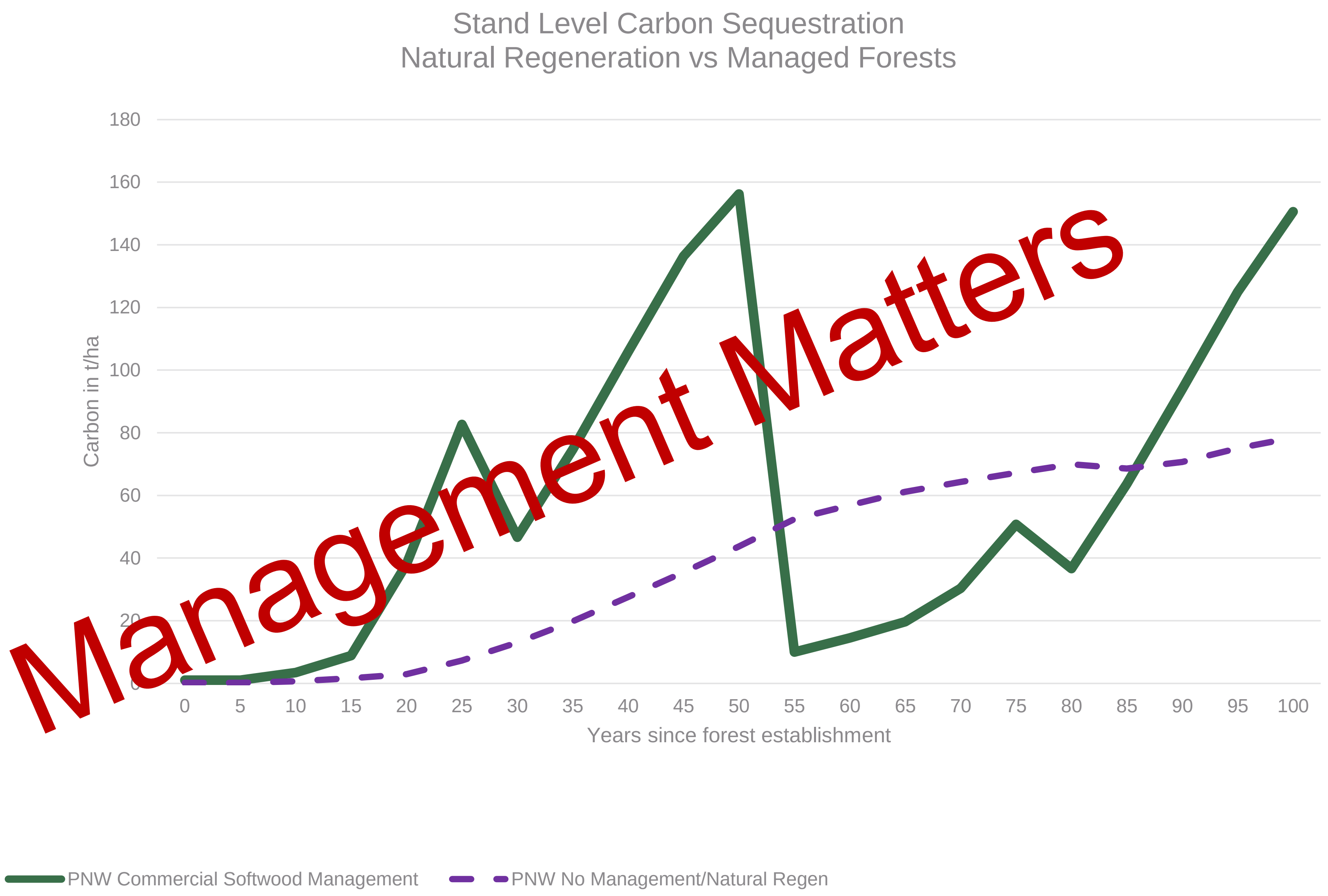

Softwood Growing Stock Changes 1952-2016
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
-1,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Regional Net Growing Stock in Cubic Feet (thousands)
National Net Growing Stock in Cubic Feet (thousands)
1952
1976
1996
2006
2016
Survey Reporting Year
NE Softwoods
NC Softwoods
SE Softwoods
SC Softwoods
GP Softwoods
IM Softwoods
RM Softwoods
AK Softwoods
PNW Softwoods
PS Softwoods
US Softwoods
Major wood producing regions
bark beetles and fire – mostly National Forests driving the trend

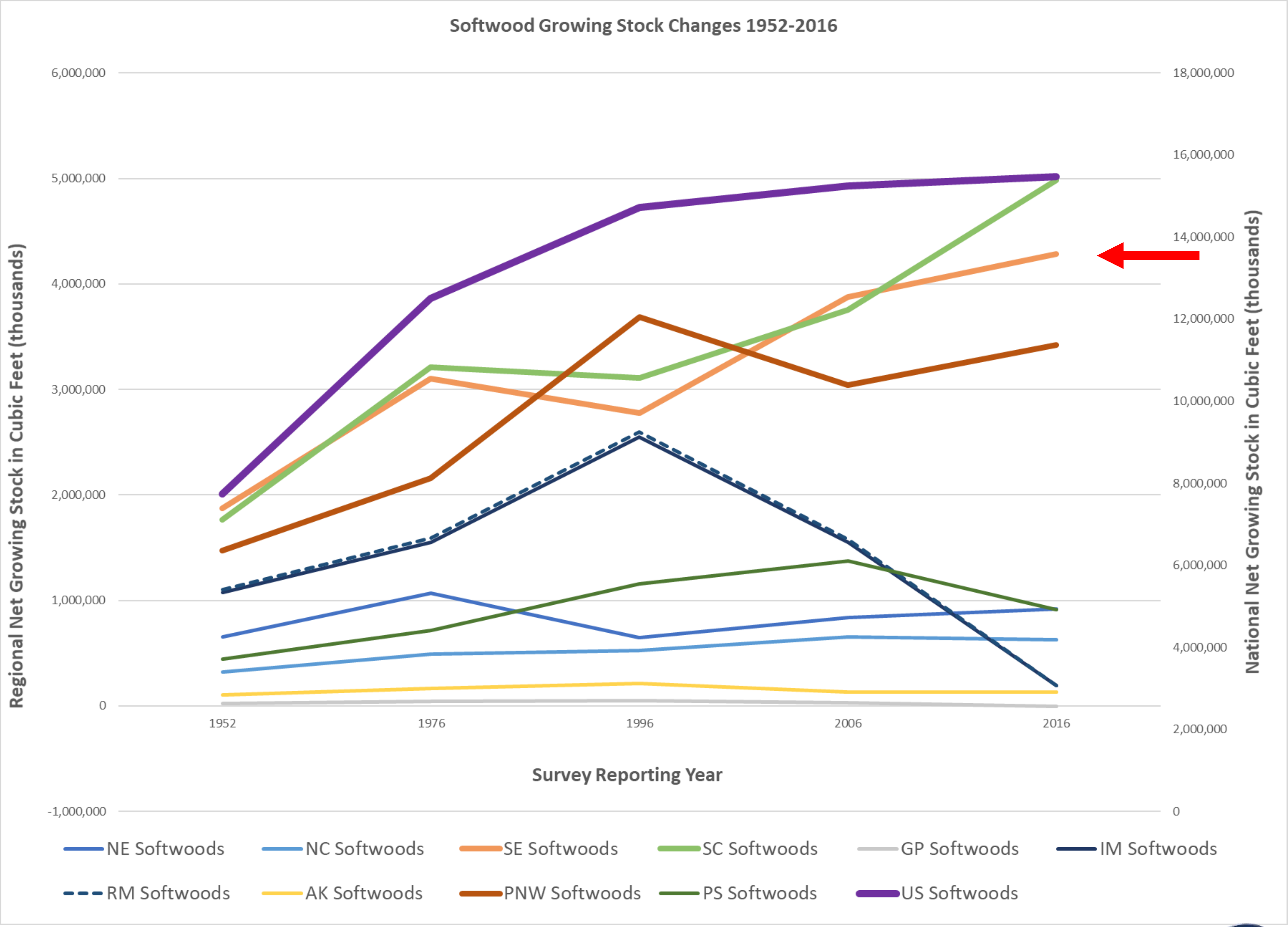
- 60 year old PNW Douglas-fir ready for harvest
- This is the result of intensive forest management that happens to be SFI certified, under a spotted owl management plan, and still part of the company's active harvesting program.


Stand Level Carbon Sequestration
PNW Commercial Softwoods
180
160
140
120
100
80
60
40
20
0
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
Years since forest establishment
PNW Commercial Softwood Management


Forest Growth with Management

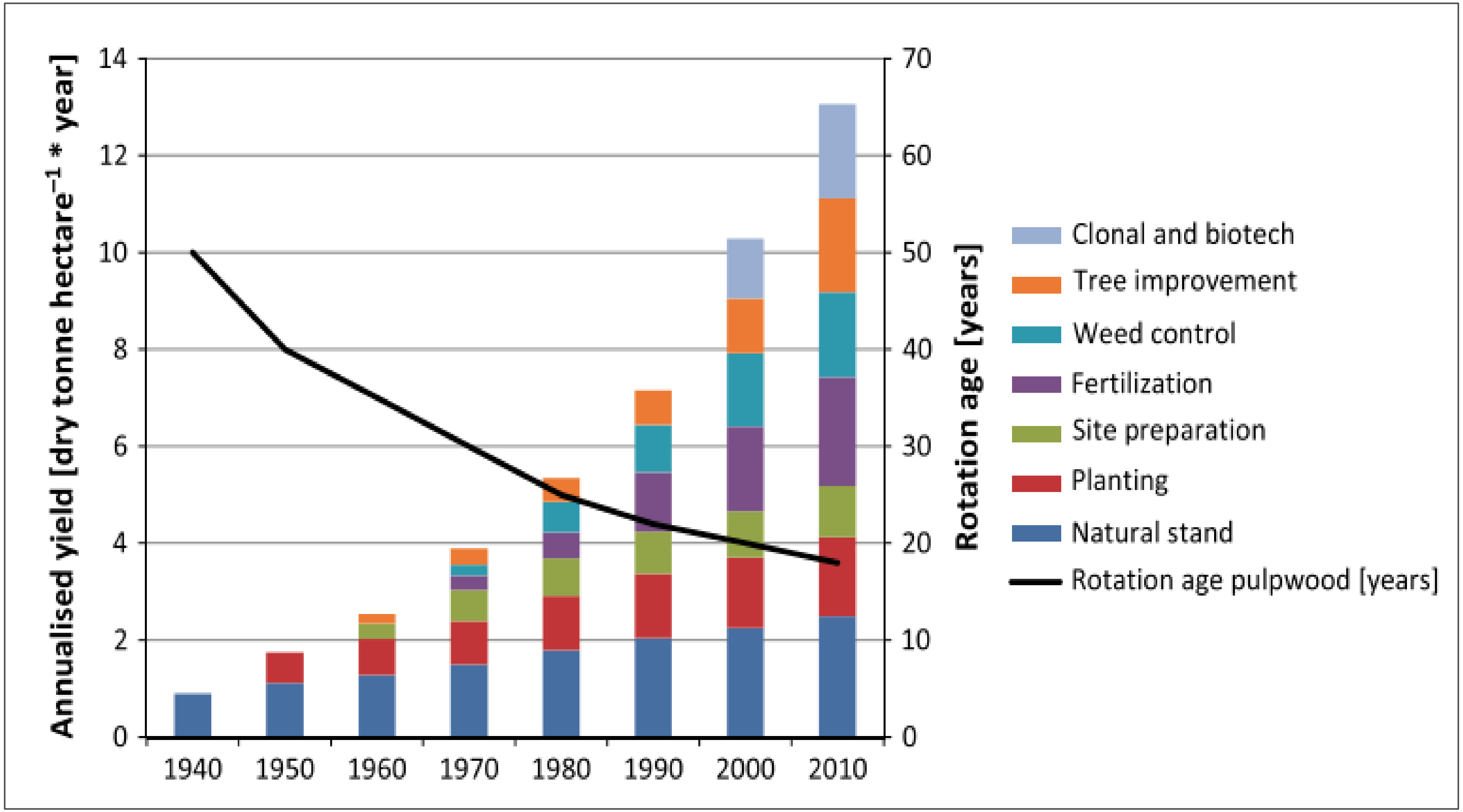

Forest Growth without Management


Stand Level Carbon Sequestration
Natural Regeneration vs Managed Forests
180
160
140
120
100
80
60
40
20
0
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
Years since forest establishment
Management Matters
PNW Commercial Softwood Management
PNW No Management/Natural Regen



SE region productivity increase

Improved Forest Management aka High Intensity Forestry



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

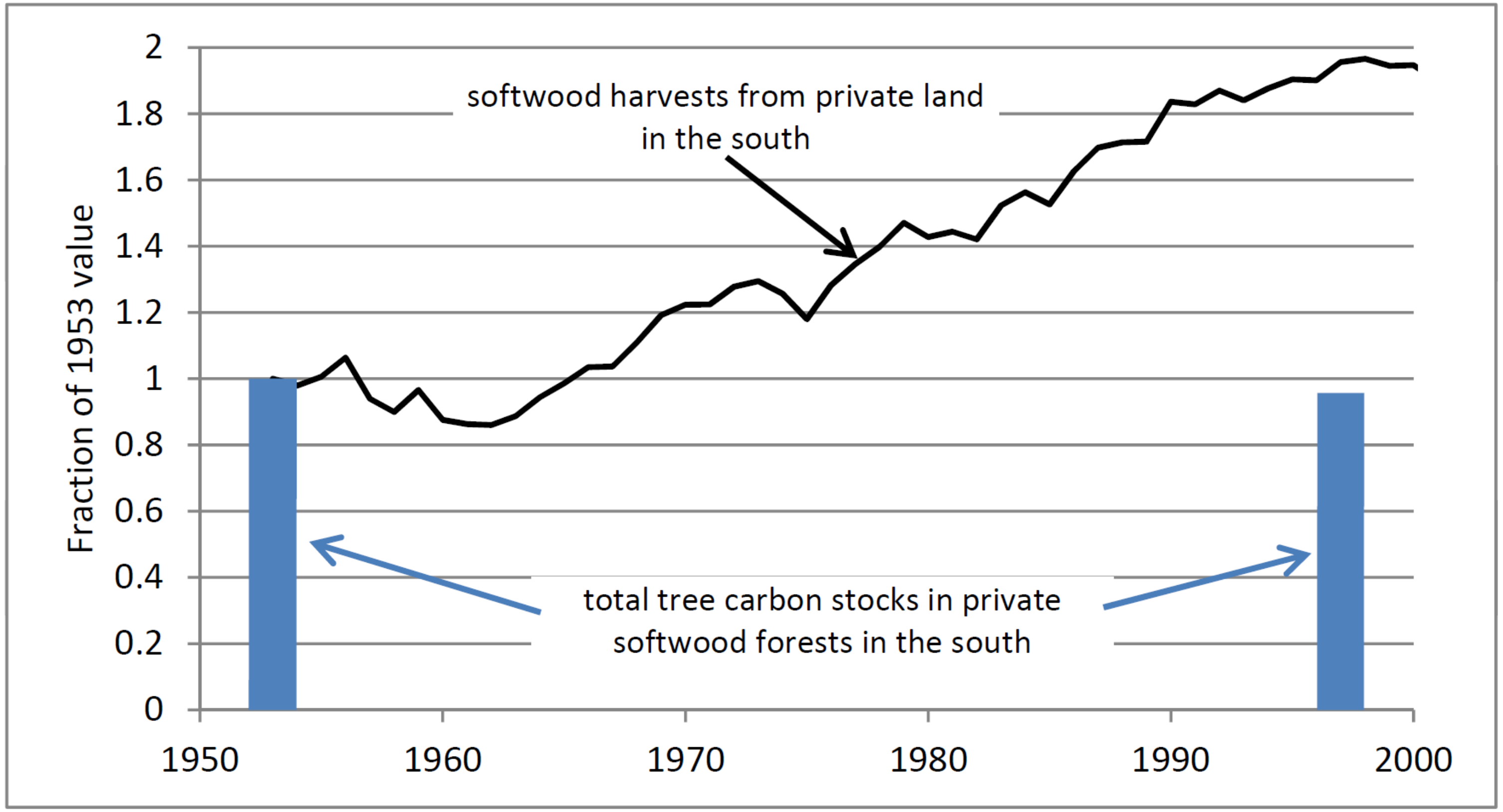
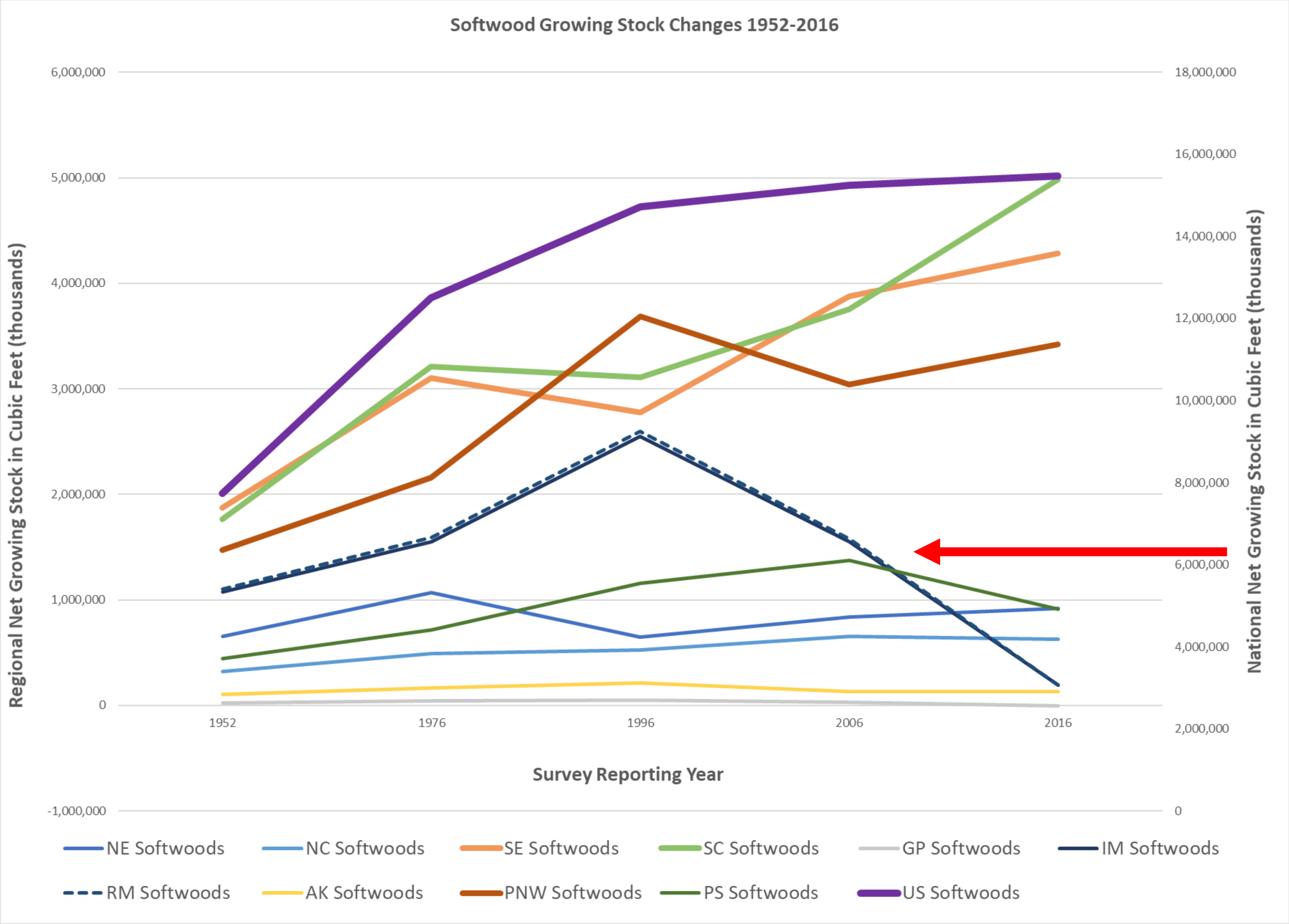
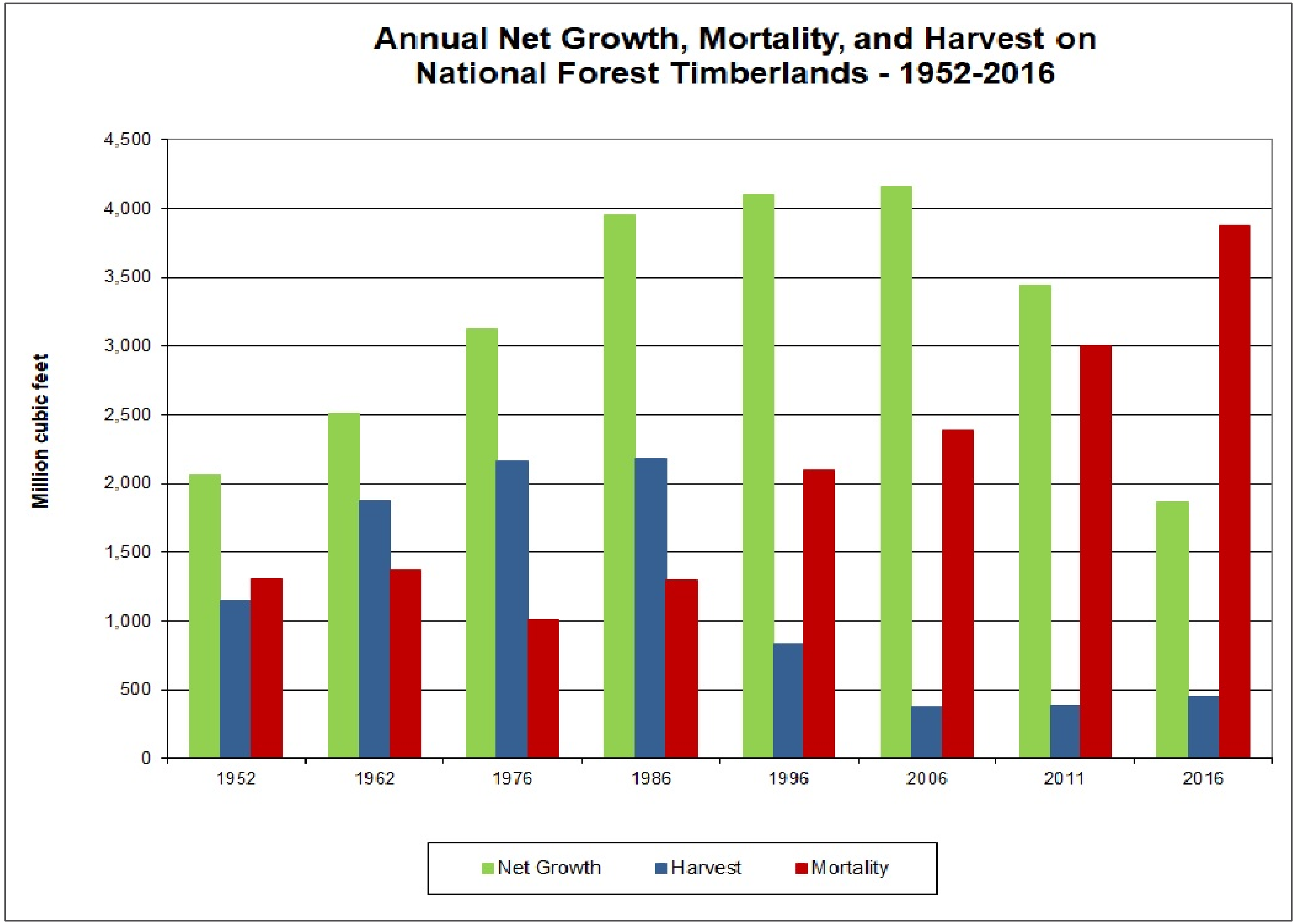


Image courtesy of Reid Miner, NCASI, 2014



Rocky Mountain region productivity decrease

Management Matters



Growth, Mortality, and Harvest on National Forest Timberlands 1952-2016. Data provided by Oswalt et al. 2018.

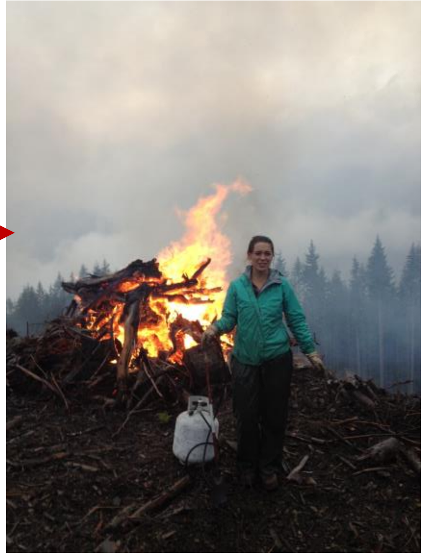
EPD "Nutritional" Label
Wood Product

Amount per Unit

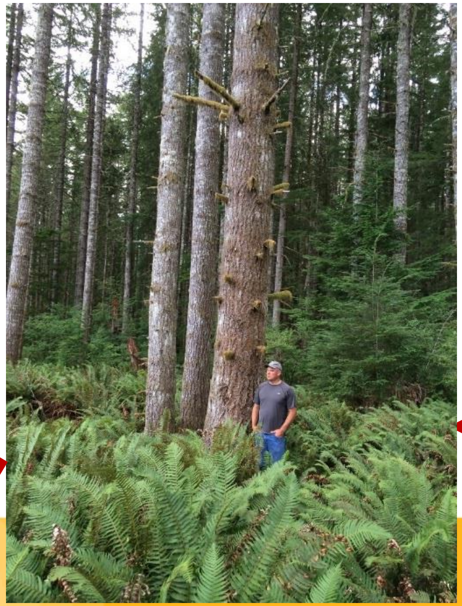
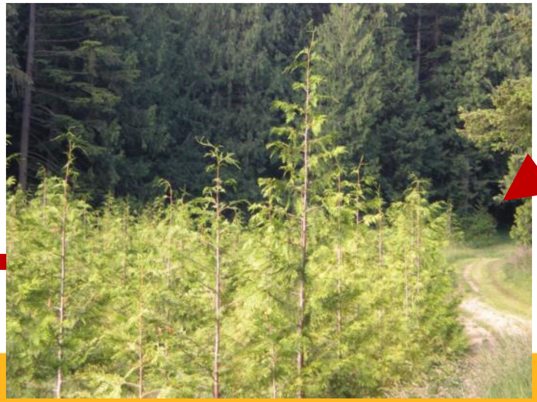
LCA Impact Assessment		Total	Forestry Operations	Wood Product Production
Global Warming Potential	kg CO_2 eq.	143	11	132
Acidification Potential	SO_2 eq.	1.60	0.15	1.45
Eutrophication	kg N eq.	0.06	0.01	0.05
Smog	kg O3 eq.	25	5	20
Total Energy	MJ	7,425	165	7,260
Non-Renewable Resources	kg	6	0.01	6
Renewable Resources	kg	640	0.00	640
Water Use	L	1,061	11	1,050

Ingredients: Carbon

Puettmann et al 2018

Forest Management Cycle


Carbon Footprint per m^3

	Reference Unit	Herbicide Treatment only	Herbicide plus Pile and Burn Treatment	*Broadcast Burn Treatment
Standard TRACI methodology for the treatment of biogenic carbon				
Production Emissions	kg CO_2 eq/m^3	10.74	18.14	23.16
co2 sequestered per m3 log	kg CO_2 eq/m^3	960.37	960.37	960.37
Net sequestration	kg CO_2 eq/m^3	-949.63	-942.23	-937.21
Modified TRACI methodology that includes biogenic carbon emissions				
Production Emissions	kg CO_2 eq/m^3	10.74	141.31	315.83
co2 sequestered per m3 log plus residues	kg CO_2 eq/m^3	1615	1615	1615
Net sequestration	kg CO_2 eq/m^3	-1604.25	-1473.69	-1299.17

Oneil and Puettmann, 2017, A Life-Cycle Assessment of Forest Resources of the Pacific Northwest, USA, Forest Prod. J. 67(5/6):316–330

Thank You

For More Information

www.corrim.org

Elaine Oneil, PhD

Director of Science and Sustainability

elaine@corrim.org

Carbon Leadership Forum

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 | Sequestration | Non-timber + Recreational Uses | Biodiversity | Carbon Storage In Forest Pools

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 certifiation 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, internviews mangagement and employees, and uses evidence from third parties
- Trained assessors following ISO practices

Accredidation – the mechanism for ensuruing 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

Image: https://hydrodictyon.eeb.uconn.edu/people/willig/Research/Brazil/Brazil.html

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

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 a one such benefit
- Assurances to a range of stakeholders including investors and donors, governments, shareholders and employees, and purchasers

Forest Management Standard

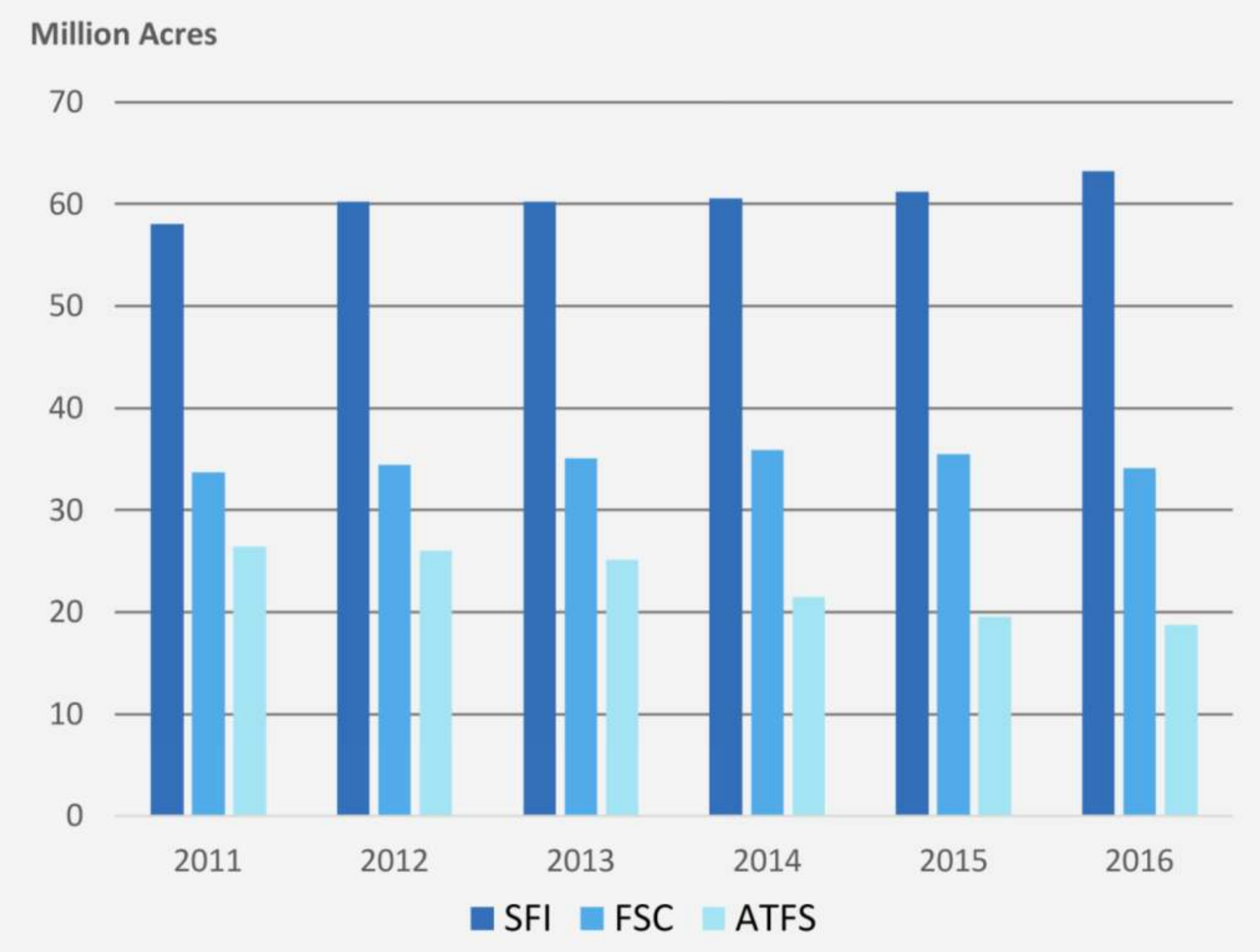
Fiber Sourcing Standard

Chain-of-Custody Standard

Core Principles

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



Certified U.S. forest area, by certification program, 2011–2016

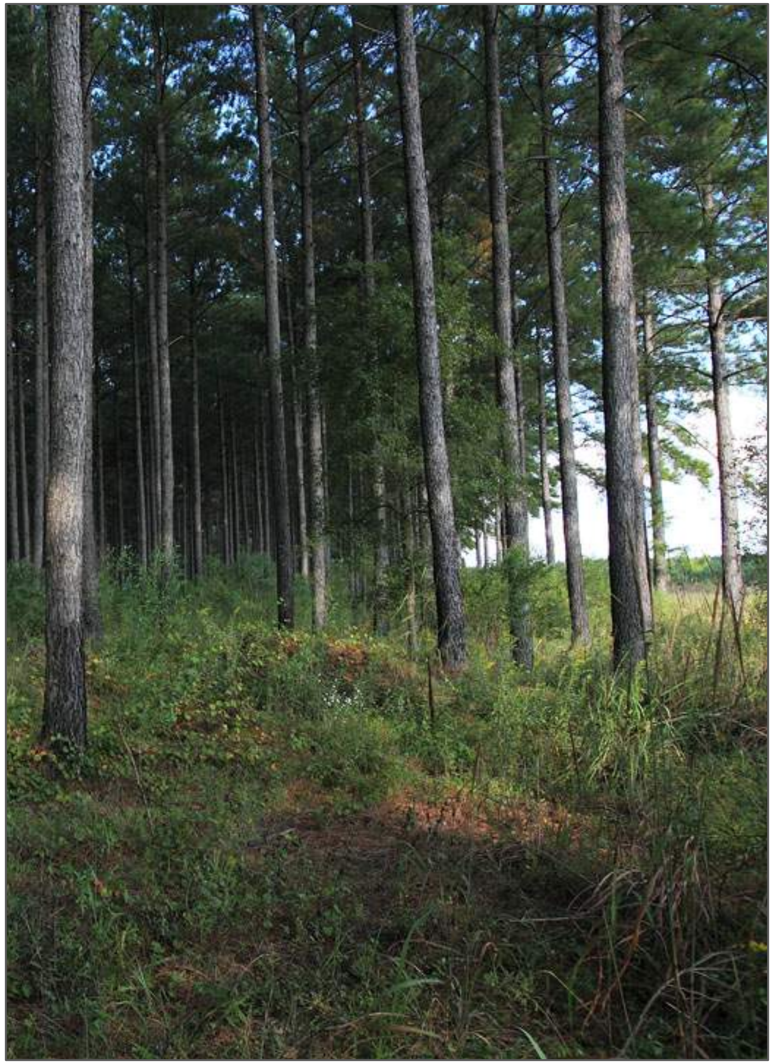
Source: Sustainable Forestry Initiative, Forest Stewardship Council, and American Tree Farm System.

Source: State of America's Forests. 2019. https://usaforests.org/

Forest management certification

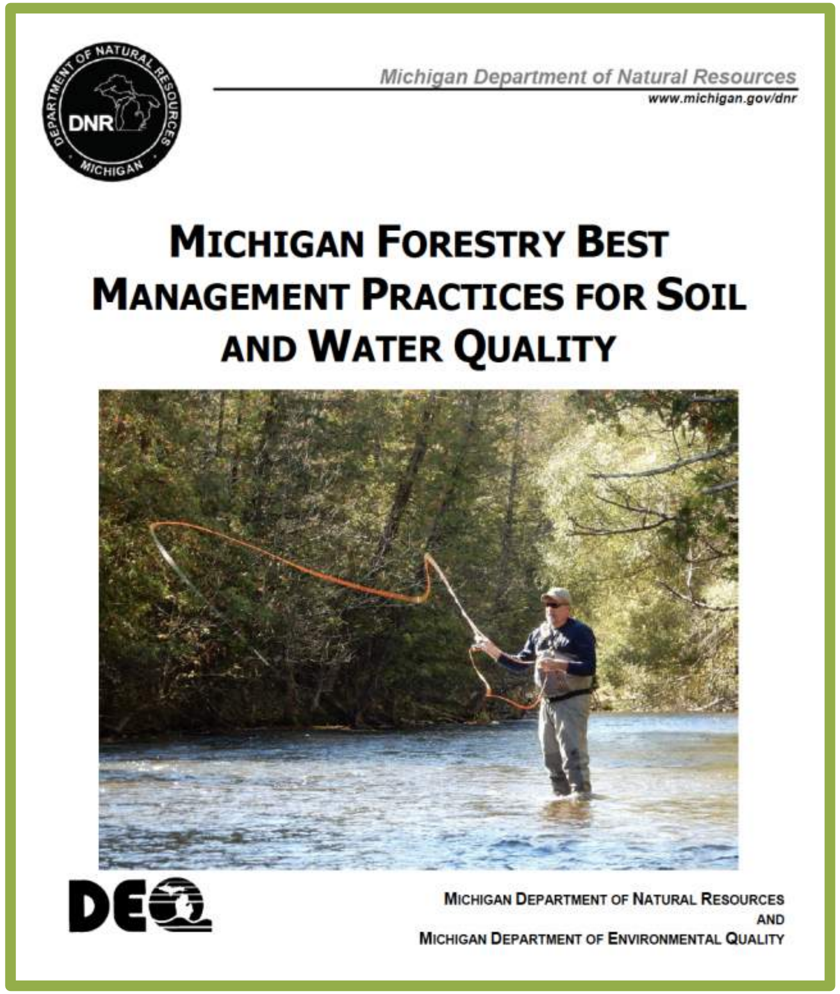
Basics of forest management certification

- 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

SUSTAINABLE FORESTRY INITIATIVE
Certified Sourcing
www.sfiprogram.org
SFI-00001

SUSTAINABLE FORESTRY INITIATIVE
Certified Chain of Custody
Promoting Sustainable Forest Management
www.sfiprogram.org

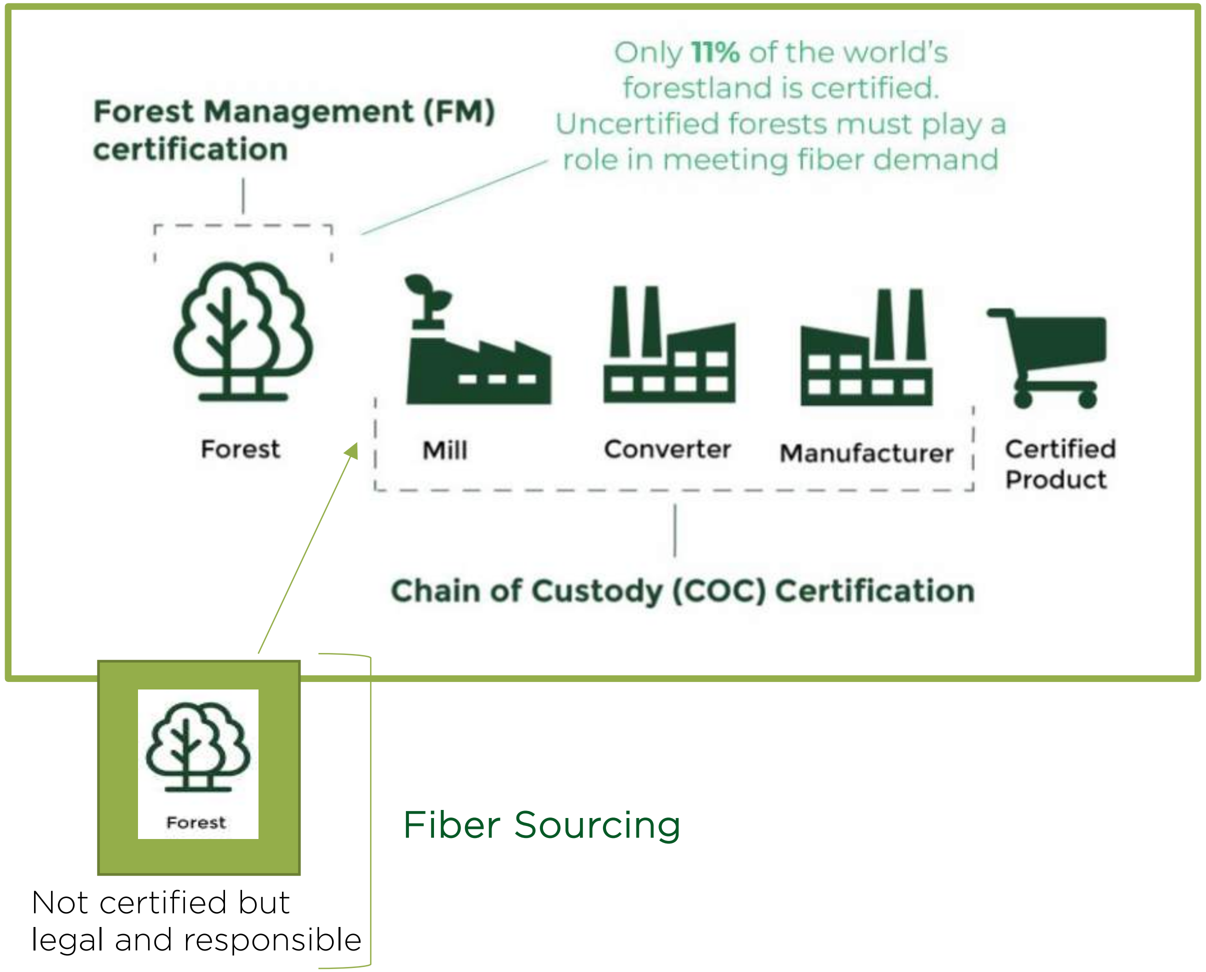
FSC www.fsc.org
MIX
From responsible sources
FSC® C000000

FSC www.fsc.org
100%
From well-managed forests
FSC® C000000

PEFC
PEFC/29-1-1

Fiber Sourcing and Chain of Custody Certification

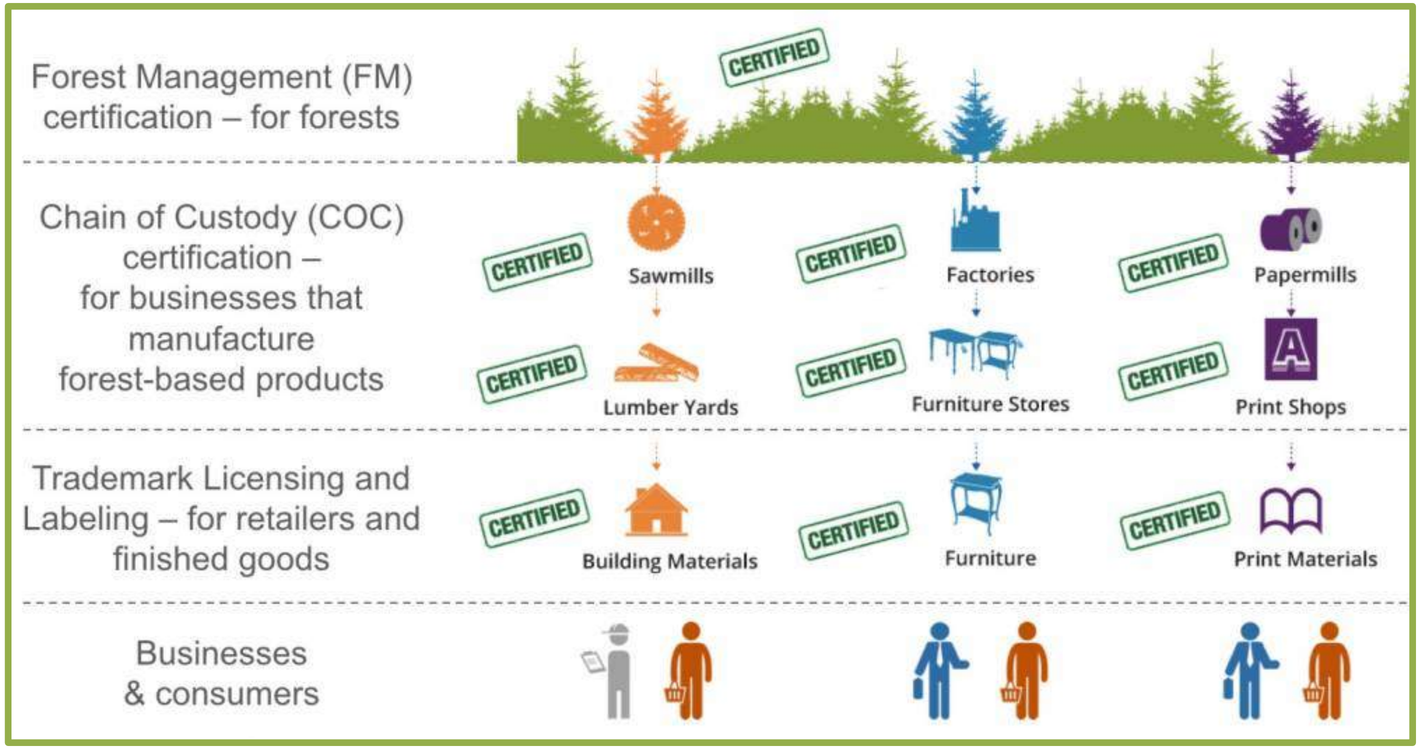
- Chain of Custody
  - Refers to the entire path of certified products from forests through to the supply chain
- Fiber sourcing
  - Refers to uncertified wood entering the mill for processing
  - Emphasis on legal, responsible sources if not certified



Source: https://greenblue.org/module-2-the-role-of-forest-certification/

Chain of Custody (CoC)

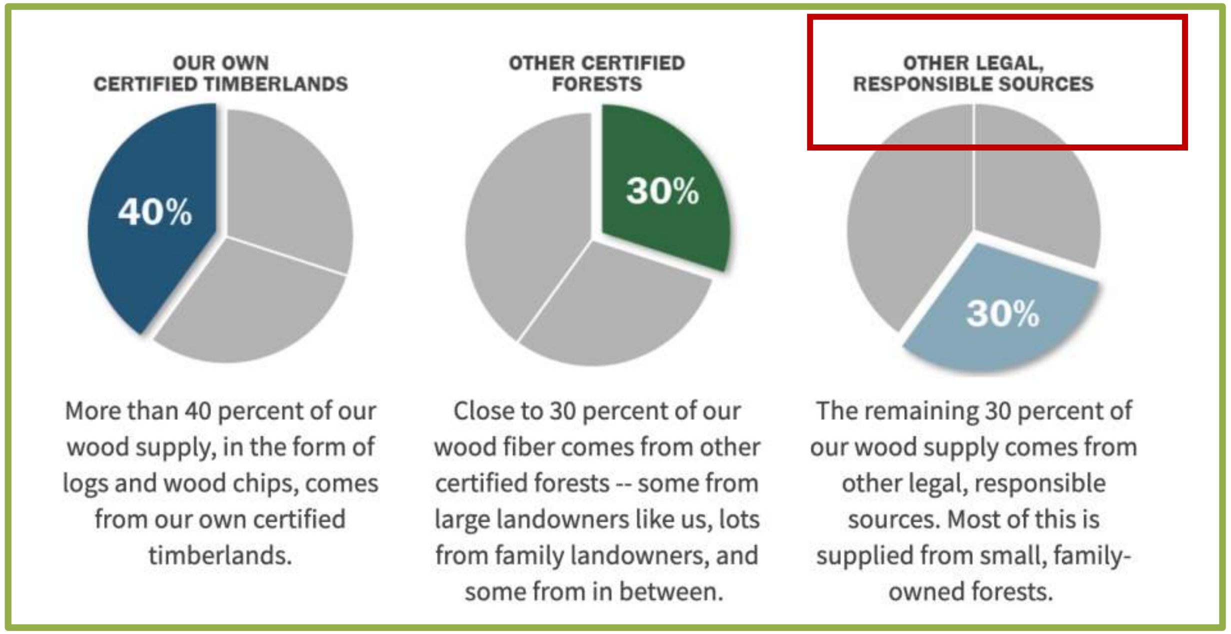
- CoC traces certified materials through the supply chain
  - Verifies that certified material is identified or kept separate from non-certified material
- Allows for communication about certified forest products
- Direct data and linkages forest to product
- CoC picks up after Forest Management Certification



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

SFI Core Principles

Resilient, healthy forests = climate adaptation

Communication & Stakeholder Engagement

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

from building perm
harvesting practice
ensure the long-ter
natural resource.

obal deforestation. The conversion of forest to
l land is decreasing but it remains the largest
to deforestation in Canada. The infinitesimal
n the forest sector makes to deforestation is
ng permanent logging access roads. Forest
practices in Canada are tightly regulated to
long-term sustainability of this important
ource.

ncentrations of forest loss
tween 2010 and 2030.

CANADA

WWF has identified 11 places where the largest concentra

Source: Achieving Net Zero Deforestation. Sustainable Forestry Initiative. https://www.sfiprogram.org/wp-content/uploads/SFI_Deforestation2018_Mar27.pdf

Key Takeaways

Time for a paradigm shift in sustainable thinking and material use!

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
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Program Director

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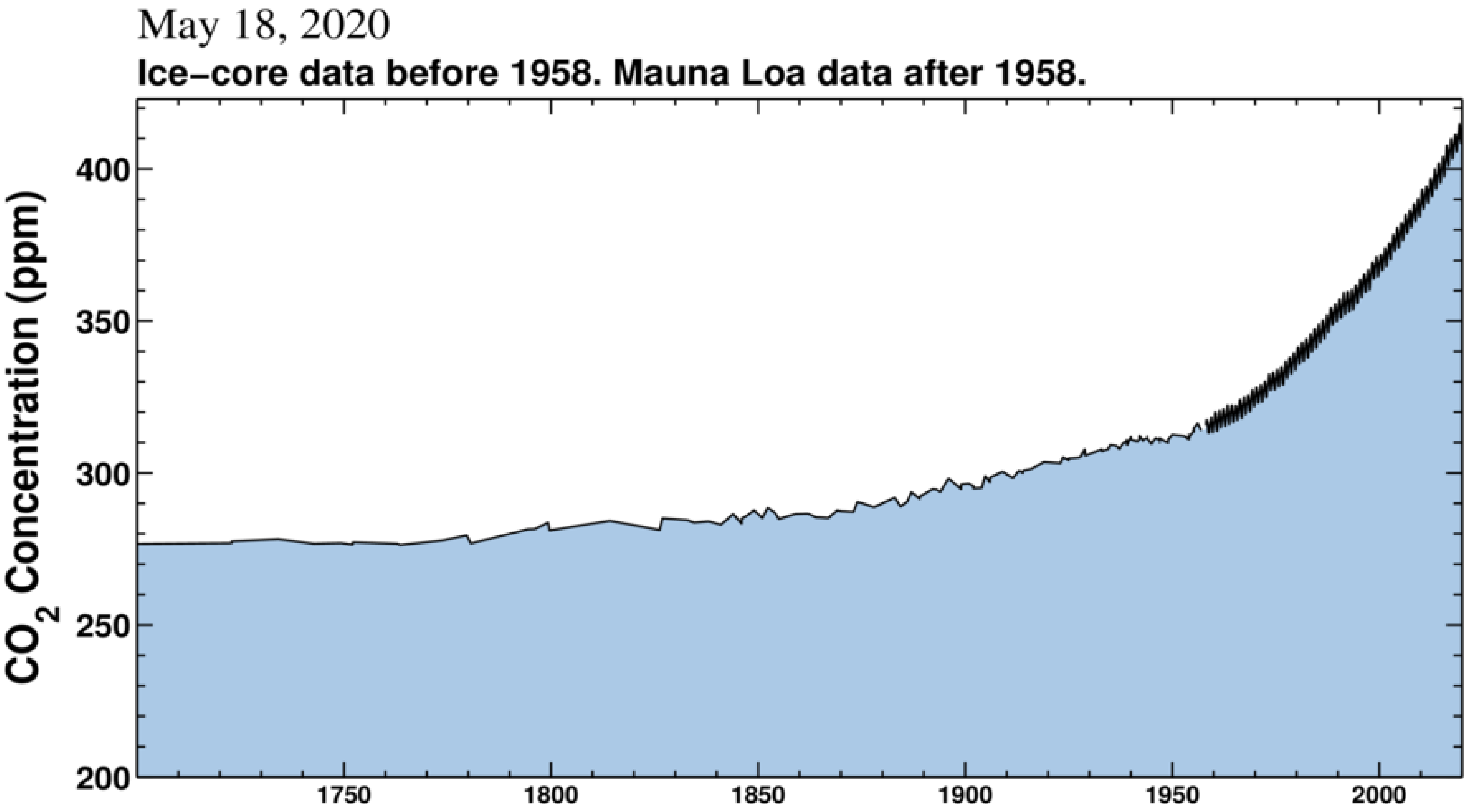
Carbon and Sustainability Tracking

Carbon Leadership Forum

Speaker Background

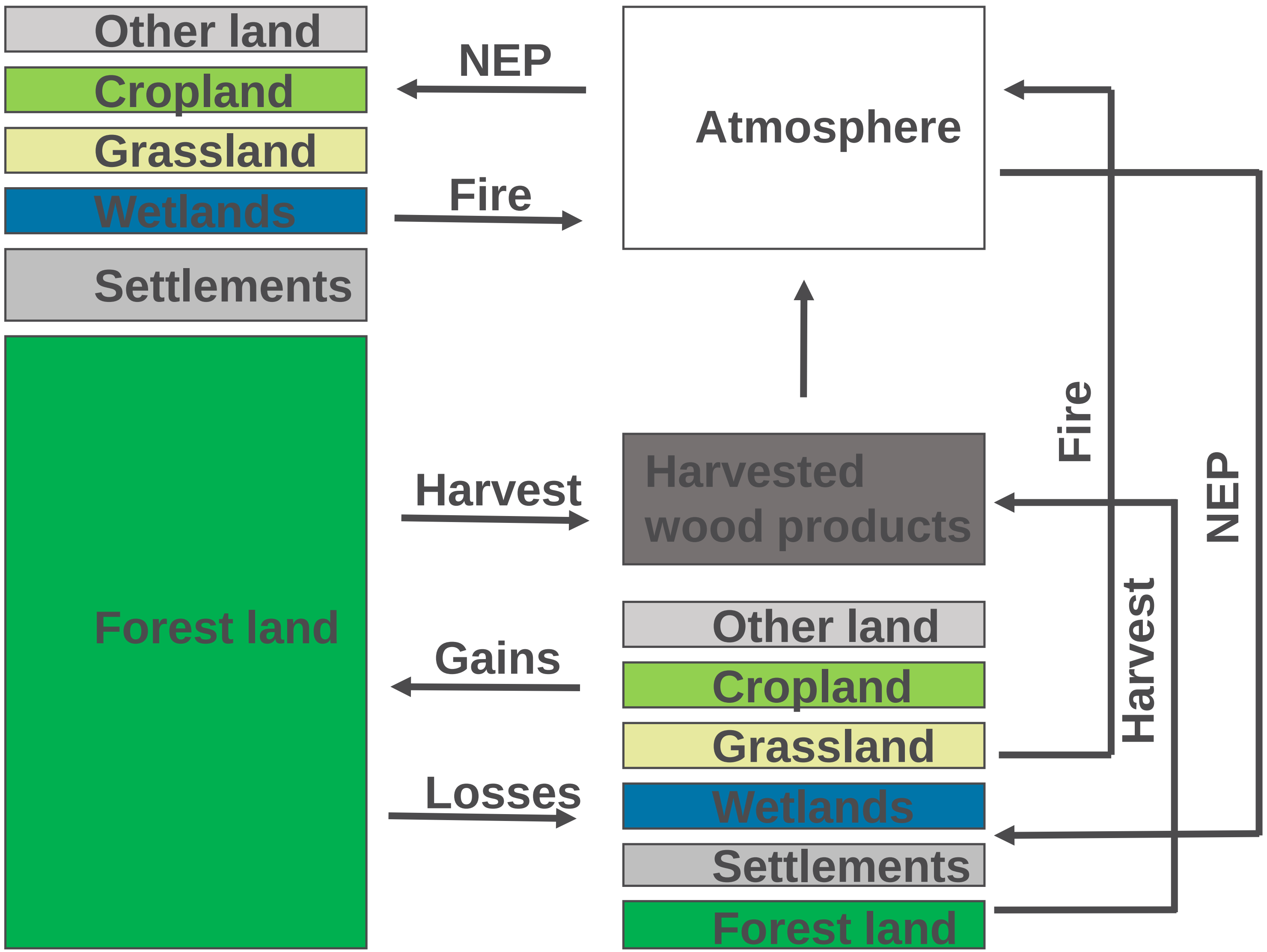
- Grant Domke
  - Current position:
    - Research Forester and Group leader, USDA Forest Service
    - Fellow, Institute on the Environment, University of Minnesota
    - Adjunct Assistant Professor, Department of Forest Resources, University of Minnesota
  - Credentials:
    - Ph.D. Forest Ecosystem 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?



Scripps Institution of Oceanography, San Diego

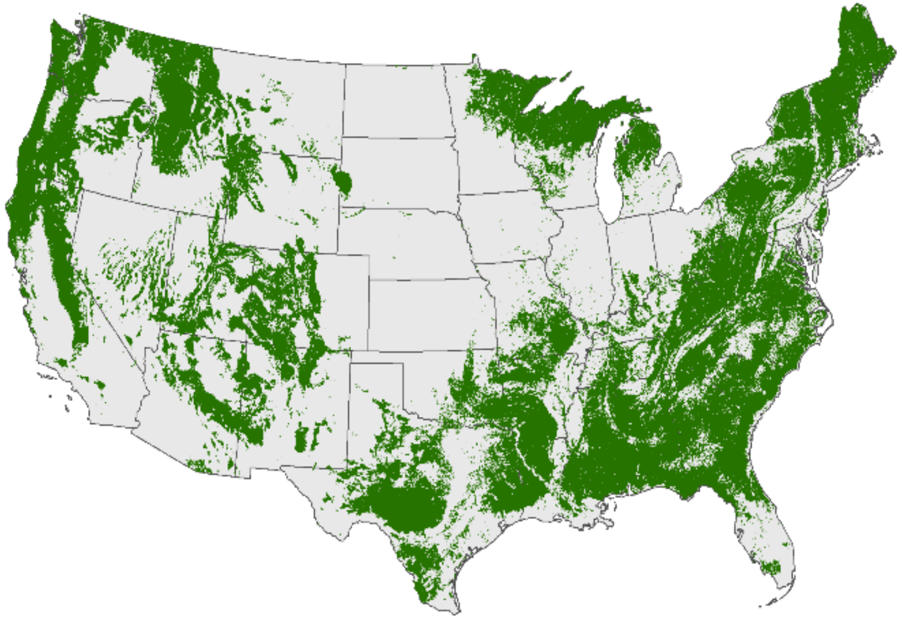
Context within the land sector

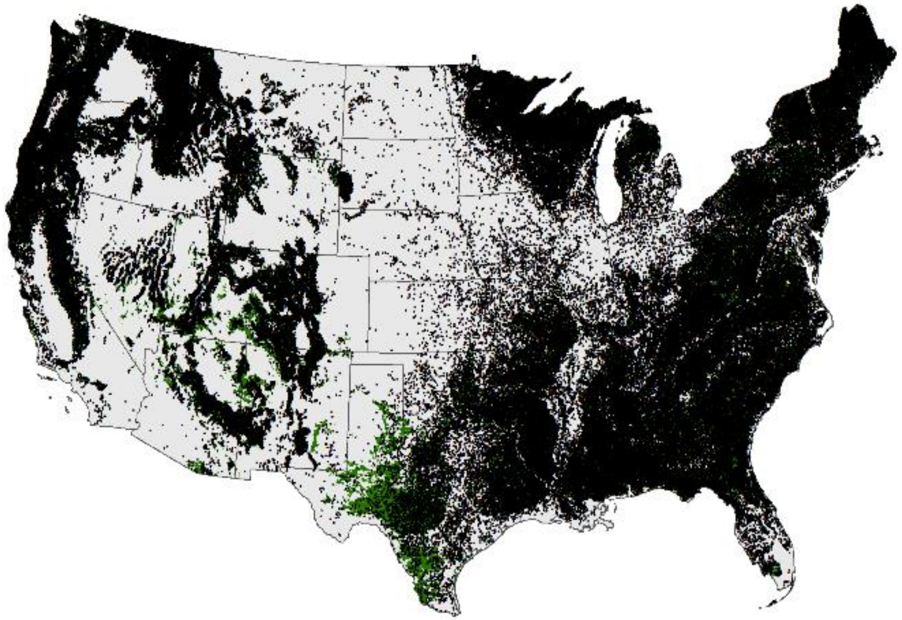


2020 NIR: (-753) MMT CO_2 eq.(14%)

National forest inventory (NFI)

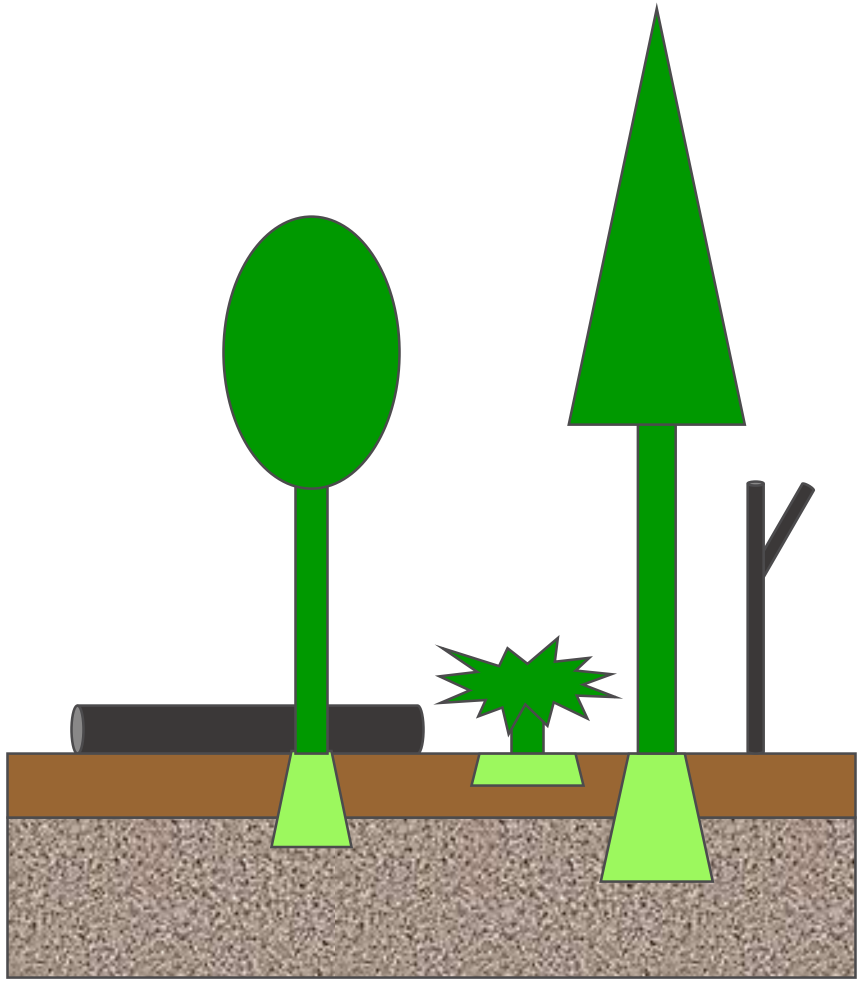
- Designed to track change over time
  - Permanent sample plots
  - Remeasurement every 5-10 years
    - ca. 15% of plots remeasured annually
- Multiple approaches for assessing disturbance (e.g., disturbance code), and ecosystem variables (e.g., growth, mortality, removals)
- Observed land cover and land use attributes





Ecosystem C pools

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



Intergovernmental Panel on Climate Change 2006. IPCC guidelines for national greenhouse gas inventories. http://www. ipcc-nggip. iges

Carbon stocks by pool in the US

Carbon Pool[a]	1990	1995	2000	2005	2010	2017	2018	2019
Forest	**51,527**	**52,358**	**53,161**	**53,886**	**54,663**	**55,746**	**55,897**	**56,051**
Aboveground biomass	11,833	12,408	12,962	13,484	14,020	14,780	14,884	14,989
Belowground biomass	2,350	2,483	2,612	2,734	2,858	3,033	3,056	3,081
Dead wood	2,120	2,233	2,346	2,454	2,568	2,731	2,753	2,777
Litter	3,662	3,670	3,676	3,647	3,646	3,639	3,640	3,641
Soil (mineral)	25,636	25,636	25,637	25,639	25,641	25,637	25,637	25,638
Soil (organic)	5,927	5,928	5,928	5,929	5,929	5,926	5,926	5,926
Harvested wood	**1,895**	**2,061**	**2,218**	**2,353**	**2,462**	**2,616**	**2,642**	**2,669**
Products in use	1,249	1,326	1,395	1,447	1,471	1,505	1,513	1,521
SWDS	646	735	823	906	991	1,112	1,129	1,148
Total stocks	**53,423**	**54,419**	**55,380**	**56,239**	**57,124**	**58,362**	**58,539**	**58,720**

Domke, Grant M.; Walters, Brian F.; Nowak, David J.; Smith, James, E.; Ogle, Stephen M.; Coulston, J.W.; Wirth, T.C. 2020. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018. Resource Update FS-227. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

U.S. Environmental Protection Agency [US EPA]. 2020. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2018. EPA 430-R-20-002. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018

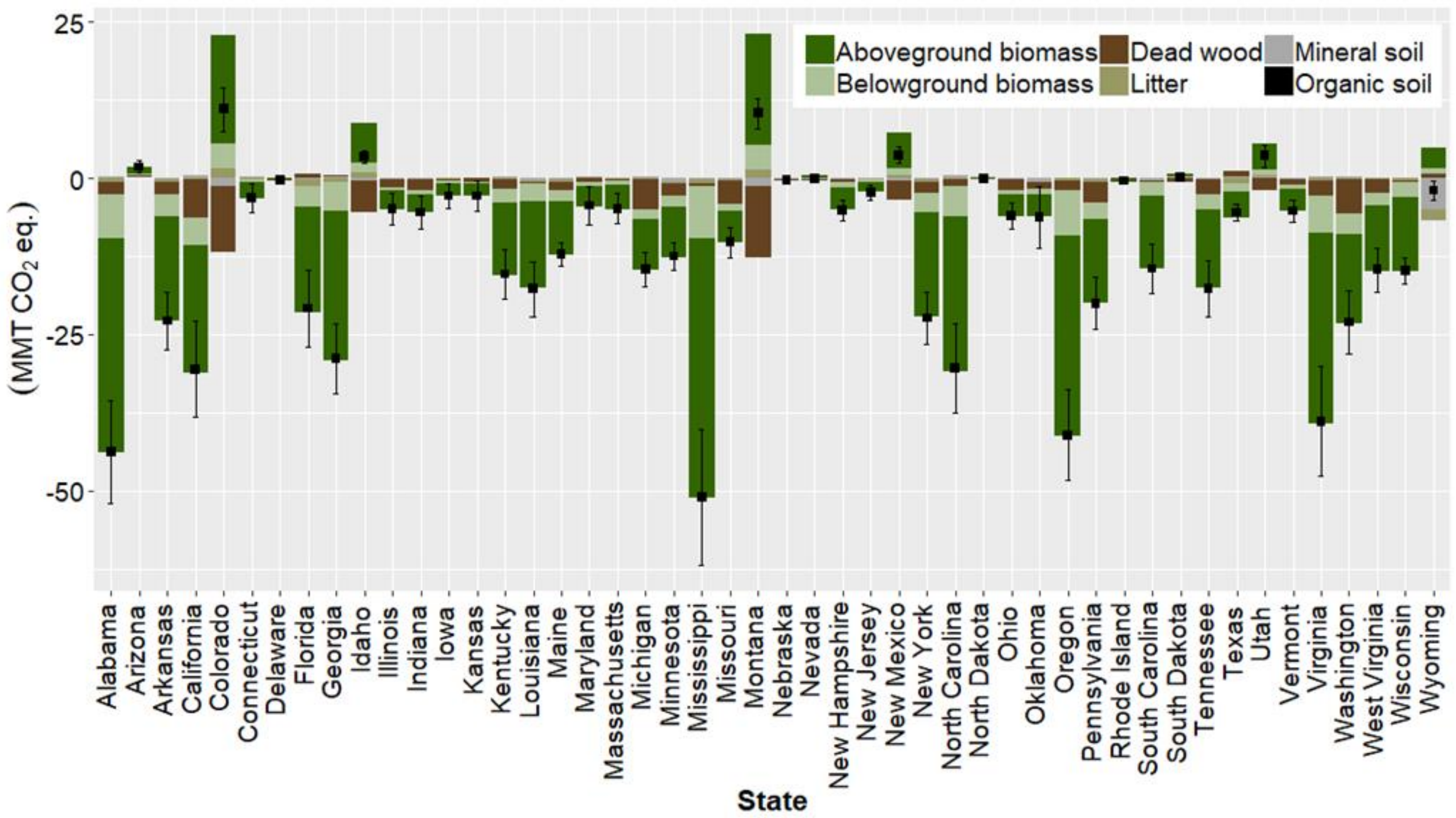
Estimated emissions and removals

Emissions and Removals Category[a]	1990	1995	2000	2005	2010	2016	2017	2018
Forest land remaining forest land[b]	(610.1)	(598.7)	(572.1)	(572.6)	(556.2)	(565.5)	(552.0)	(564.5)
Non-CO_2 emissions from fire	1.5	0.6	2.9	8.2	4.6	5.6	18.8	18.8
N_2O emissions from forest soils	0.1	0.3	0.5	0.5	0.5	0.5	0.5	0.5
Non-CO_2 emissions from drained organic soils	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forest land converted to non-forest land[b]	119.1	120.8	122.5	124.4	126.0	127.4	127.4	127.4
Non-forest land converted to forest land[b]	(109.4)	(109.7)	(109.9)	(110.2)	(110.4)	(110.6)	(110.6)	(110.6)
Harvested wood products	(123.8)	(112.2)	(93.4)	(106.0)	(69.1)	(92.4)	(95.7)	(98.8)
Woodlands remaining woodlands[c]	5.0	4.9	4.8	4.6	4.4	4.1	4.0	4.0
Urban trees in settlements[d]	(96.4)	(103.3)	(110.4)	(117.4)	(124.6)	(129.8)	(129.8)	(129.8)
Total Emissions and Removals	**(813.9)**	**(797.2)**	**(755.0)**	**(768.4)**	**(724.7)**	**(760.6)**	**(737.3)**	**(752.9)**

Domke, Grant M.; Walters, Brian F.; Nowak, David J.; Smith, James, E.; Ogle, Stephen M.; Coulston, J.W.; Wirth, T.C. 2020. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018. Resource Update FS-227. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

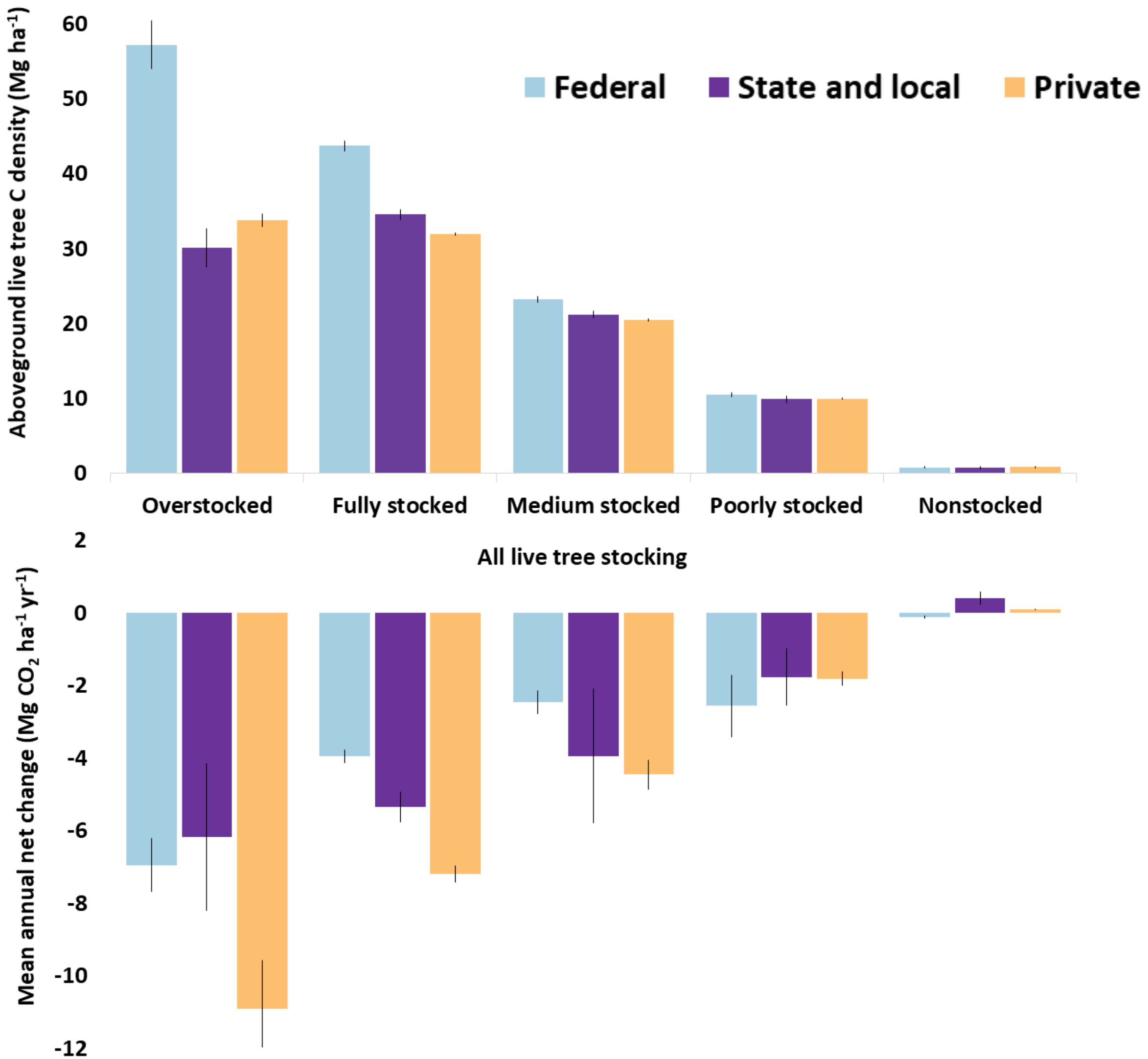
EPA. 2020. Inventory of U.S. Greenhouse Gas Emissions and Sinks. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

Emissions and removals, 2018

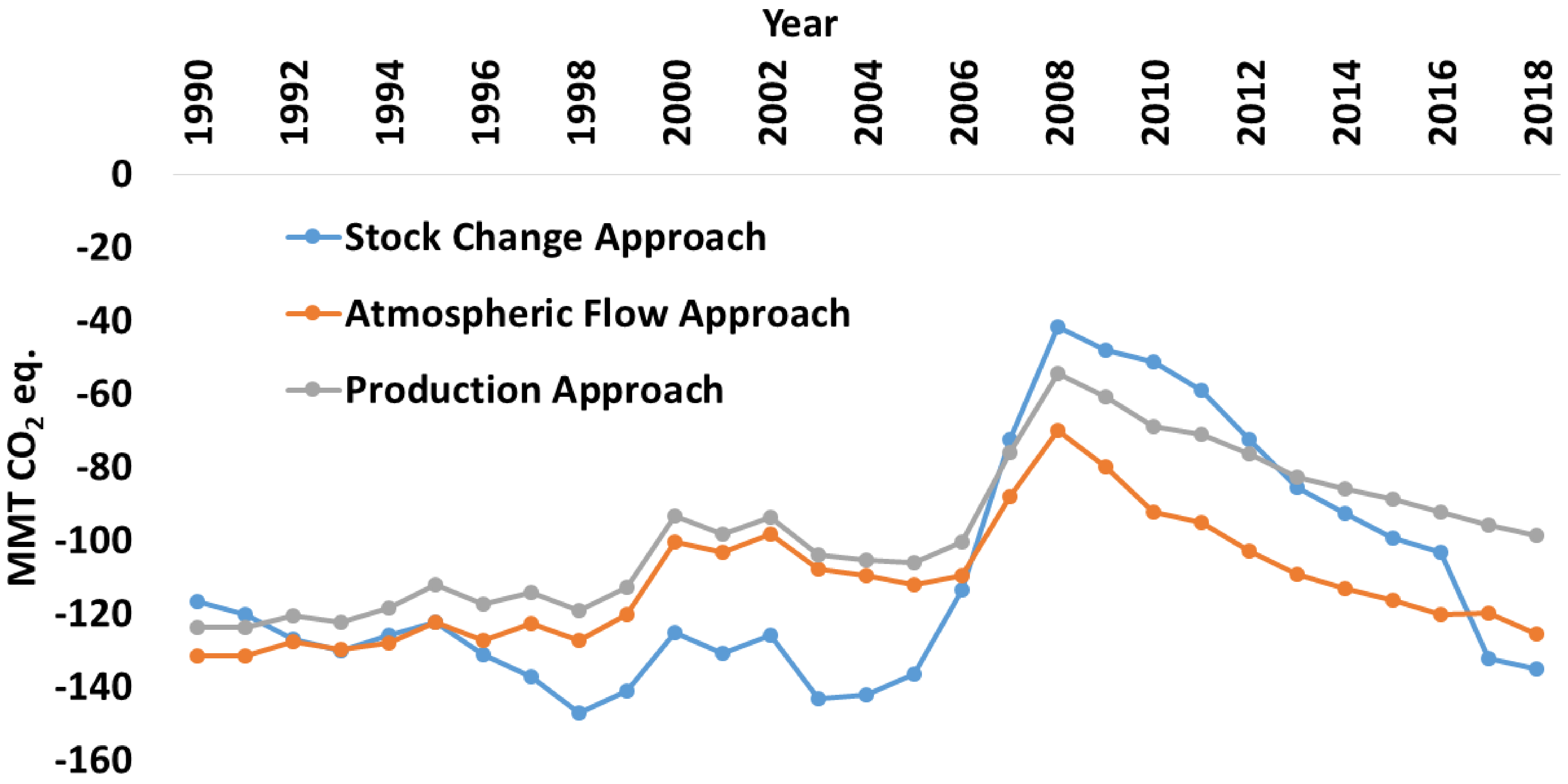


Domke, Grant M.; Walters, Brian F.; Nowak, David J.; Smith, James, E.; Ogle, Stephen M.; Coulston, J.W.; Wirth, T.C. 2020. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018. Resource Update FS-227. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

Aboveground live carbon by ownership



Harvested wood products estimation



IPCC 2019, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

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/

Wood in LCIs and LCA Tools

Carbon Leadership Forum

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)

Materials Production

Flow	Quantity
Electricity	100,000 MWh
Fuel oil	100,000 MJ
Emissions	100,000 tons

+

Manufacturing

Flow	Quantity
Natural Gas	100,000 ft^3
Electricity	100,000 MWh
Waste	100,000 tons

+

Distribution

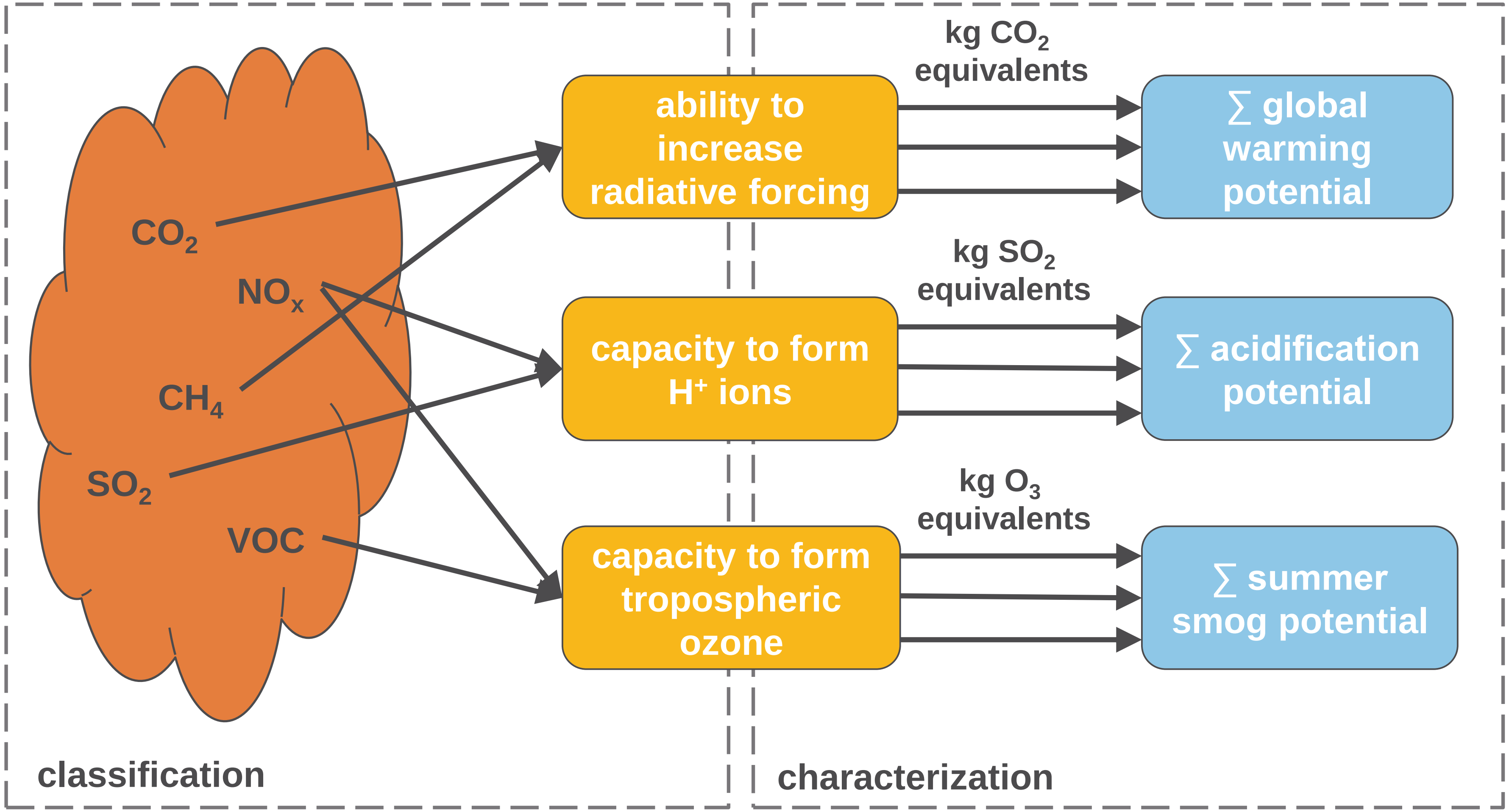
Flow	Quantity
Diesel Fuel	100,000 gal.

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

Resources		Emissions	
0.5 MJ	Crude oil	6.5 kg	CO_2, to air
0.9 MJ	Hard coal	0.03 kg	NO_x, to air
200 kg	Ground water	0.03 kg	Nitrates, to water
	…		…

= *elementary flows/exchanges*

Life Cycle Impact Assessment (LCIA)



Life Cycle Impact Assessment (LCIA)

Inventory value	*	GWP Factor	=	Impact potential
25 kg CO_2	*	1	=	25 [kg CO_2-Equivalent]
2 kg CH_4	*	30	=	60 [kg CO_2-Equivalent]
...	*	...	=	...
			Total:	85 [kg CO_2-Equivalent]

Elementary flow/exchange
LCI value

LCIA result

Topics

LCA Software

- GaBi
- SimaPro
- Open LCA
- Umberto

GaBi Solutions

LCI Databases

- GaBi
- Ecoinvent
- US LCI / Federal LCA Commons

GaBi Database

LCA Tools

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

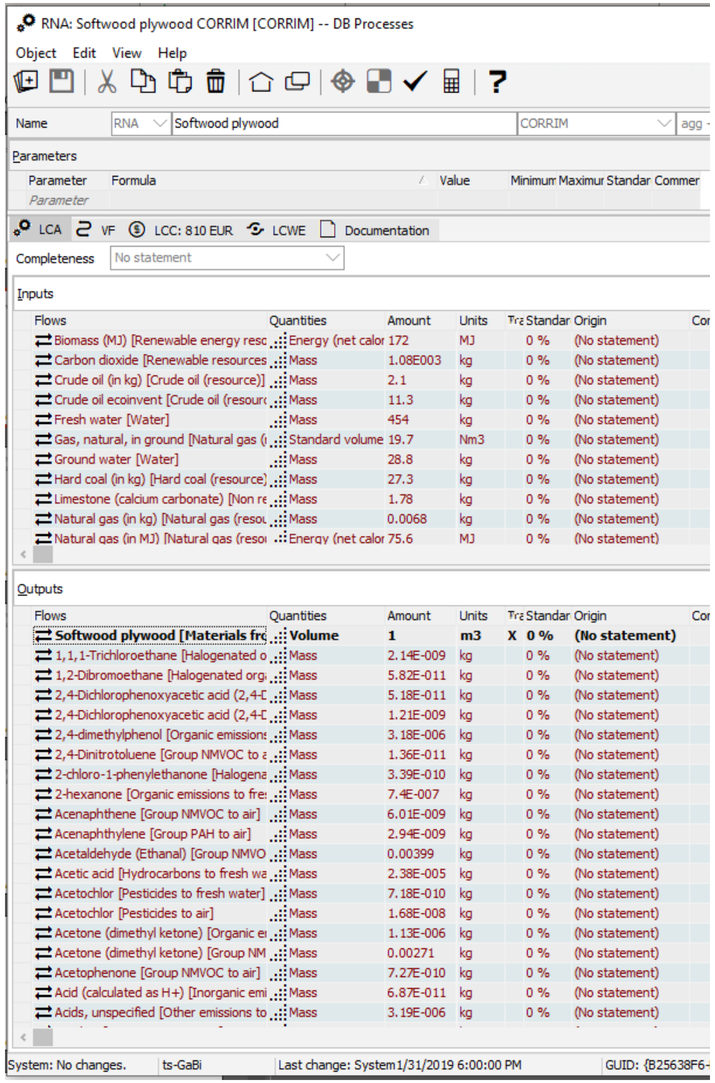
LCIA Databases

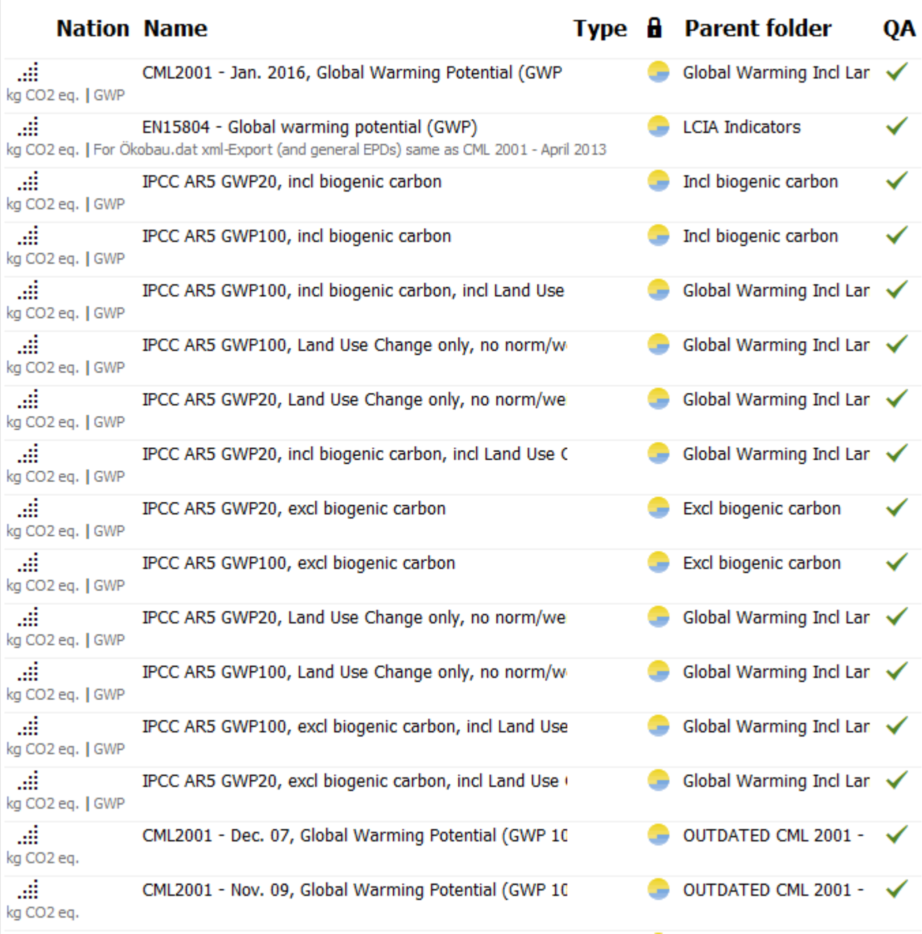
- Quartz (suspended)

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

sphera™
GaBi Database

ecoinvent
Centre

FEDERAL LCA COMMONS

Biogenic Carbon Modeling in LCA Software

- 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 CO_2 that was removed from the atmosphere is released as CO_2 again, i.e. not transformed to CH_4
- 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

Emission	TRACI 2.1 (IPCC AR4)		IPCC AR5	
	Incl. biogenic	Excl. biogenic	Incl. biogenic	Excl. biogenic
Carbon dioxide, fossil	1	1	1	1
Carbon dioxide, biogenic	1	0	1	0
Methane, fossil	25	25	30	30
Methane, biogenic	25	22.3	30	28
Nitrous oxide	298	298	265	265

LCA Tools

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

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

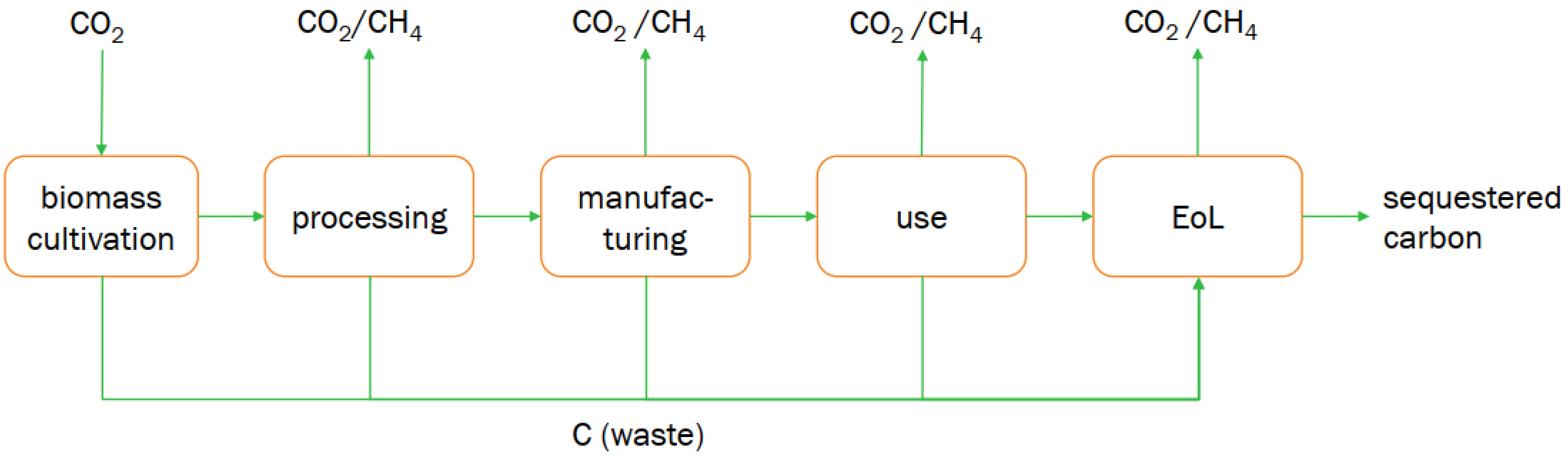
Conclusions

- 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

Carbon Leadership Forum

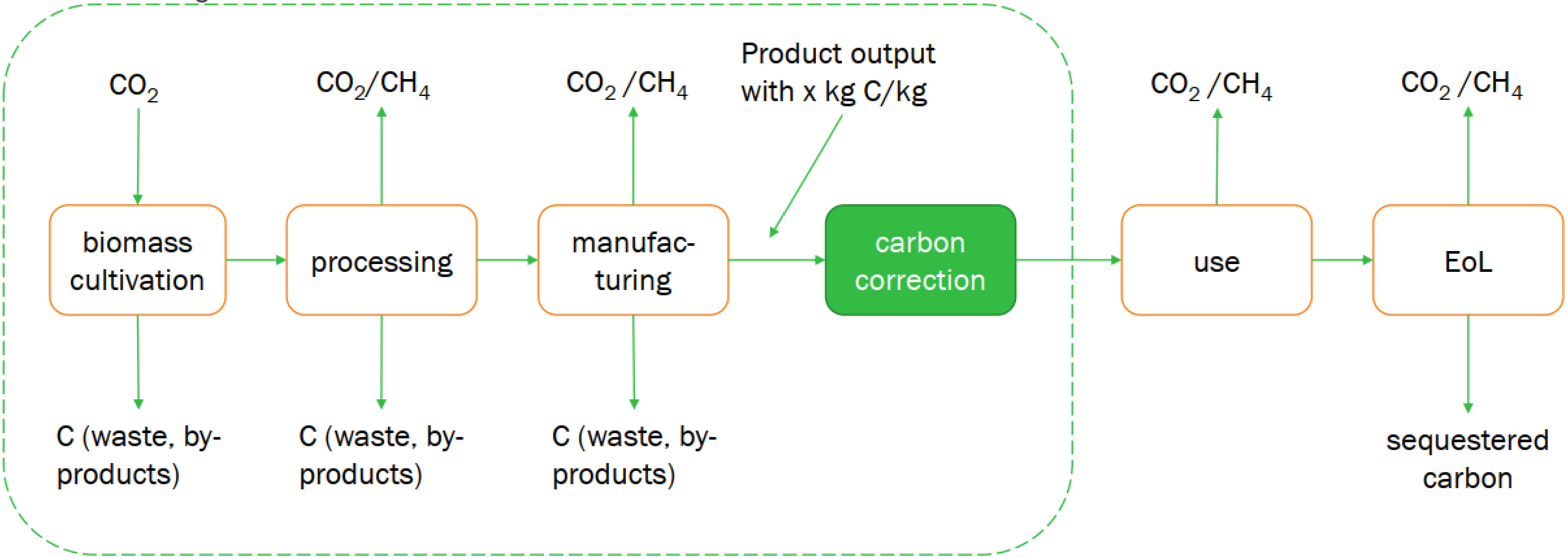
Additional Slides

Biogenic Carbon Modeling in LCA software

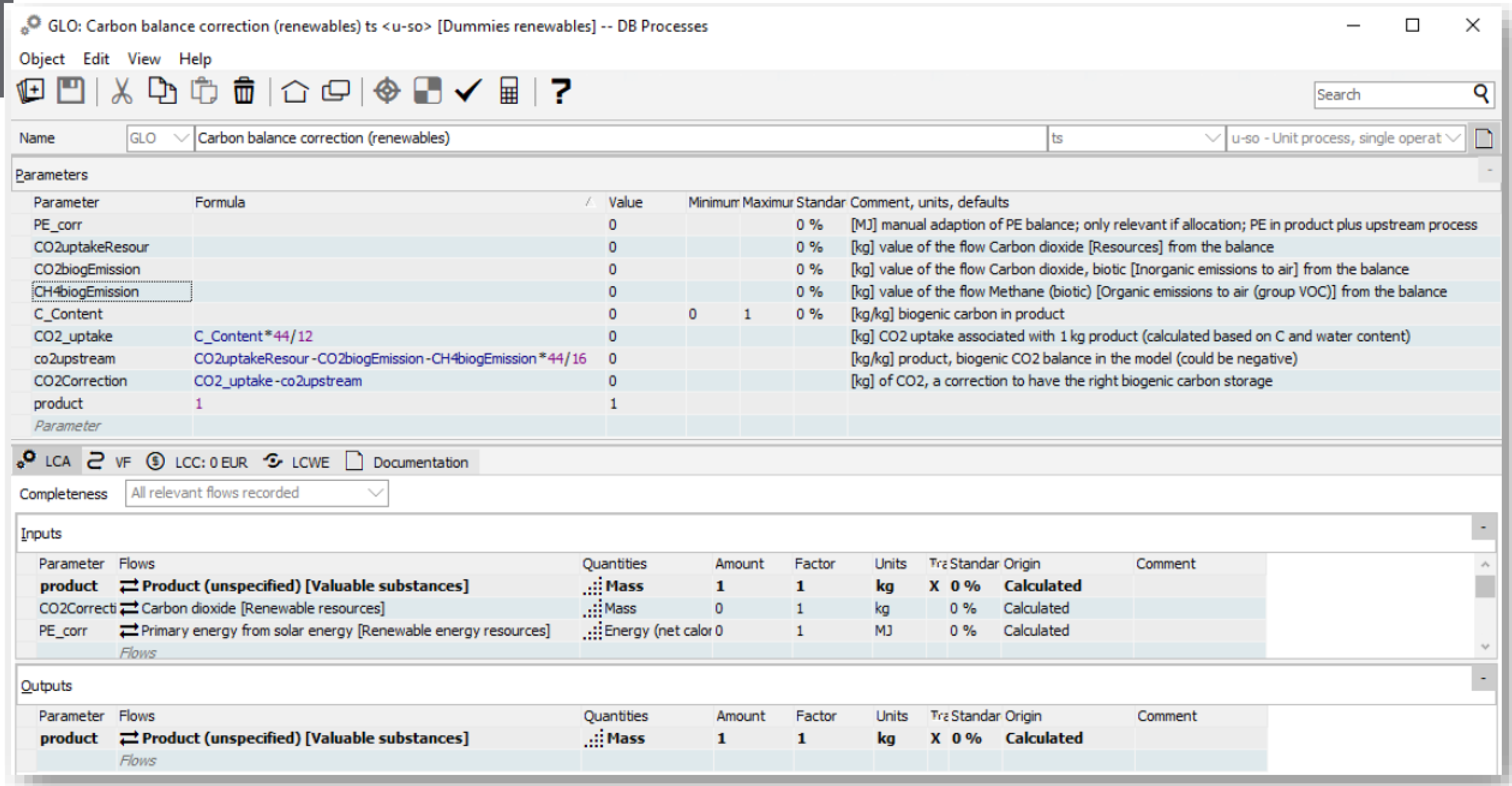


Biogenic Carbon Modeling in LCA software

Cradle-to-gate



GWP excl. bio CO2 – GWP incl bio CO2 ≡ C content of product


GLO: Carbon balance correction (renewables) ts <u-so> [Dummies renewables] -- DB Processes
Object Edit View Help
Search
Name GLO Carbon balance correction (renewables) ts u-so - Unit process, single operat
Parameters
Parameter | Formula | Value | Minimum | Maximum | Standar | Comment, units, defaults
PE_corr | | 0 | | | 0 % | [MJ] manual adaption of PE balance; only relevant if allocation; PE in product plus upstream process
CO2uptakeResour | | 0 | | | 0 % | [kg] value of the flow Carbon dioxide [Resources] from the balance
CO2biogEmission | | 0 | | | 0 % | [kg] value of the flow Carbon dioxide, biotic [Inorganic emissions to air] from the balance
CH4biogEmission | | 0 | | | 0 % | [kg] value of the flow Methane (biotic) [Organic emissions to air (group VOC)] from the balance
C_Content | | 0 | 0 | 1 | 0 % | [kg/kg] biogenic carbon in product
CO2_uptake | C_Content*44/12 | 0 | | | | [kg] CO2 uptake associated with 1 kg product (calculated based on C and water content)
co2upstream | CO2uptakeResour-CO2biogEmission-CH4biogEmission*44/16 | 0 | | | | [kg/kg] product, biogenic CO2 balance in the model (could be negative)
CO2Correction | CO2_uptake-co2upstream | 0 | | | | [kg] of CO2, a correction to have the right biogenic carbon storage
product | 1 | 1
Parameter
LCA VF LCC: 0 EUR LCWE Documentation
Completeness All relevant flows recorded
Inputs
Parameter | Flows | Quantities | Amount | Factor | Units | Tra | Standar | Origin | Comment
product | Product (unspecified) [Valuable substances] | Mass | 1 | 1 | kg | X | 0 % | Calculated
CO2Correcti | Carbon dioxide [Renewable resources] | Mass | 0 | 1 | kg | | 0 % | Calculated
PE_corr | Primary energy from solar energy [Renewable energy resources] | Energy (net calor | 0 | 1 | MJ | | 0 % | Calculated
Flows
Outputs
Parameter | Flows | Quantities | Amount | Factor | Units | Tra | Standar | Origin | Comment
product | Product (unspecified) [Valuable substances] | Mass | 1 | 1 | kg | X | 0 % | Calculated
Flows

CLF Carbon Leadership Forum

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

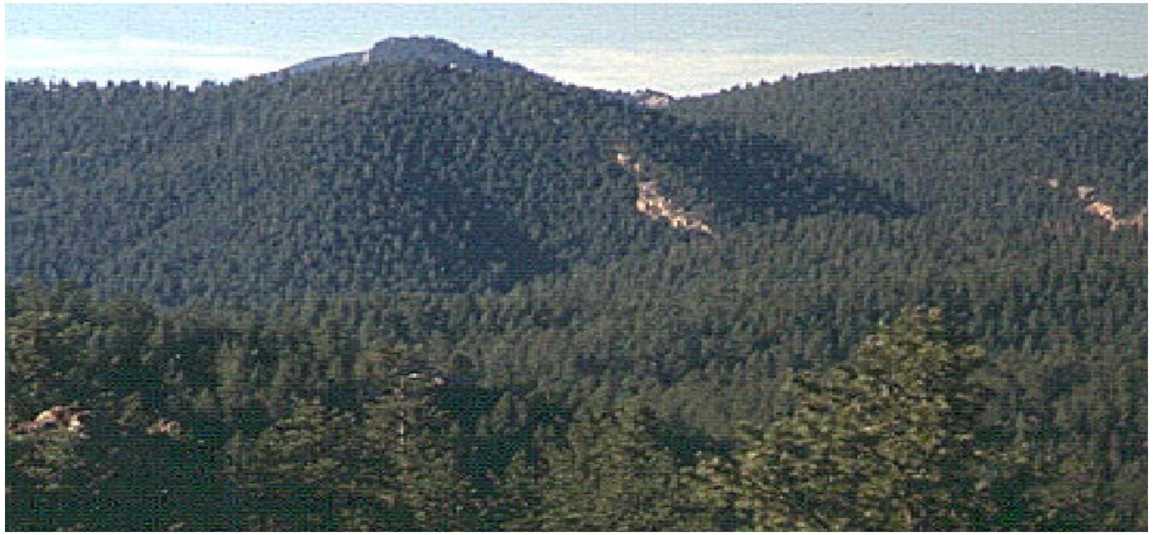
Forest Change in the US South

Clemson Experimental Forest
Photo Archives

Natural fire-dominated landscape

Cheesman Lake 1900

Prescribed fire/stocking issues



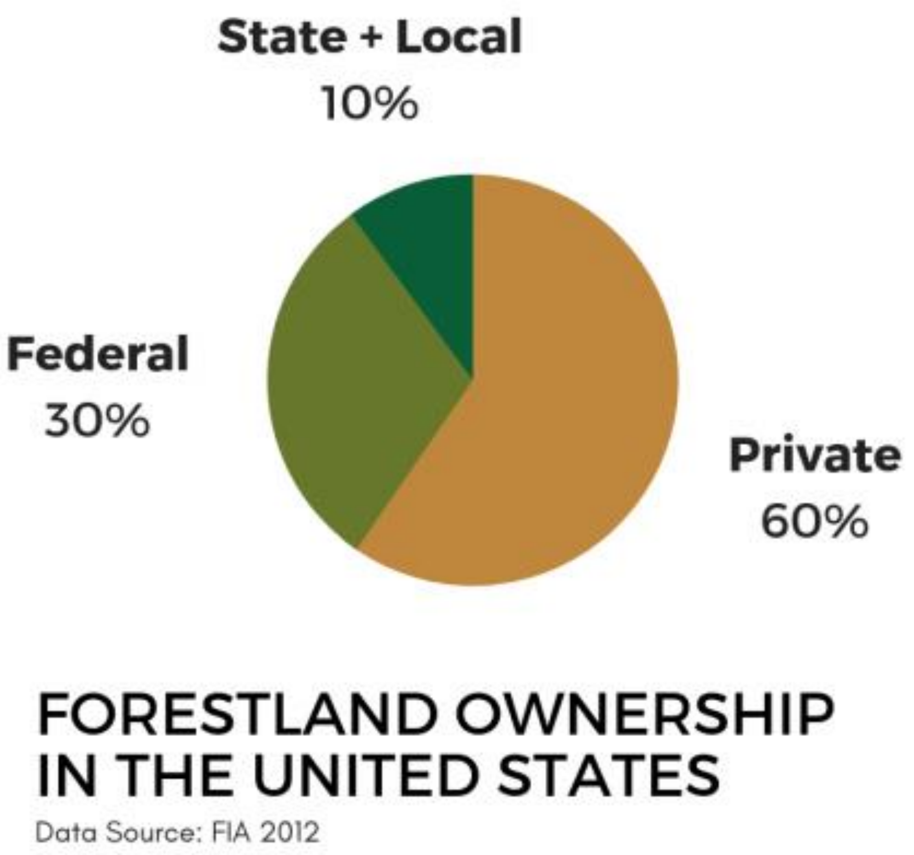
South Platte 2002

Office of the Colorado State Forester, 2003-4

Denver Water

Sabrina Hall

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

Area of Forest and Woodlands for Selected Regions, Types, Ownerships and Origins – Who Plants Trees

		All owners			National forest			Other public			Private corporate			Private non-corporate		
Forest-type group		Total	Planted	Natural origin	Total	Planted	Natural origin	Total	Planted	Natural origin	Total	Planted	Natural origin	Total	Planted	Natural origin
								Thousand acres								
	Longleaf-slash pi	12,999	7,200	5,799	1,192	258	934	2,282	650	1,632	5,423	3,891	1,532	4,102	2,401	1,700
	Loblolly-shortleaf	63,904	34,202	29,702	3,309	514	2,795	2,896	708	2,188	26,123	19,674	6,448	31,575	13,305	18,270
South total:		245,513	48,236	197,277	13,130	878	12,251	20,131	1,749	18,382	69,114	26,730	42,384	143,139	18,878	124,261
Pacific Coast:																
	Douglas-fir	21,087	8,130	12,957	7,344	1,304	6,040	4,171	1,425	2,746	6,390	4,630	1,759	3,183	771	2,412
	Ponderosa pine	9,493	1,189	8,304	5,121	664	4,457	683	35	648	1,516	379	1,136	2,172	110	2,062
	Fir-spruce	52,251	390	51,861	6,027	191	5,837	21,567	24	21,543	22,013	159	21,854	2,643	15	2,628
Pacific Coast total:		213,549	12,977	200,572	48,502	3,070	45,431	95,907	1,841	94,066	49,349	6,727	42,622	19,792	1,339	18,453
United States:		765,493	68,005	697,488	144,868	5,126	139,742	177,143	5,197	171,946	155,748	34,666	121,082	287,733	23,015	264,718

53%

75%

44%

38%

72%

24%

9%

Forest Resources of the United States, 2017

95% of planted pines in South are on private land

66% of planted Douglas-firs are on private land

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.

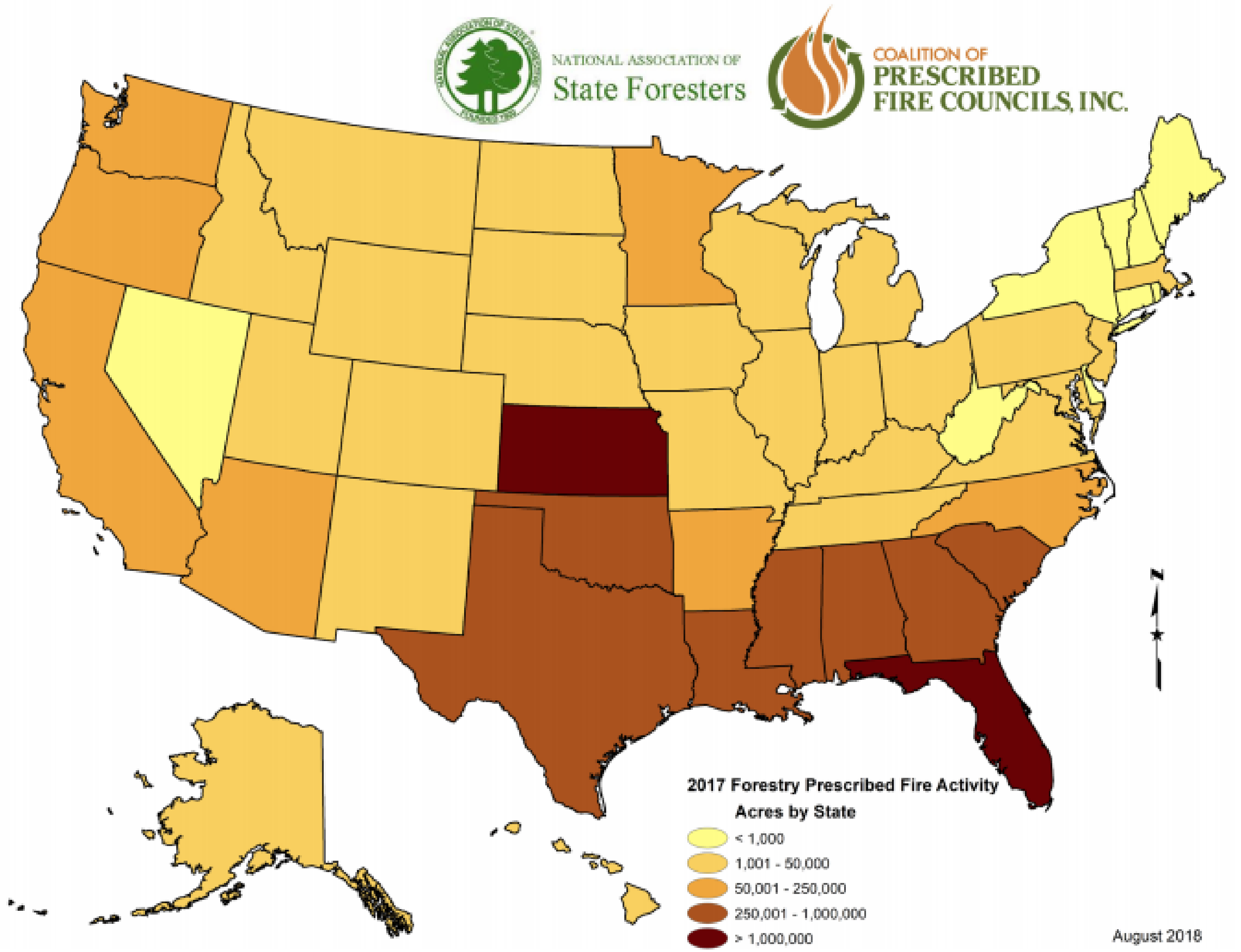
SC Landowners - Managed Forests

Private Corporate

Private Non-Corporate

Photos by Pat Layton

Prescribed Fire Use for Forestry Objectives by State in 2017

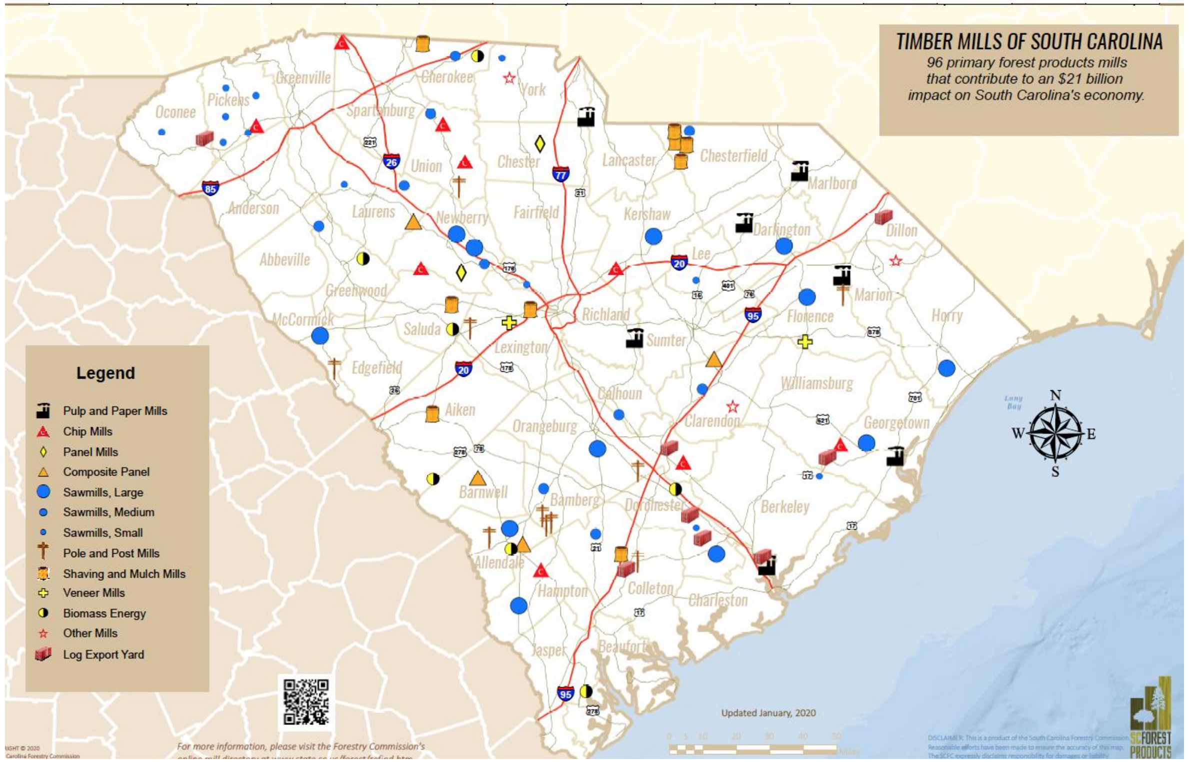


Economics of the system

- 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

Photos by Pat Layton

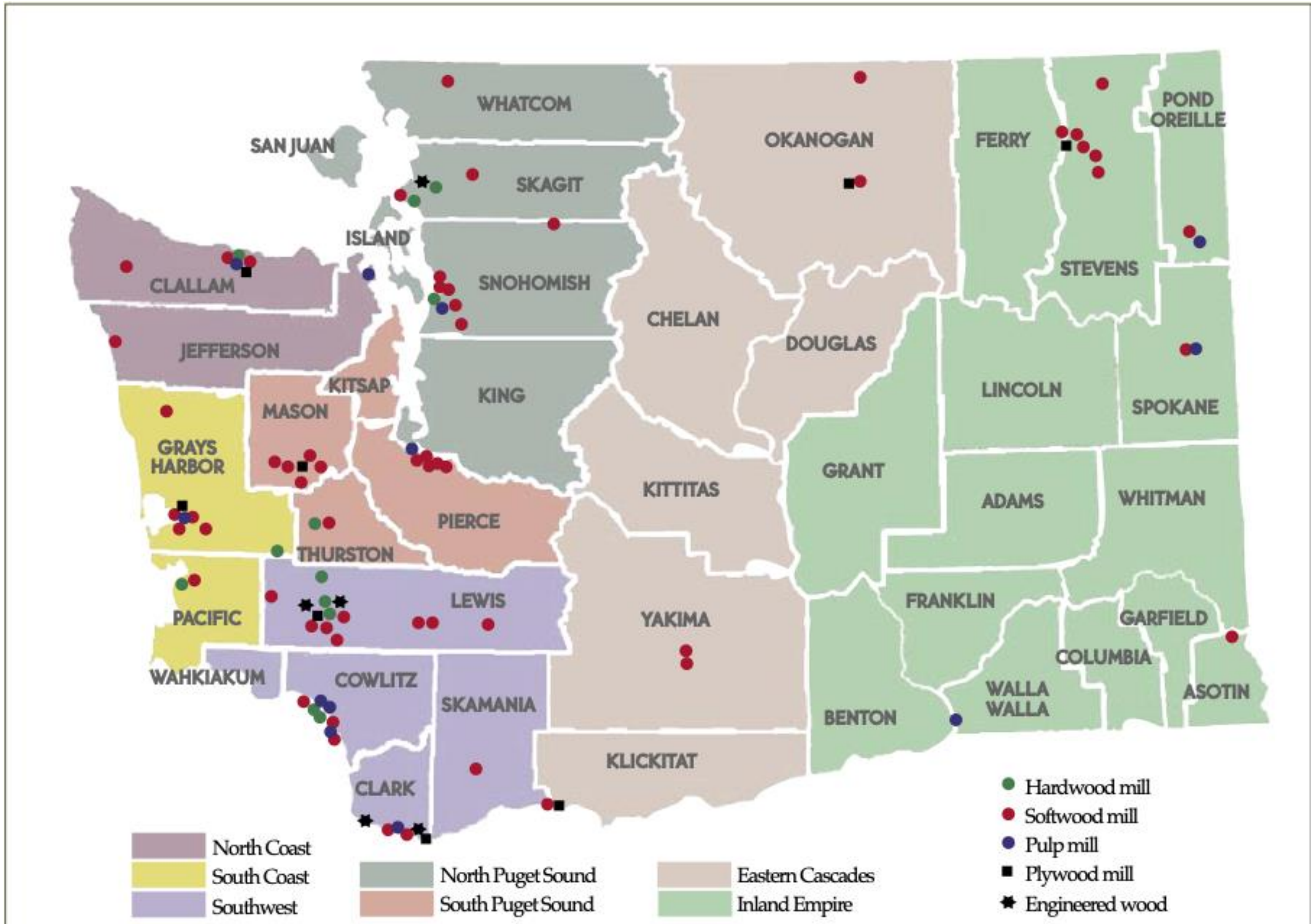
“Wood Baskets” for Mills



SC Forestry Commission

- 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



Washington's Forests, Timber Supply, and Forest-Related Industries https://file.dnr.wa.gov/publications/em_fwfeconomiclow1.pdf

Modern Softwood Sawmills – What Logs Are Harvested

Courtesy of Collum's Lumber Products, LLC

- ≅ 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

<u>Grade Mark Key</u>

1. Registered Trademark
2. Grade of Lumber
3. Moisture Content
4. Mill Identification Number
5. Heat Treated for Pest Pasteurization

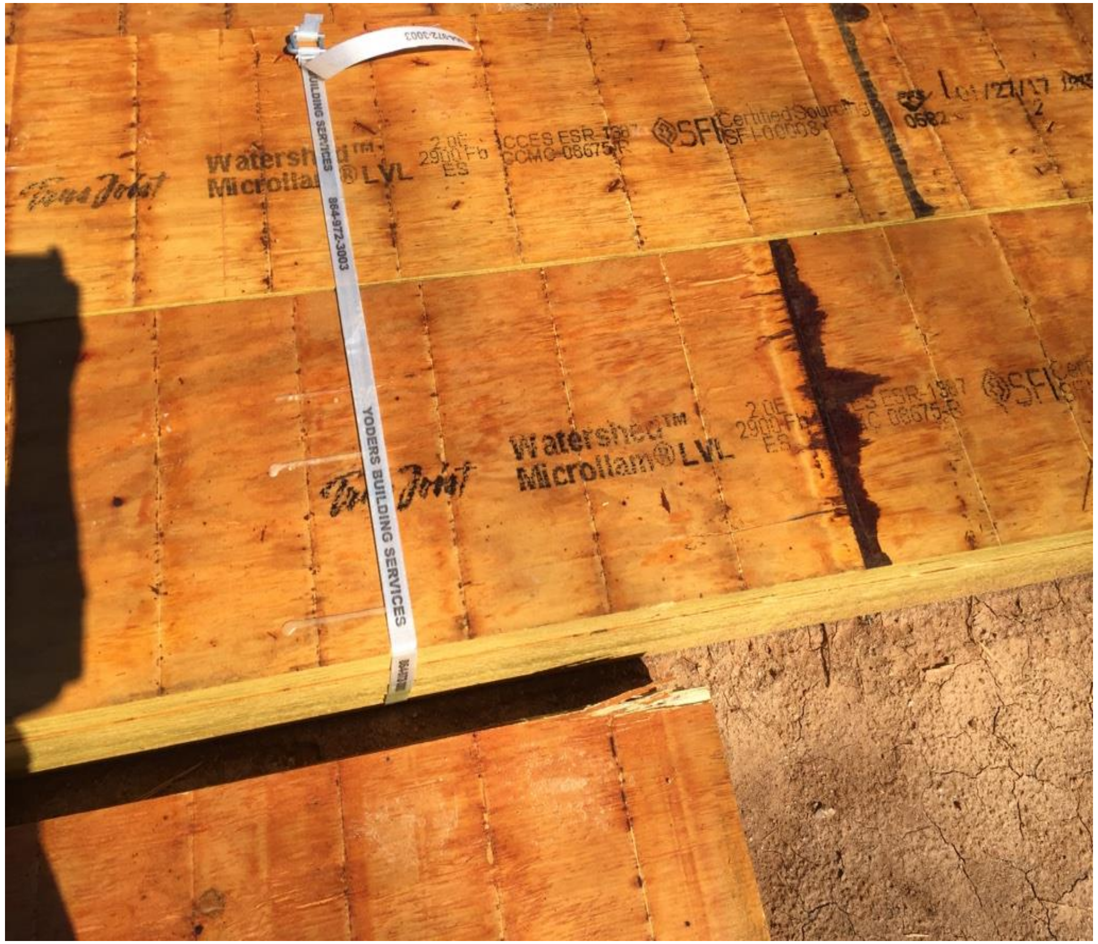
Grade Marking Western Wood Products

- WWPA certification mark
- 12 – Mill ID
- Stand – Grade Identification
- Species
- Seasoning
  - Includes type of drying and moisture content

Distribution Centers and Softwood Dimension Lumber Mills

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

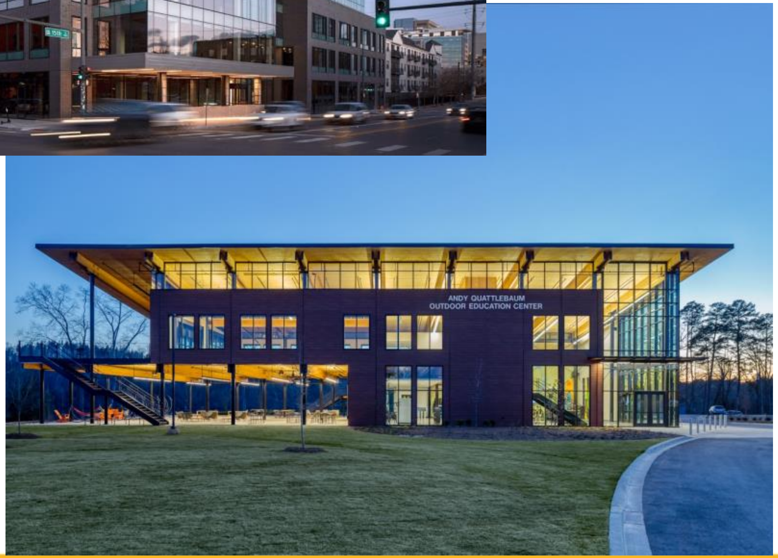
UMASS: Total SQ FT: 76,030
76 Truckloads delivered to jobsite
1,025,808 bd ft of Mass Timber: 245,136 Glulam Beams + 780,672 CLT.

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)

NORDIC

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

Cooper Carry



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

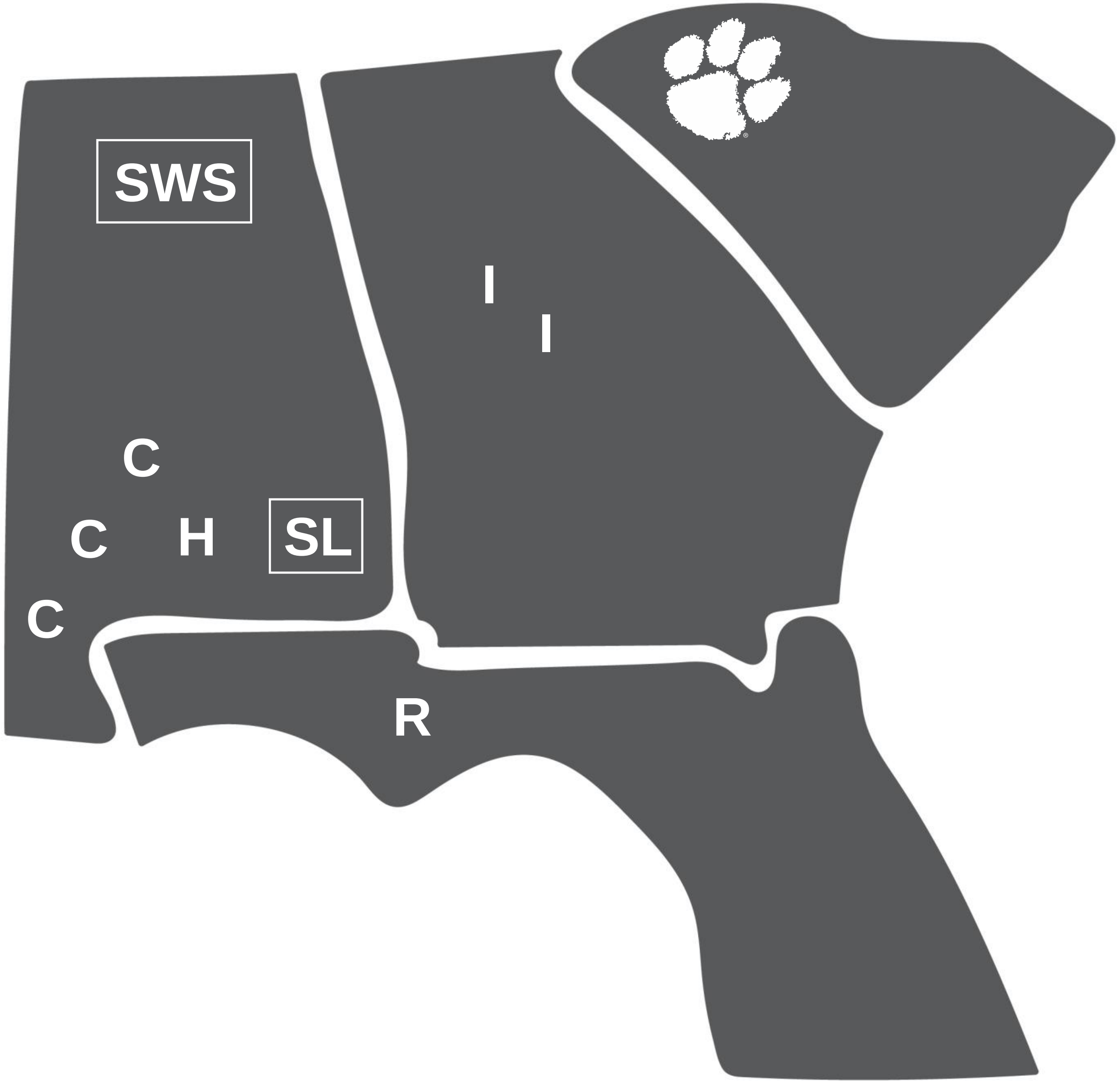
SmartLam (SL) - CLT

- 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

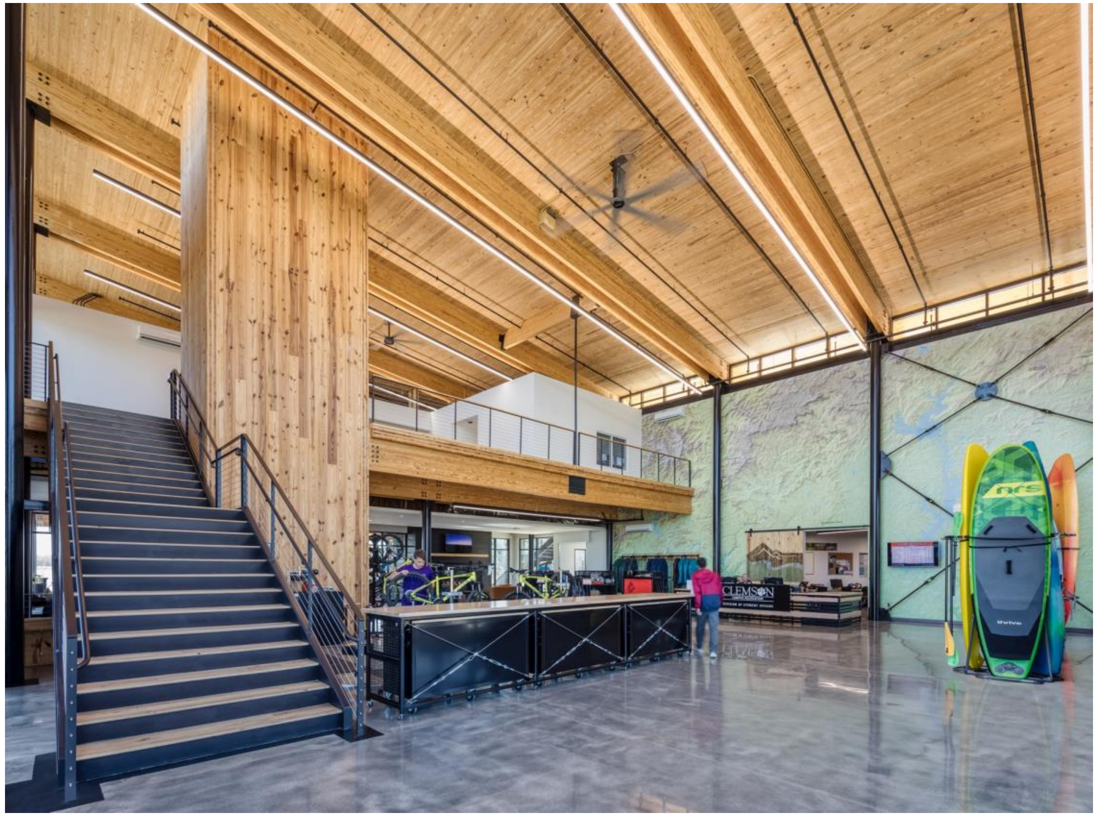


Influencing Carbon in Wood Products

- 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 <u>not</u> always climate-smart forestry

Carbon Leadership Forum

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
  - 2009-2011 - Analyst covering domestic and international forest carbon science, policy, and markets. Lead author of State of the Forest Carbon Markets 2011.
  - 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

FORESTRY CHOICES MATTER

- Forest carbon balance exerts a significant influence on our global climate.

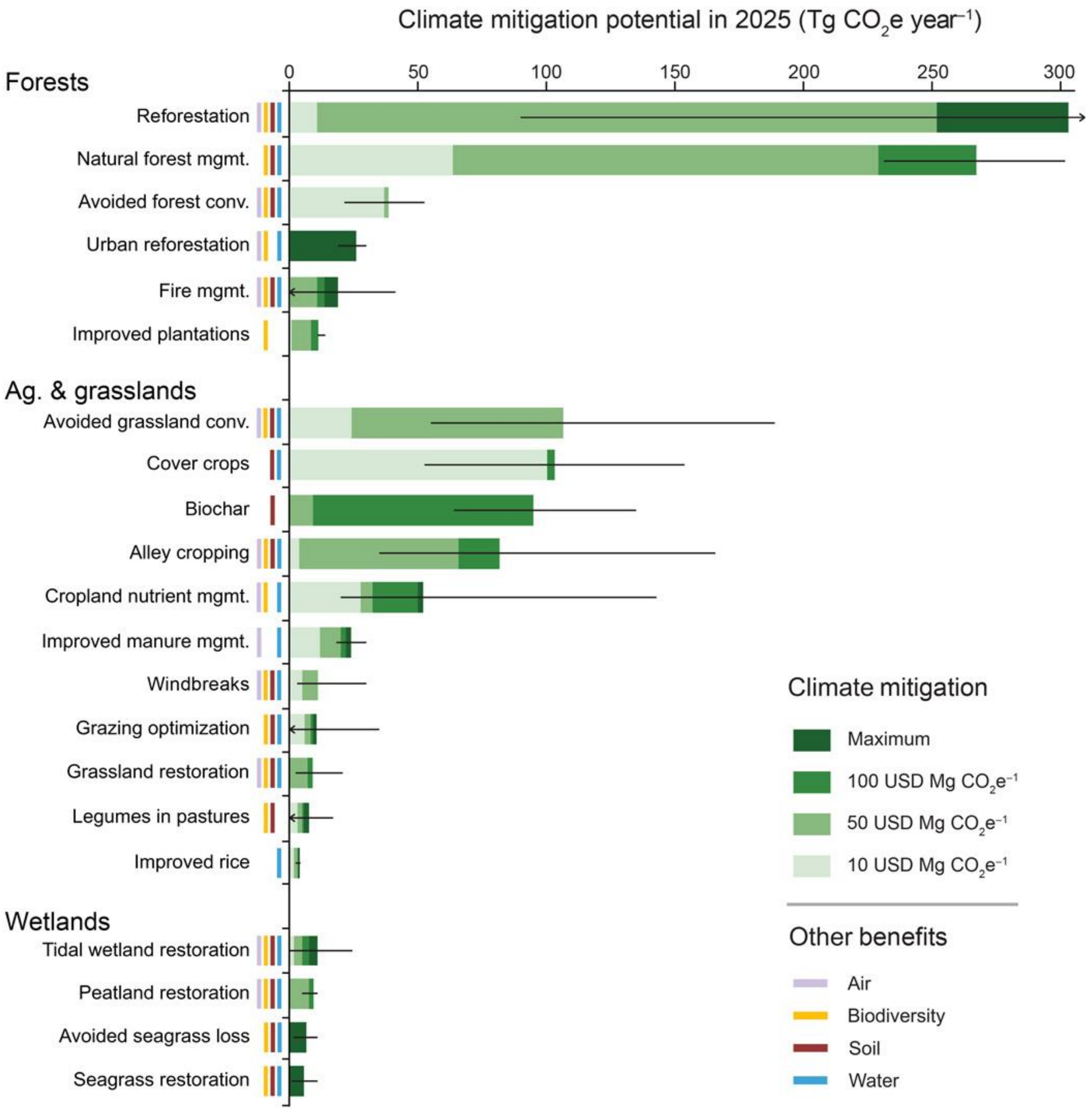
- Choices around how forests are treated and where we source wood products from are moving to forefront of business decisions amidst our climate crisis.

- Forests provide fundamental benefits including food, clean water, and shelter, in addition to economic development opportunities.

FORESTS DOMINATE NATURAL CLIMATE SOLUTIONS

- 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.



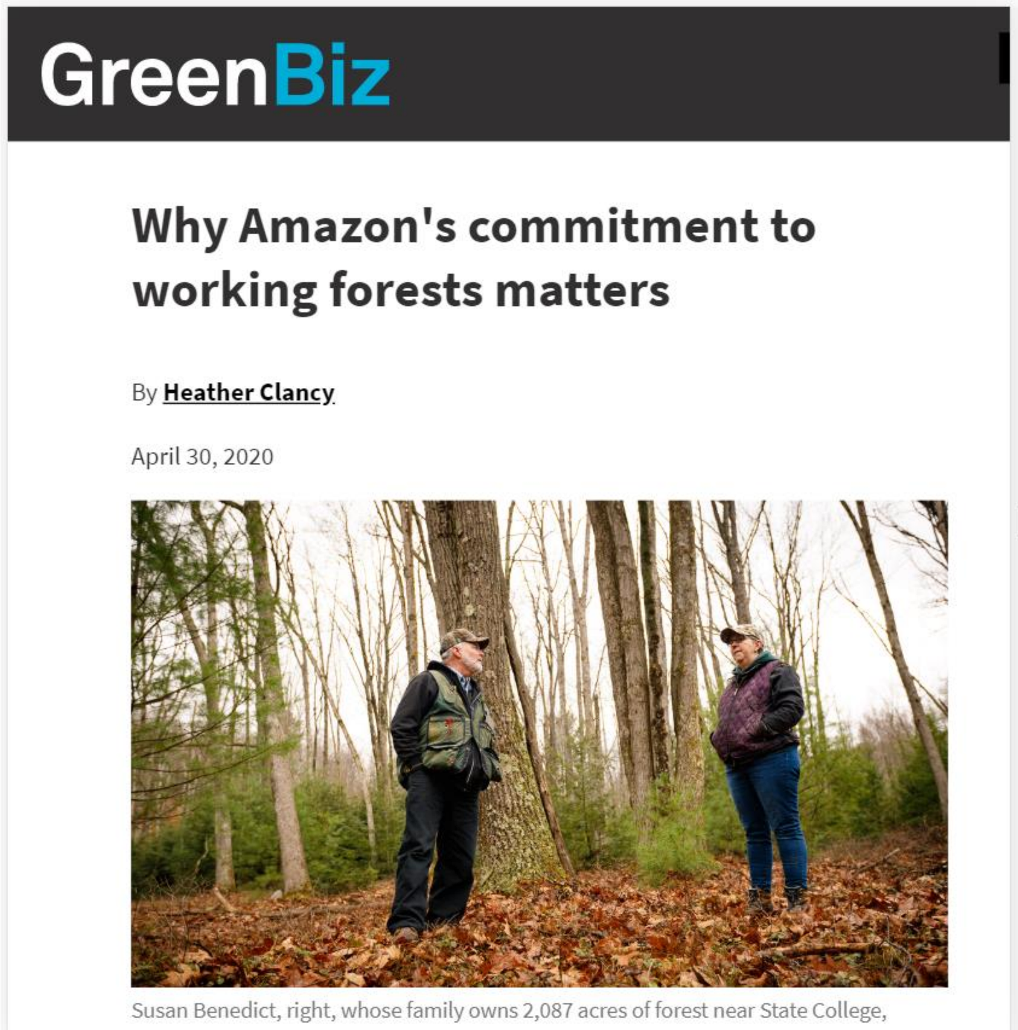
Fargione et al. (2018). Science Advances 4(11)

Millions are being invested into forests that go beyond carbon neutrality


The Seattle Times

Microsoft buys carbon credits in forest near Rainier to offset pollution

Originally published November 25, 2015 at 7:12 pm | *Updated November 25, 2015 at 9:09 pm*


GreenBiz

Why Amazon's commitment to working forests matters

By **Heather Clancy**

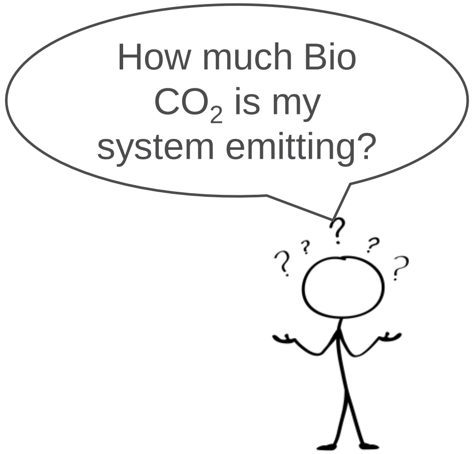
April 30, 2020

Susan Benedict, right, whose family owns 2,087 acres of forest near State College,

FOCUSING ON EMBODIED CARBON

SKANSKA

4 General Approaches to Forest Product LCA Calculations



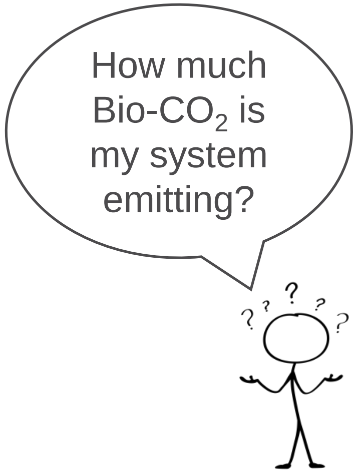
1 CO_2 is removed from the atmosphere before harvesting while the tree is growing

2 CO_2 is removed from the atmosphere after harvest by the trees that replace the tree that was harvested

3 CO_2 is removed from the atmosphere in the year of harvest by non-harvested trees growing across the landscape

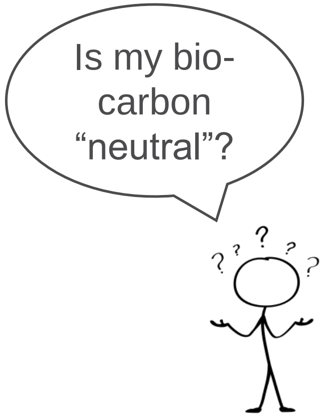
4 Any of the previous approaches adjusted to account for foregone sequestration

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

MOVING BEYOND NEUTRALITY

A basic formula for adding non-zero forest carbon balance to existing LCAs

Environmental Impact Assessment Review 29 (2009) 165–168

Contents lists available at ScienceDirect

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Environmental Impact Assessment Review

journal homepage: www.elsevier.com/locate/eiar

Environmental Impact Assessment Review

Goodbye to carbon neutral: Getting biomass footprints right

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A R T I C L E   I N F O

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Keywords:
Carbon accounting
Biofuels
Sequestration credits
Carbon footprinting
LCA

A B S T R A C T

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 debits, 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.

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.

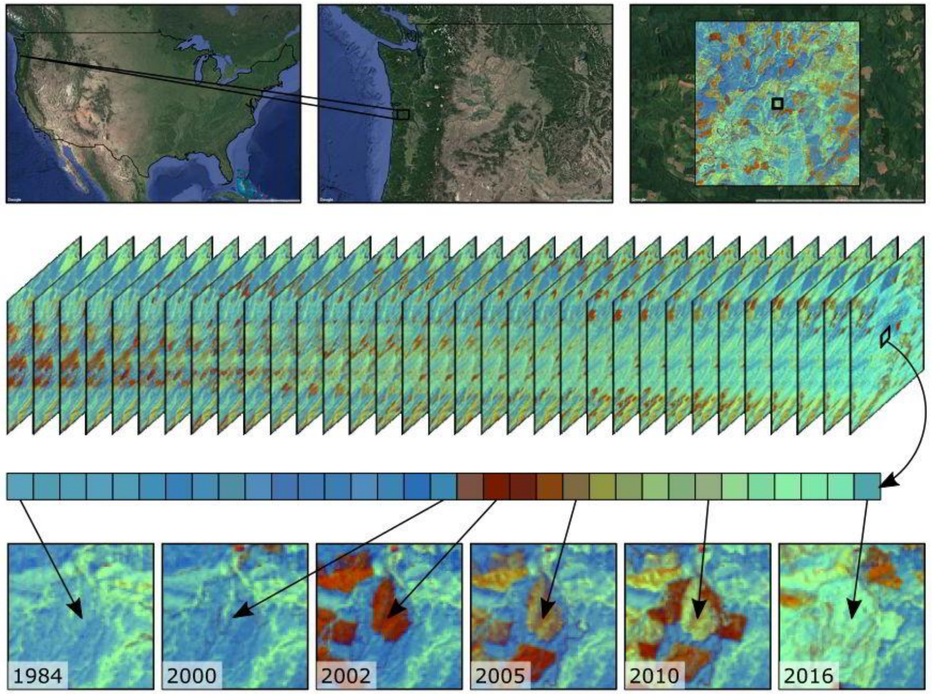
2. **Calculate timber output**
   Total output of industrial roundwood from same area and timeframe.

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

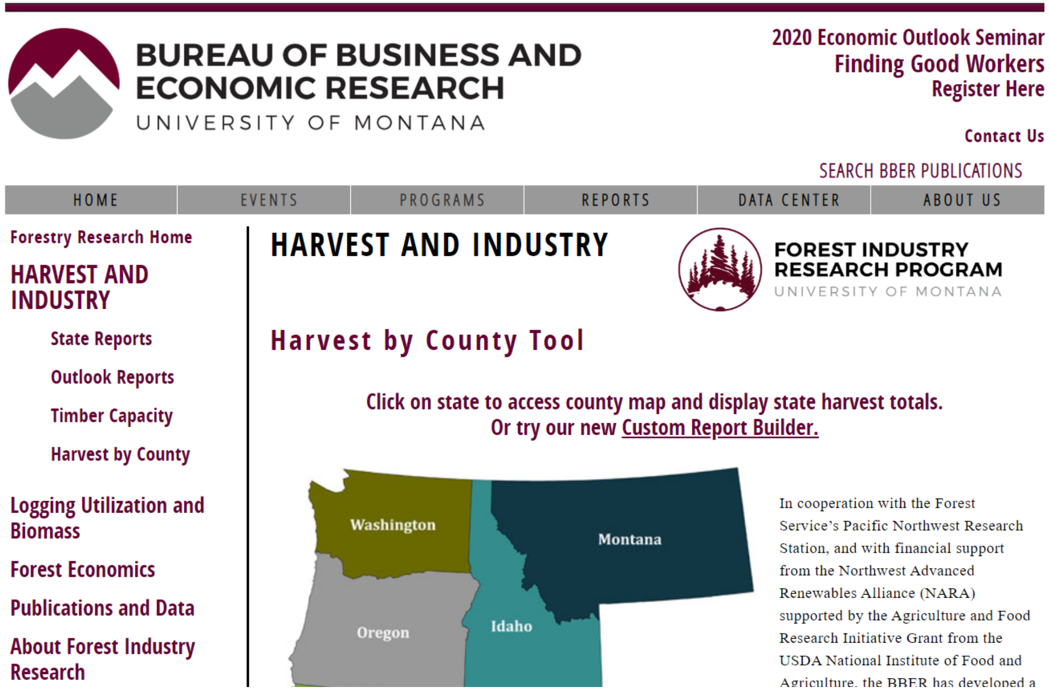
   - This “upstream” embodied carbon is cleanly separated from “downstream” stocks and fluxes which are comparatively well-reflected in existing LCIs, LCAs, and EPDs for forest products.

UTILIZE OBSERVATIONAL DATA

Time series of forest conditions and timber outputs



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.

A basic formula for adding non-zero forest carbon balance to existing LCAs

1. **Calculate carbon stock change in the forest**
   Using NASA CMS data, convert biomass (Mg) to carbon (kgCO_2e) and subtract total carbon stock in at the end of the period from carbon stock at the beginning.

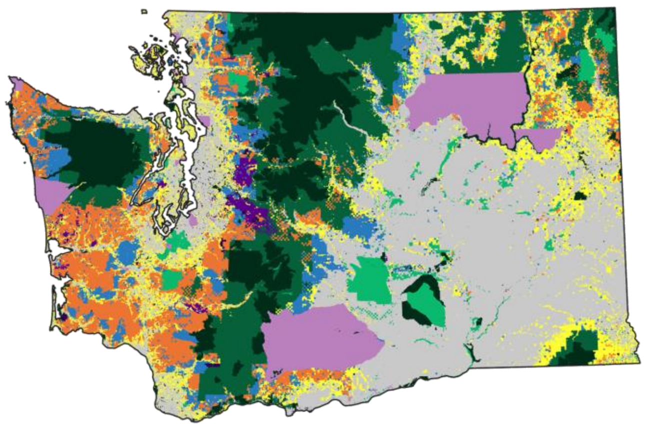
2. **Calculate timber output**
   Using independent timber output reports, calculate total timber produced over specified timeframe, convert Scribner boardfeet to cubic meters of industrial roundwood (assuming 0.1395 MBF per m^3).

3. **Calculate “upstream” embodied carbon**
   Divide #1 by #2 to calculate “upstream” embodied carbon (kgCO_2e /m^3) for that area of interest over the specified timeframe.

   - The following example covers non-reserved forests of Washington State from 1990-2016.

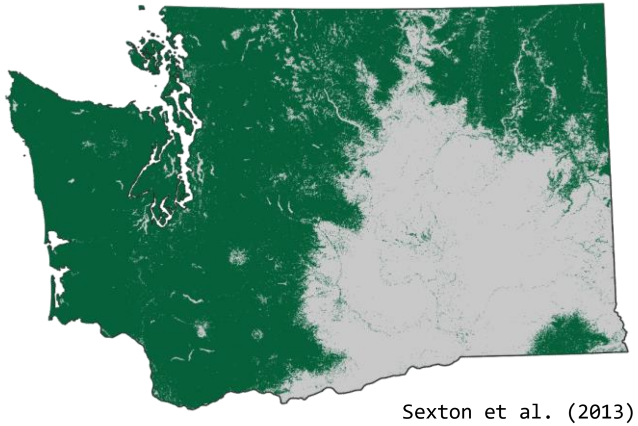
OWNERSHIP

from RTI, PADUS, and US Census data



FOREST COVER

in 2000, 2005, 2010, or 2015



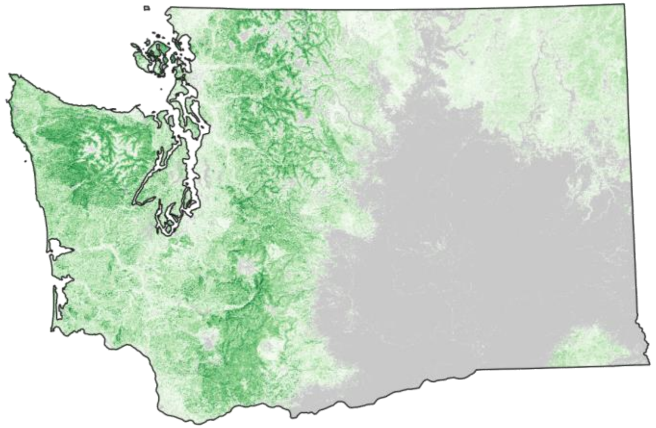
Sexton et al. (2013).
“GFCC30TC” https://cmr.earthdata.nasa.gov

COUNTIES

to indicate “woodsheds”

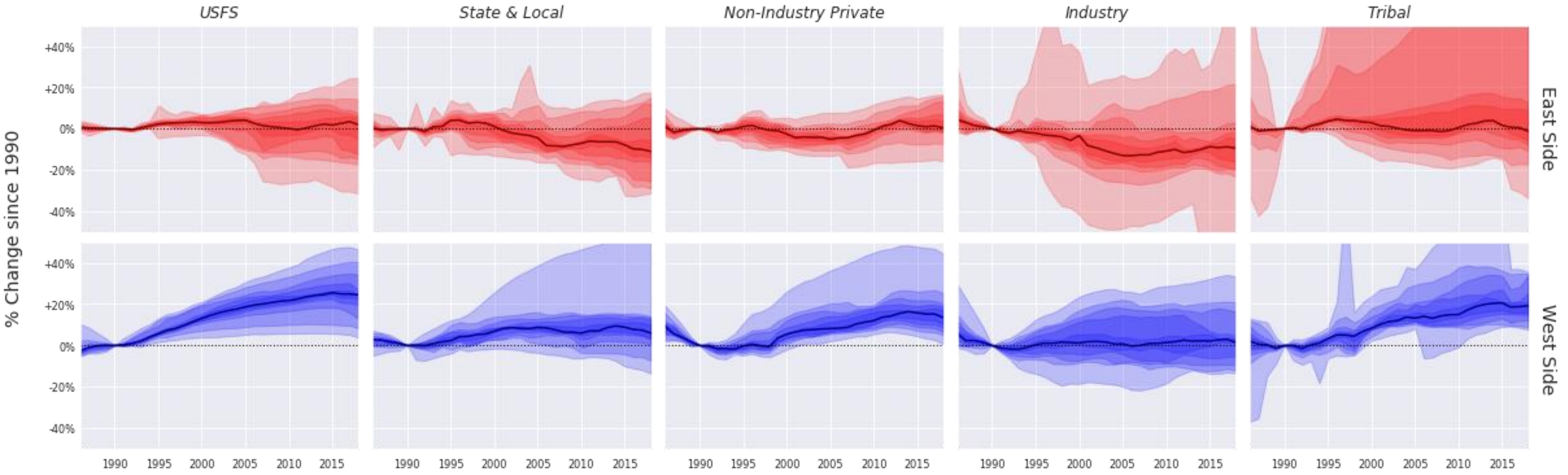
BIOMASS

from Landtrendr 1986-2018



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.

UNPACKING GLULAM'S EMBODIED CARBON

Contextualizing the magnitude of emissions and sequestration from a smattering of EPDs and LCAs

ENVIRONMENTAL PRODUCT DECLARATION

AMERICAN WOOD COUNCIL Canadian Wood Council Conseil canadien du bois

North American Glued Laminated Timbers (Glulam)
North American Structural and Architectural Wood Products

According to ISO 14025 and ISO 21930:2007

This declaration is an environmental product declaration in accordance with ISO 14025 that describes environmental characteristics of the described product and provides transparency and disclosure of the impacts caused by the product life cycle. This EPD does not guarantee that any performance benchmarks, including environmental performance benchmarks, are met. EPDs are intended to compliment Type I environmental performance labels.

CERTIFIED

Cradle to Gate Life Cycle Assessment of Glue-Laminated Timbers Production from the Pacific Northwest

Maureen Puettmann, Woodlife Environmental Consultants, LLC
Elaine Oneil, University of Washington
Leonard Johnson, Professor Emeritus, University of Idaho

January 2013

Cradle-to-Gate Life-Cycle Impact Analysis of Glued-Laminated (Glulam) Timber: Environmental Impacts from Glulam Produced in the US Pacific Northwest and Southeast*

Tait Bowers
Maureen E. Puettmann
Indroneil Ganguly
Ivan Eastin

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:

+5 $kgCO_2e$ / m^3 roundwood - Forest Operations

+20 $kgCO_2e$ / m^3 roundwood - Lumber Production

+20–40 $kgCO_2e$ / m^3 roundwood - Glulam Production

-375–455 $kgCO_2e$ / m^3 roundwood - Retained in Product

OWNERS SHAPE EMBODIED CARBON

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

EAST SIDE

"upstream" embodied carbon ($kgCO_2e/m^3$ roundwood)

county percentiles	0 (min)	5	25	50 (median)	75	95	100 (max)
USFS	-1,567	-1,524	-744	-234	+1,861	+6,417	+9,028
State & Local	-457	-448	-271	+137	+335	+1,070	+1,473
Non-Industry Private	-1,058	-677	-105	-20	+18	+644	+1,069
Industry	-700	-624	0	+138	+298	+424	+485

WEST SIDE

"upstream" embodied carbon ($kgCO_2e/m^3$ roundwood)

county percentiles	0 (min)	5	25	50 (median)	75	95	100 (max)
USFS	-27,565	-18,036	-8,360	-7,751	-4,634	-2,256	-616
State & Local	-3,859	-1,652	-504	-131	-61	+157	+200
Non-Industry Private	-910	-694	-143	-111	-88	-63	-47
Industry	-250	-223	-119	-40	+86	+153	+178

Note: Percentiles indicate distribution among counties, not adjusted/normalized by timber output.

OWNERS SHAPE EMBODIED CARBON

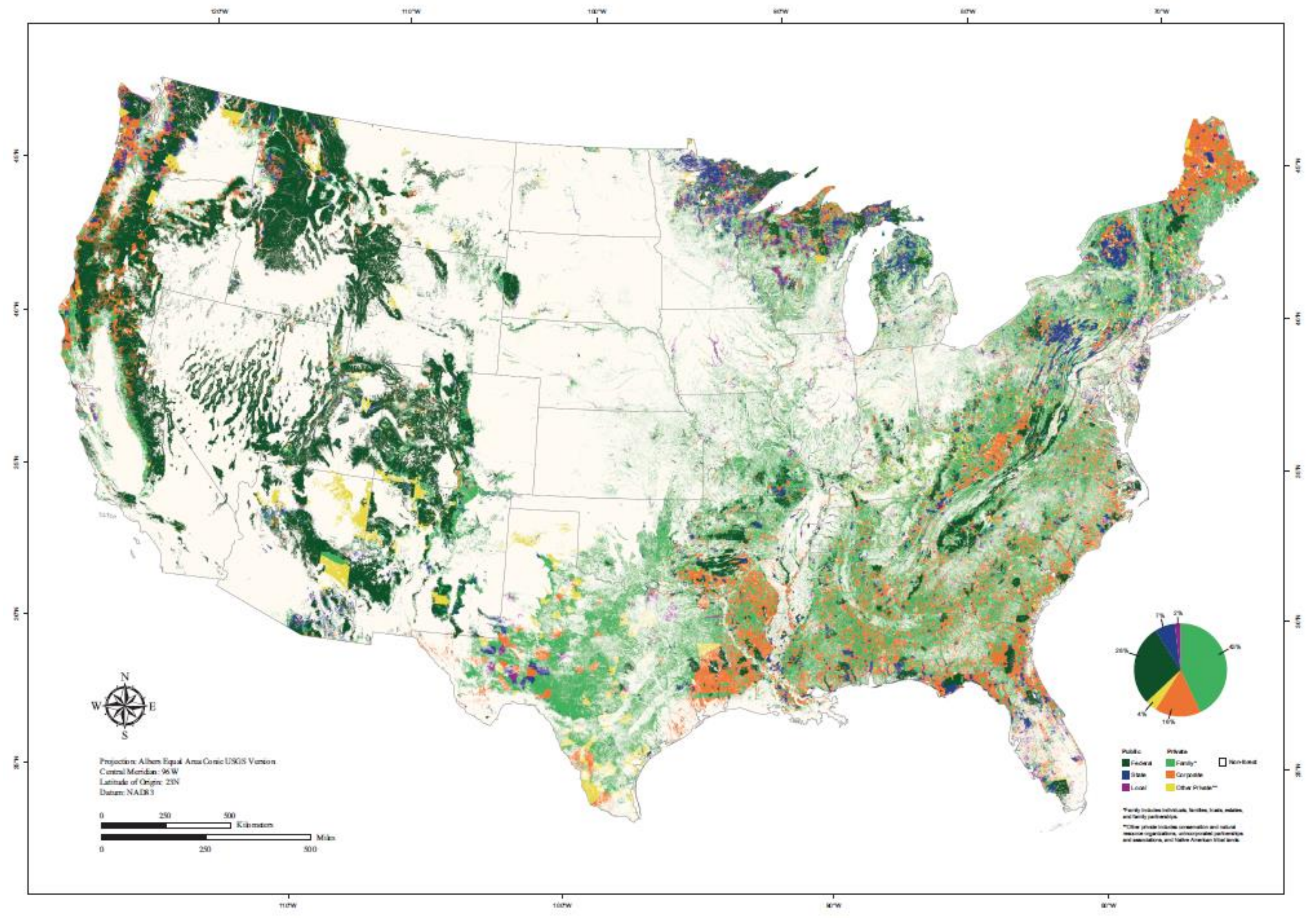
Looking back on Washington's non-reserved forests from 1990-2016

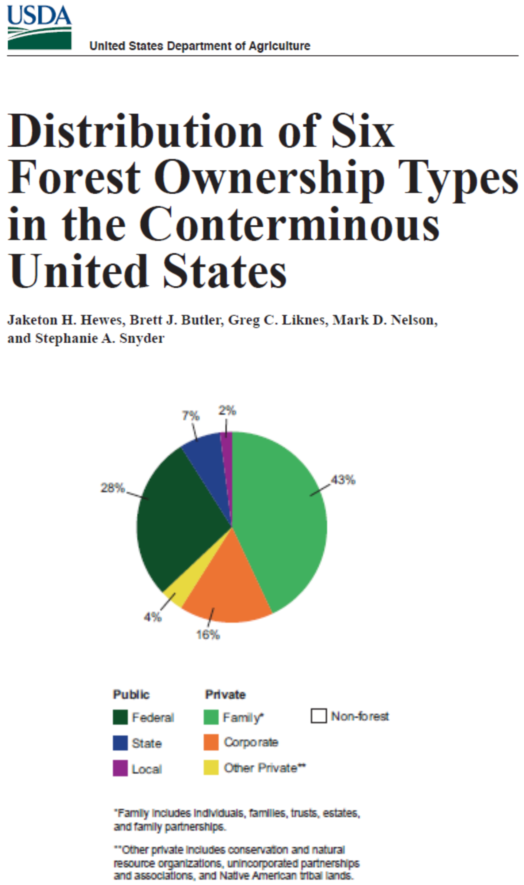
	"upstream" embodied carbon ($kgCO_2e/m^3$ roundwood)									Average Annual Timber Output (2012 - 2017)	
timber supply percentiles	10	20	30	40	50	60	70	80	90	%	MMBF
Industry	-238	-208	-149	-54	-24	-1	+73	+159	+181	40%	1,665
Non-Industry Private	-162	-134	-114	-101	-94	-86	-68	-51	+5	29%	1,203
State & Local	-364	-195	-178	-116	-89	-81	-64	+48	+150	24%	988
USFS	-7,163	-5,021	-4,725	-3,521	-1,190	-896	-221	+1,974	+3,390	3%	133
Other Federal	-1,100	-916	-916	-71	-71	-71	-71	+699	+4,111	1%	43

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

GOING NATIONAL

Embodied carbon disclosure will be coming to US forests soon




USDA
United States Department of Agriculture

Distribution of Six Forest Ownership Types in the Conterminous United States

Jaketon H. Hewes, Brett J. Butler, Greg C. Liknes, Mark D. Nelson, and Stephanie A. Snyder

*Family includes individuals, families, trusts, estates, and family partnerships.

**Other private includes conservation and natural resource organizations, unincorporated partnerships and associations, and Native American tribal lands.

"All models are wrong but some are useful." -- George E.P. Box

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 <u>probably not</u> "good enough."

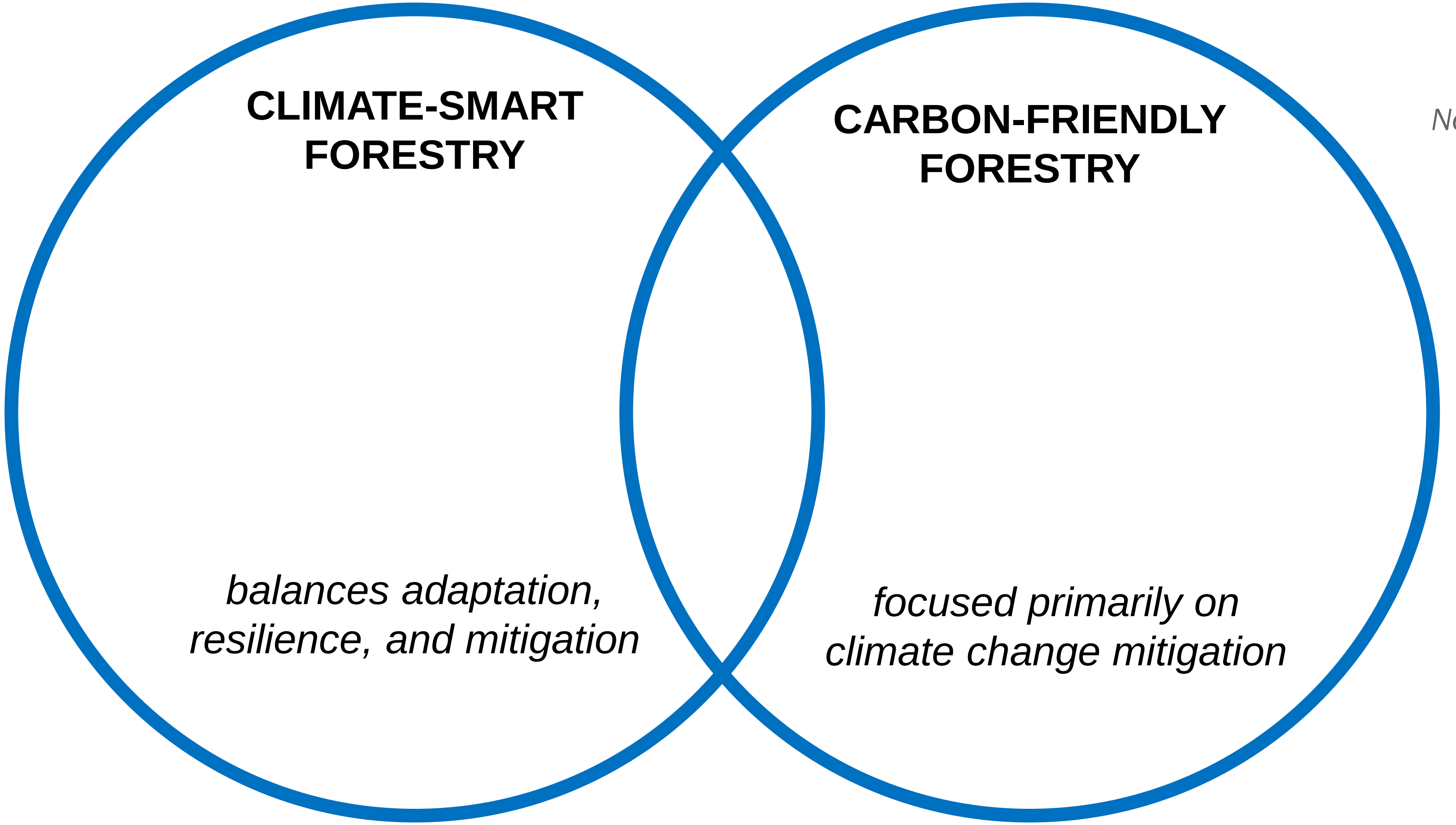
- To identify and address relevant (policy) questions and tradeoffs, you need to enter the realm of counter-factual (or "what if…") scenario modeling to, however crudely, interrogate how market, policy, and social and environmental interactions and impacts would occur with and without certain interventions.

Carbon Leadership Forum

...and why carbon-friendly forestry is <u>not</u> always climate-smart forestry

CARBON-FRIENDLY vs. CLIMATE-SMART

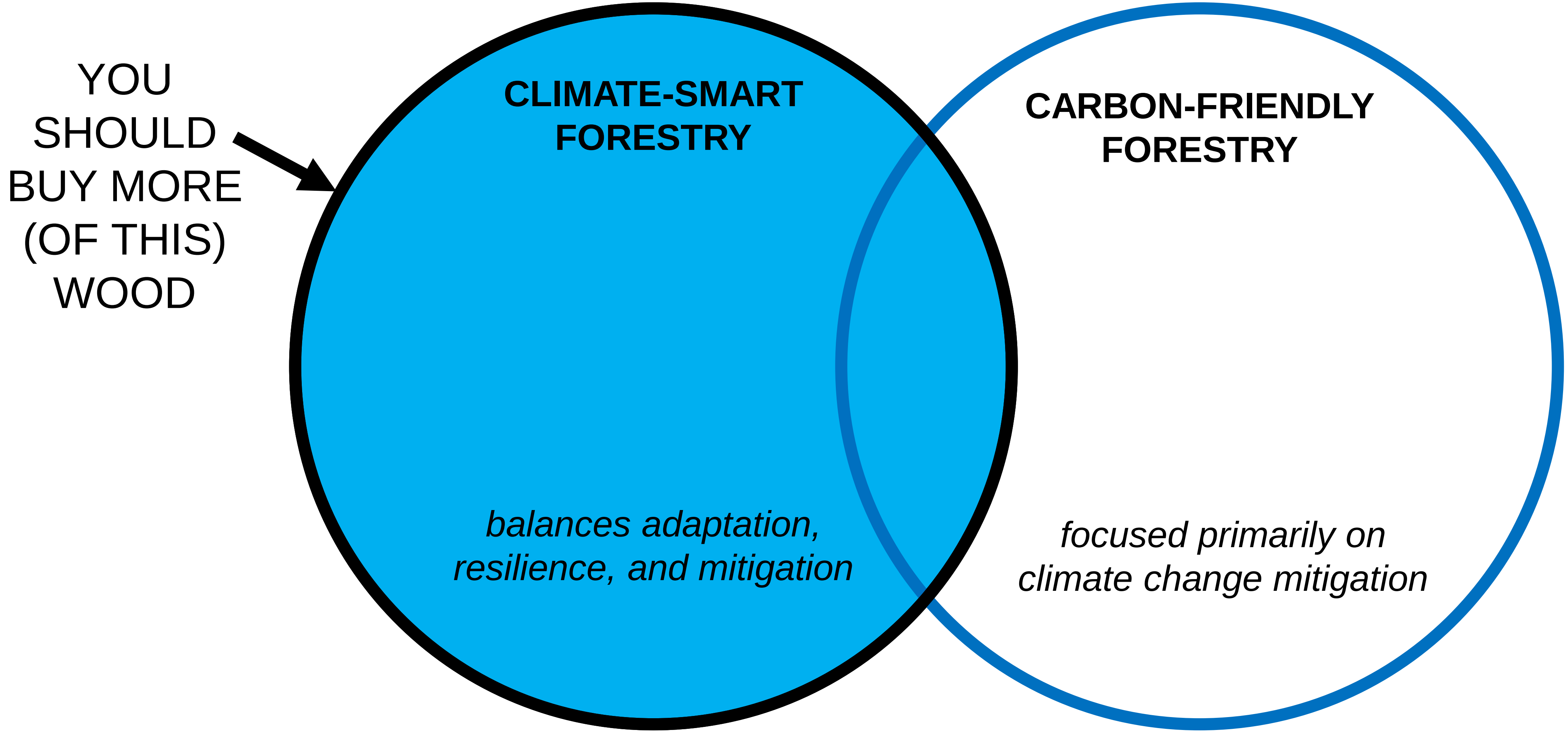
Carbon is the tail, not the dog



Note: Not drawn to scale :)

CARBON-FRIENDLY vs. CLIMATE-SMART

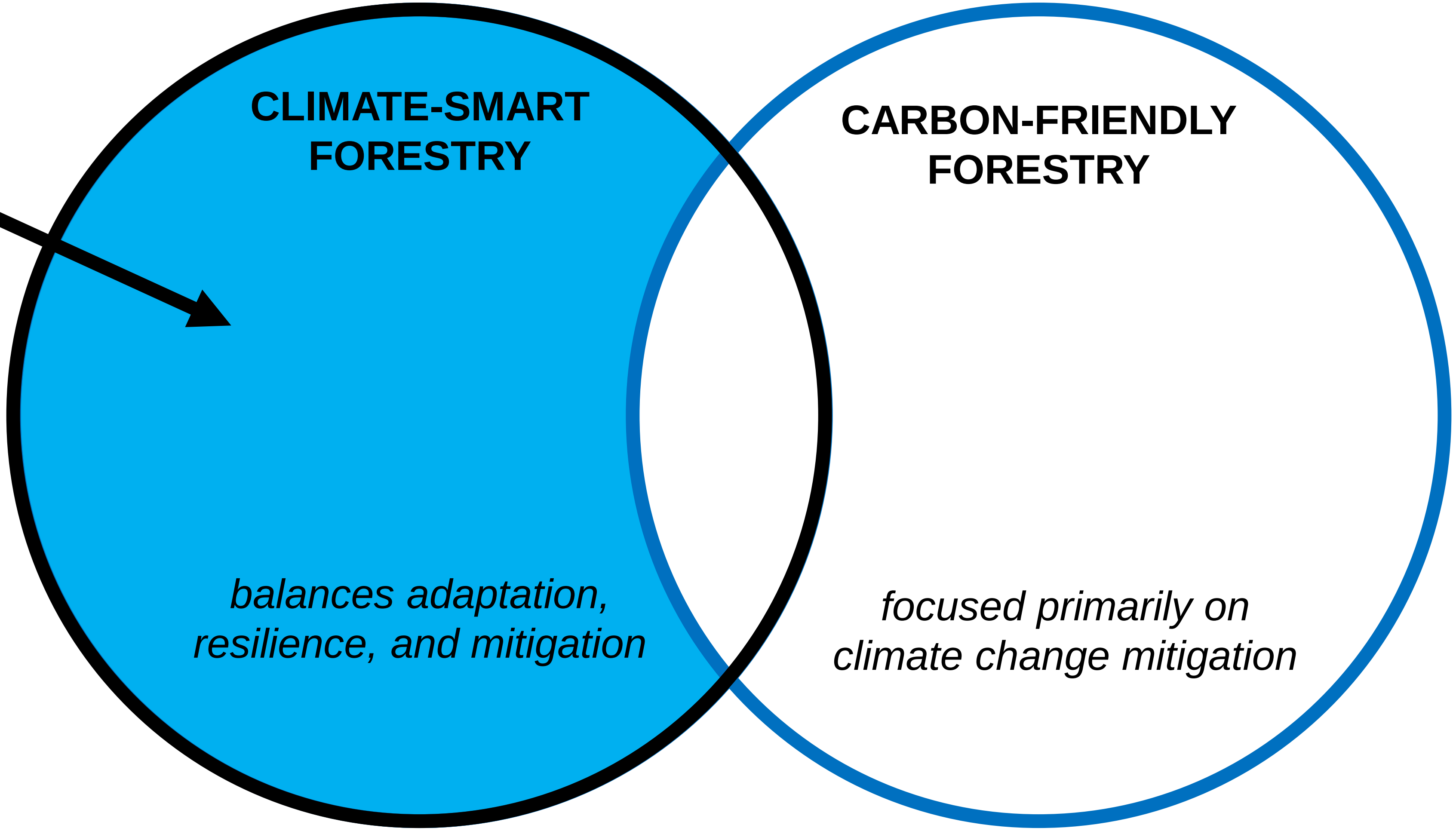
Carbon is the tail, not the dog



CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

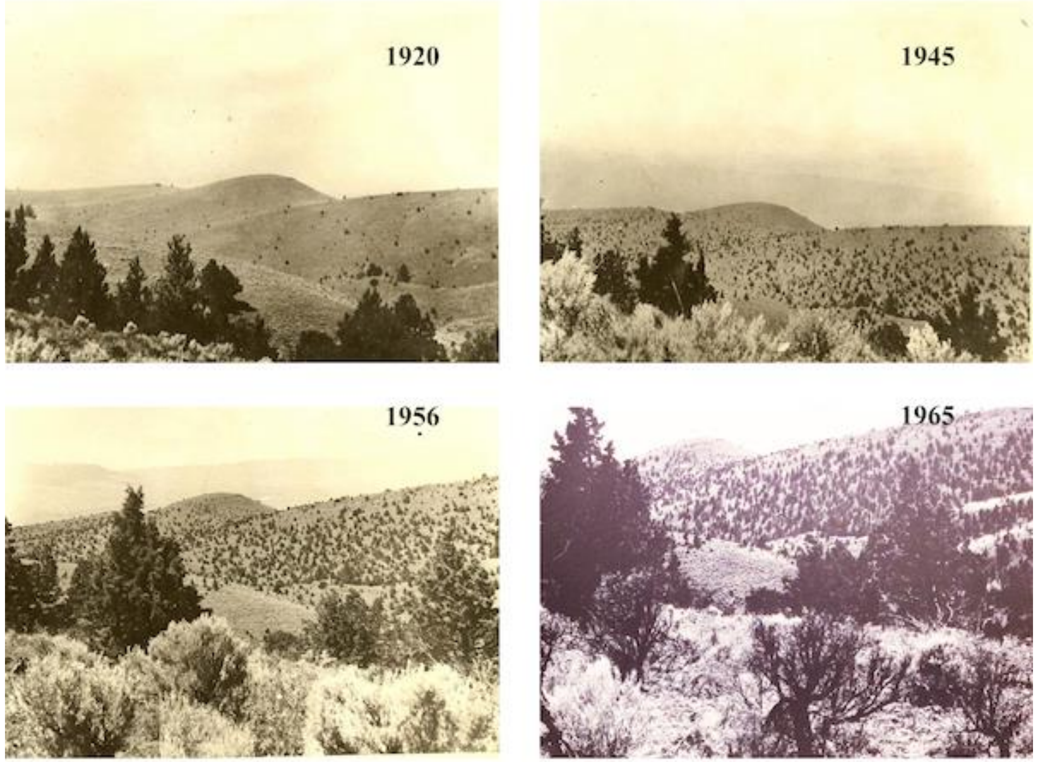
BUT
WHAT IS
ALL THIS
ABOUT?



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.



Credit: Sustainable Northwest.
https://greatnorthwestwine.com/2016/05/11/a-to-z-wineworks-puts-western-juniper-use-vineyards/

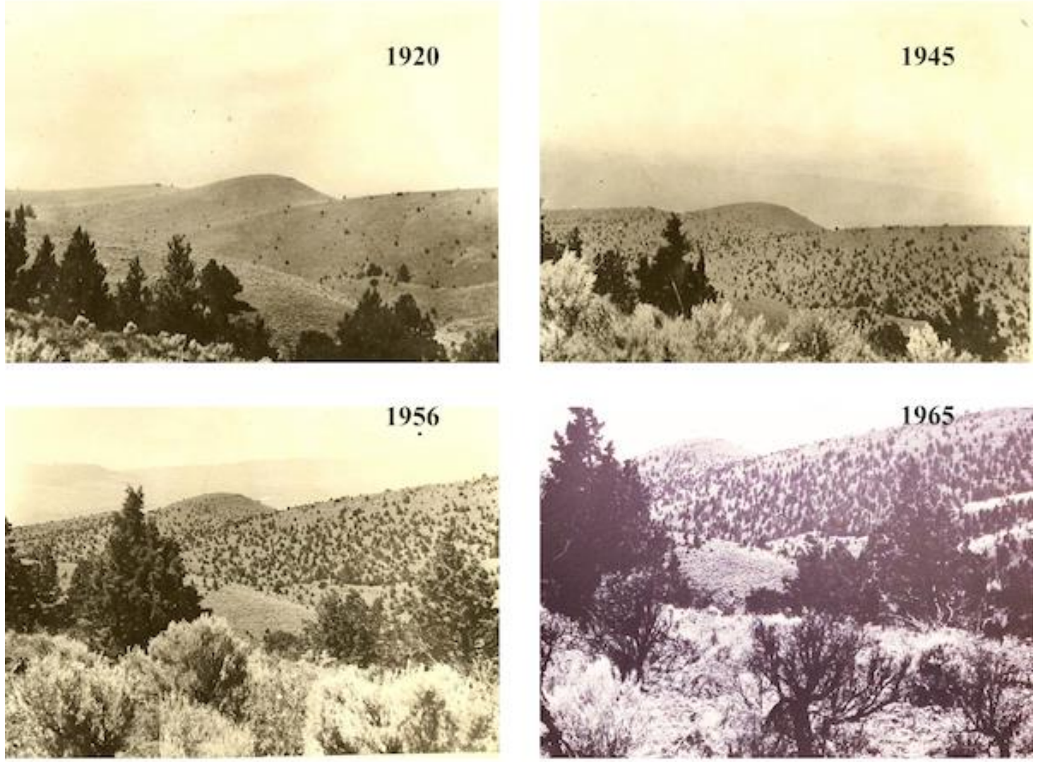
ELSEVIER
Rangeland Ecology & Management
Volume 70, Issue 1, January 2017, Pages 87-94

Bird Responses to Removal of Western Juniper in Sagebrush-Steppe ☆

Aaron L. Holmes [a, b], Jeremy D. Maestas [c], David E. Naugle [d]

"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."

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



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https://greatnorthwestwine.com/2016/05/11/a-to-z-wineworks-puts-western-juniper-use-vineyards/

ELSEVIER
Rangeland Ecology & Management
Volume 70, Issue 1, January 2017, Pages 116-128

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

Patrick R. Kormos [a], Danny Marks [a], Frederick B. Pierson [a], C. Jason Williams [a], Stuart P. Hardegree [a], Scott Havens [a], Andrew Hedrick [a], Jonathan D. Bates [b], Tony J. Svejcar [b]

"…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..."

CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

Credit: Marcus Yam/Los Angeles Times.
https://www.sandiegouniontribune.com/news/watchdog/story/2019-12-22/how-new-utility-law-shifts-13-5-billion-of-future-wildfire-damages-to-consumers

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

https://dw.maps.arcgis.com/apps/Cascade/index.html?appid=5fadefb8803d44a3b3ef128528e38eac

CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog

Credit: The Nature Conservancy
https://www.nature.org/en-us/newsroom/forest-restoration-in-the-upper-south-platte-watershed-colorado/

THANK YOU.

David Diaz

ddiaz@ecotrust.org

Ecotrust

School of Environmental and Forest Sciences

Center for Sustainable Forestry at Pack Forest

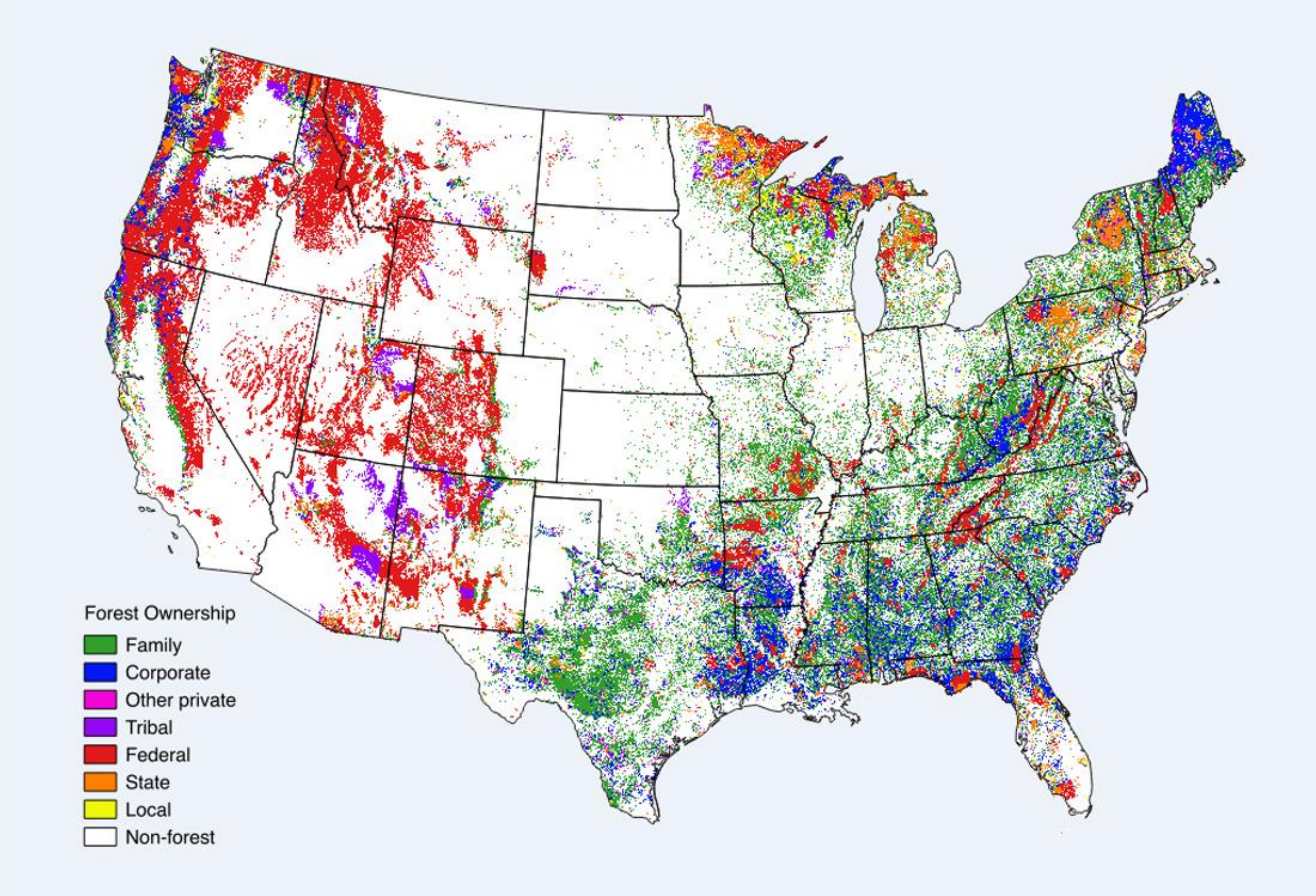
Carbon Leadership Forum

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

Webinar 1 and 2- Forests and Forest Products 101



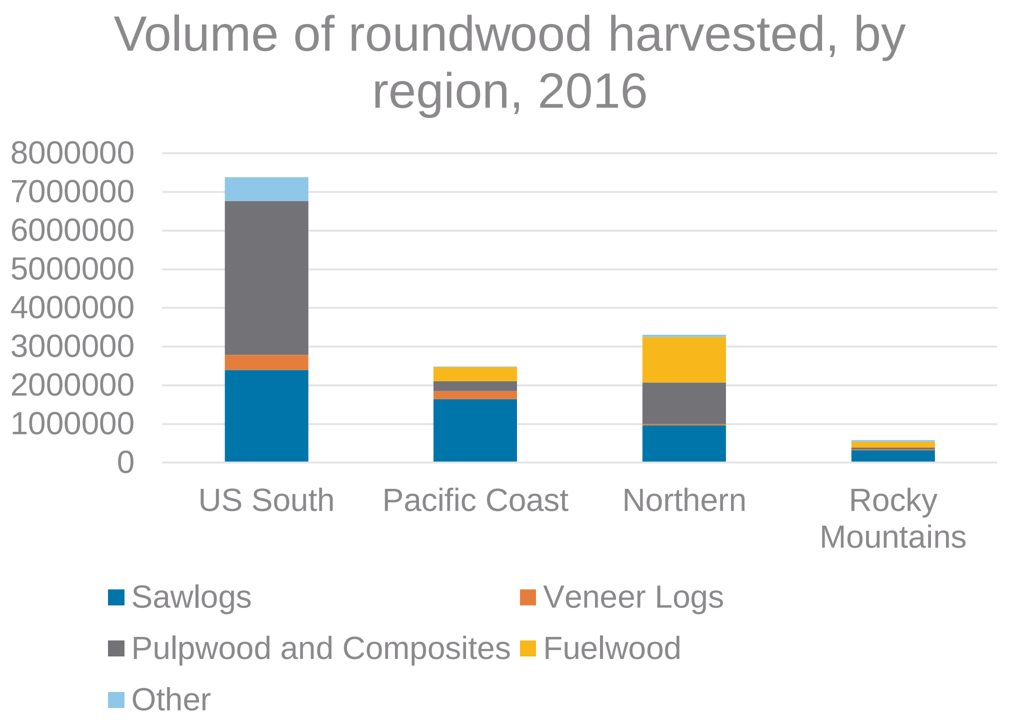
Lots of forests in US, owned by different landowner types. Ownership patterns different in different regions of the county

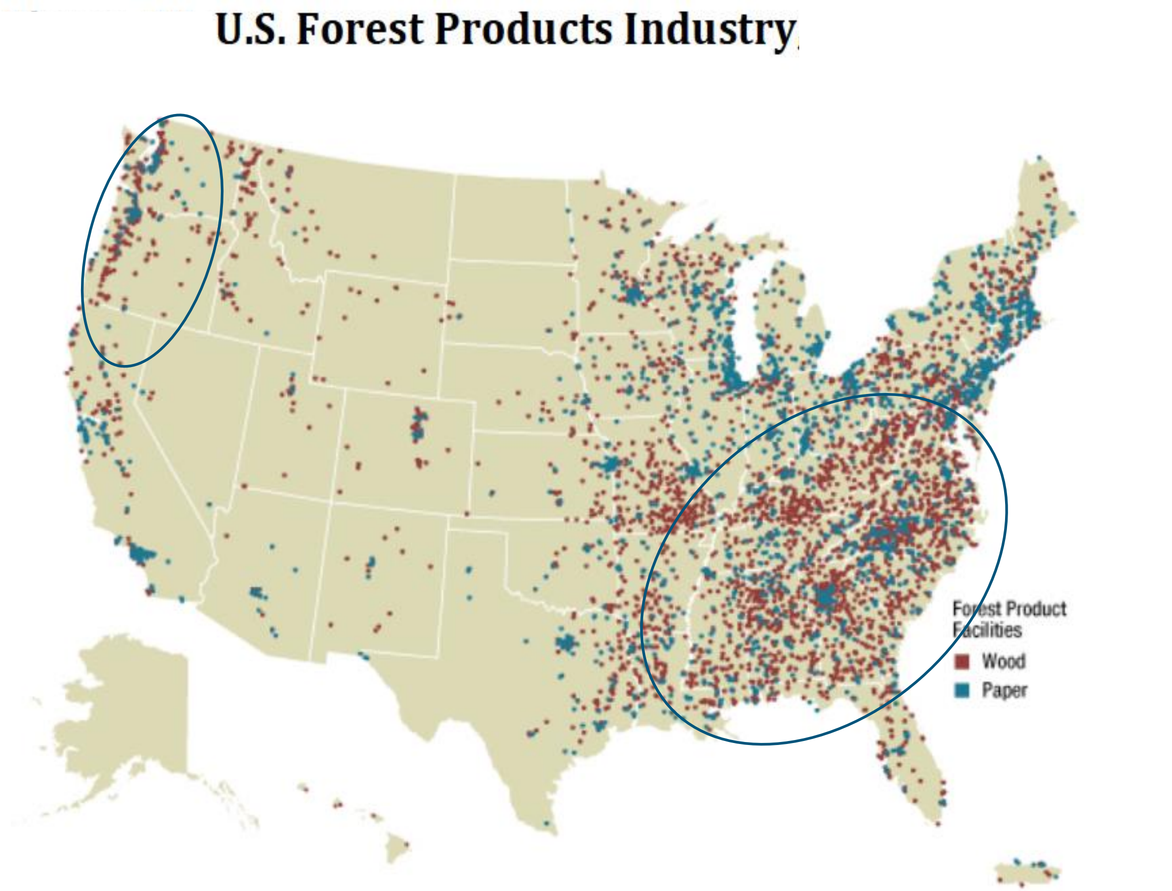
Total US= 765.5 million acres
Private non-corporate (family forests) = 287.7 million acres
Federal = 237 million acres
Private Corporate = 155.7 million acres
State= 70.5 million acres
County = 13.7 million acres

Source: **US Endowment for Forestry and Communities**, 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.

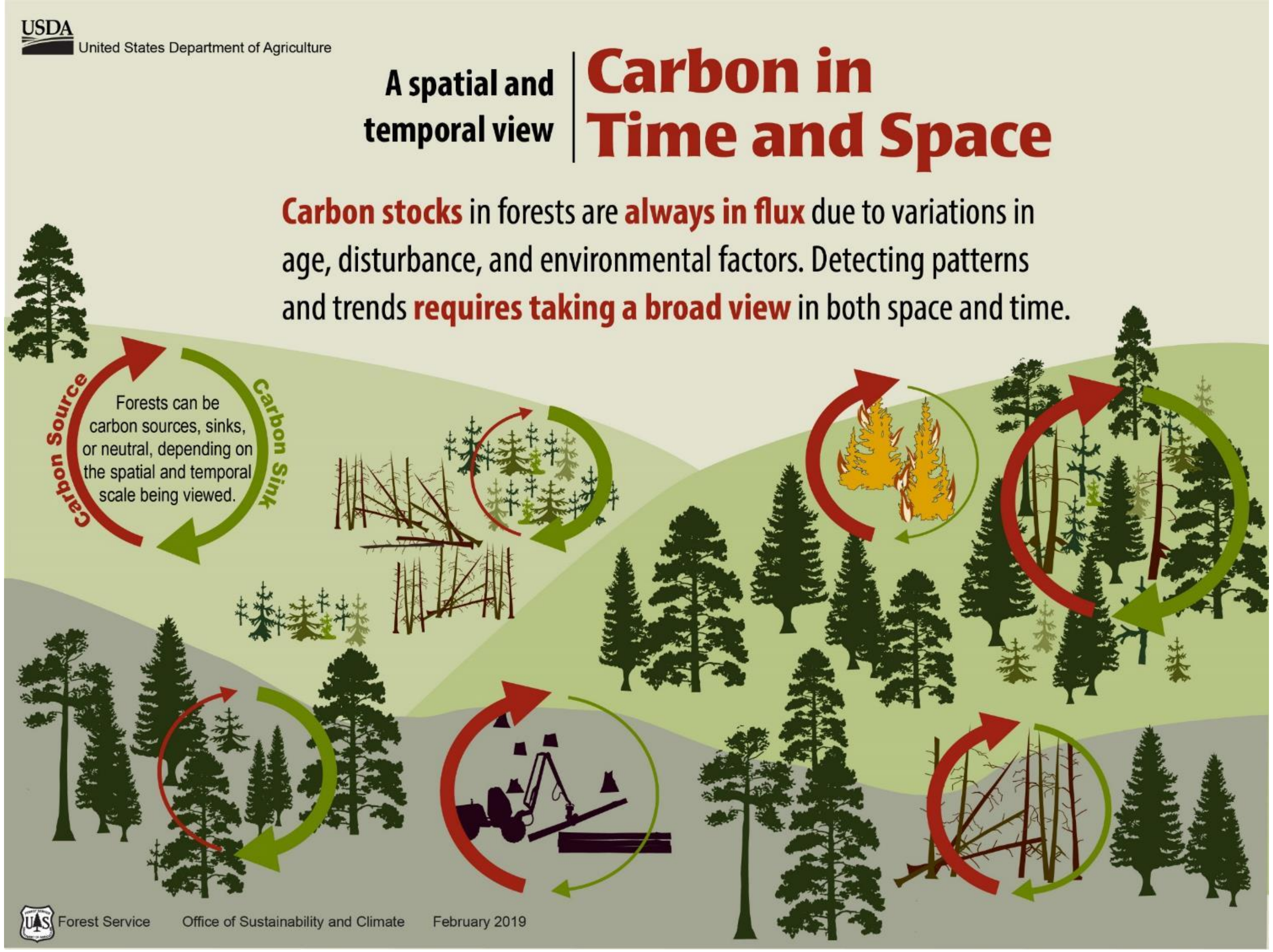




Source: U.S. Environmental Protection Agency (2011) (http://www.epa.gov/sectors/sectorinfo/sectorprofiles/forest/map.html)

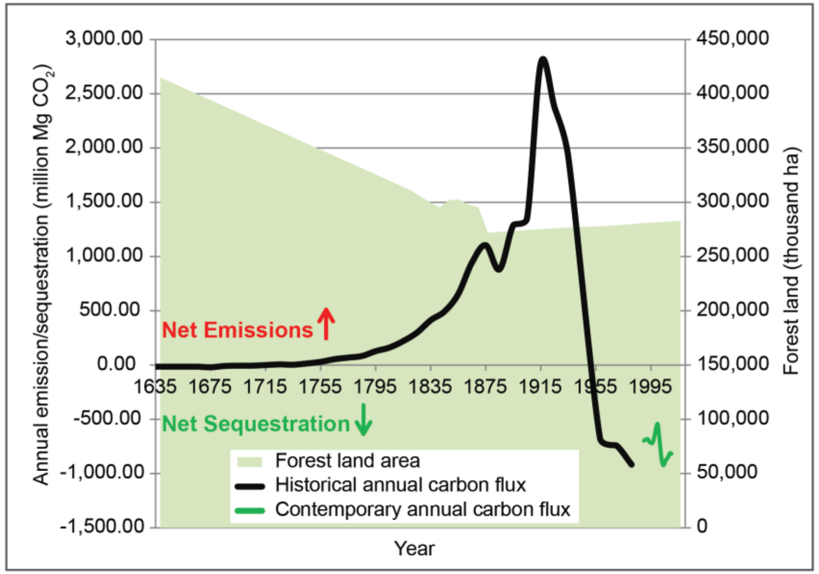
Data from Oswalt et al 2018, displayed in Alvarez 2018 State of America's Forests, https://usforests.maps.arcgis.com/apps/Cascade/index.html?appid=6d3076faddfb4b8c8b6933cfcf4963cb

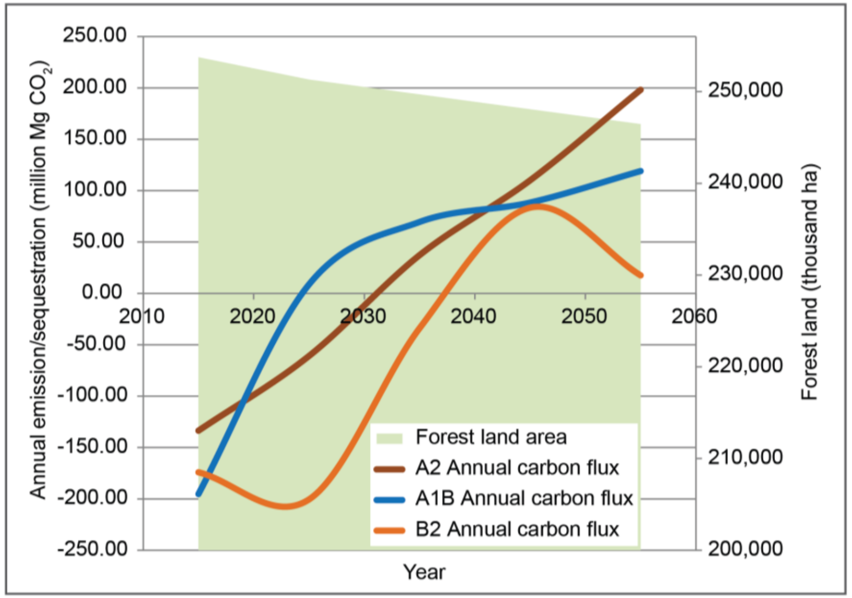
Webinar 1 and 2- Forests and Forest Products 101



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

From: USFS, 2012: Future of America's forest and rangelands: 2010 Resources Planning Act assessment. General Technical Report WO-87. 198 pp., U.S. Department of Agriculture, U.S. Forest Service, Washington, D.C. URL

Webinar 3 and 4- LCA and Wood

Lots of Terms!!!
Carbon Neutrality
Attributional LCA
Consequential LCA

- 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

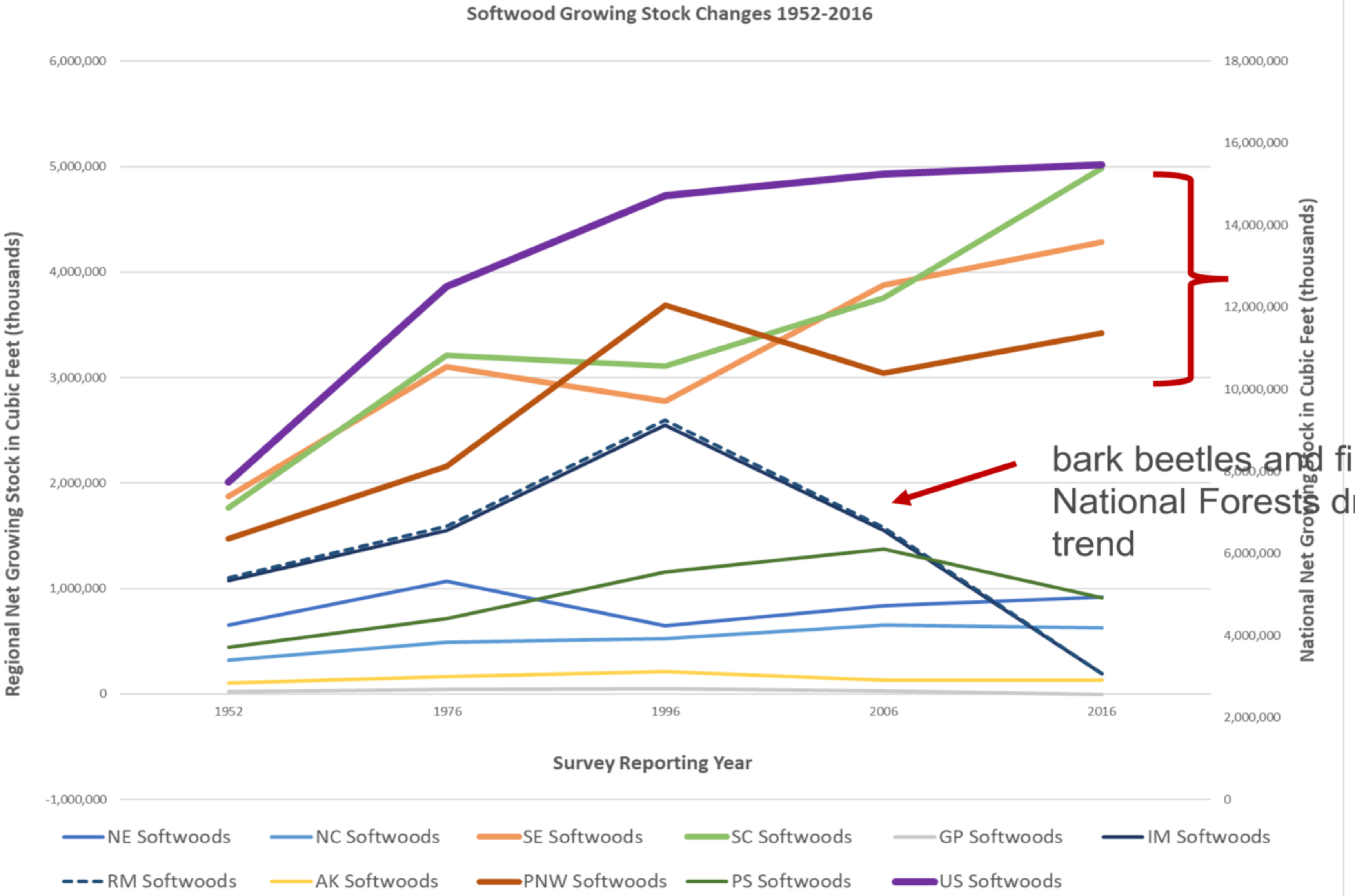
“Sustainably Managed Forests” for Biogenic C ISO 21930: Section 7.2.11

- 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

Carbon Leadership Forum

Wood Carbon Seminars, James Salazar 10

Webinar 3 and 4- LCA and Wood



Major wood producing regions

bark beetles and fire – mostly National Forests driving the trend

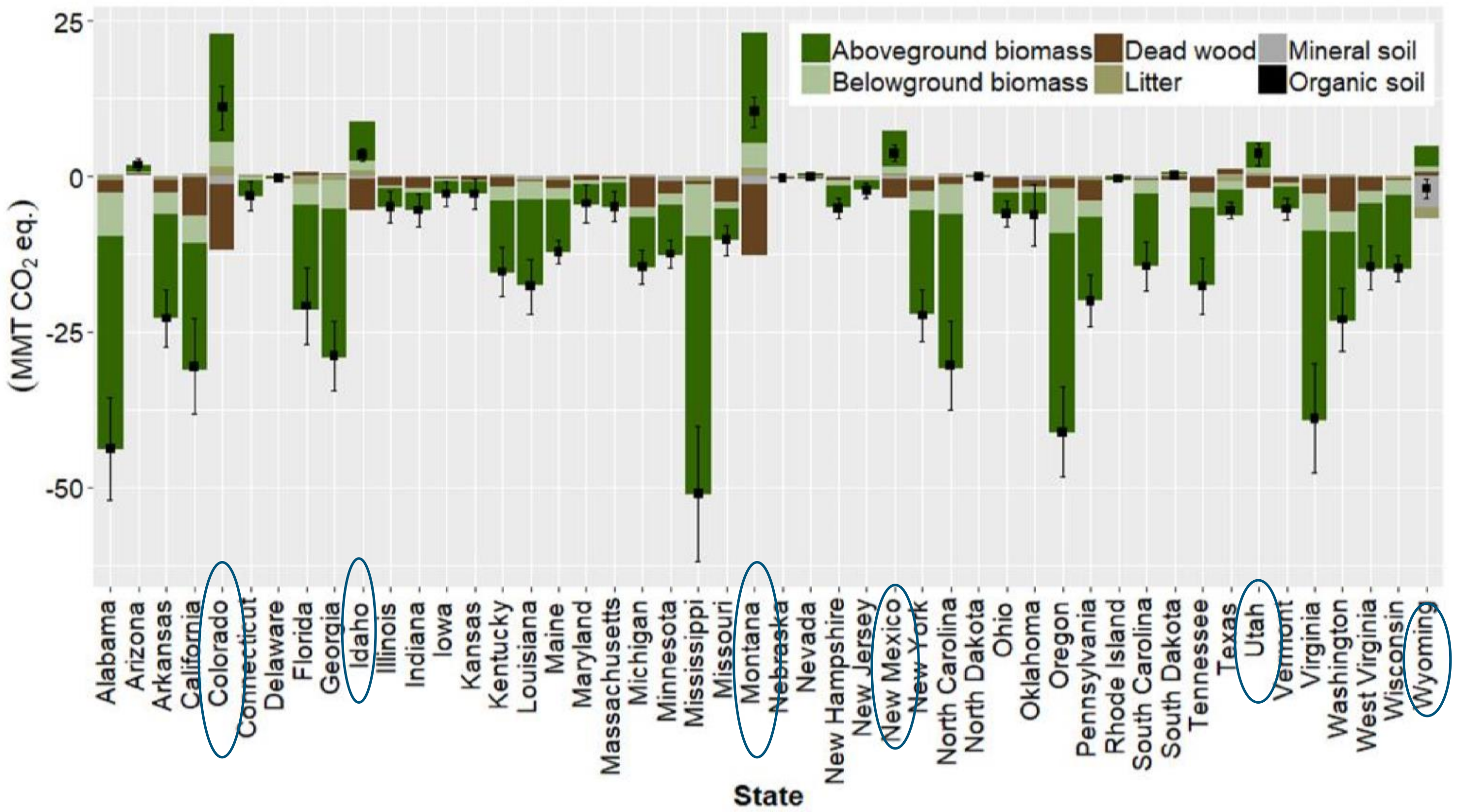
Webinar 5 and 6: Carbon and Sustainability Tracking

Annual Flux MMT CO2e

Emissions and Removals Category[a]	1990	1995	2000	2005	2010	2016	2017	2018
Forest land remaining forest land[b]	(610.1)	(598.7)	(572.1)	(572.6)	(556.2)	(565.5)	(552.0)	(564.5)
Non-CO_2 emissions from fire	1.5	0.6	2.9	8.2	4.6	5.6	18.8	18.8
N_2O emissions from forest soils	0.1	0.3	0.5	0.5	0.5	0.5	0.5	0.5
Non-CO_2 emissions from drained organic soils	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Forest land converted to non-forest land[b]	119.1	120.8	122.5	124.4	126.0	127.4	127.4	127.4
Non-forest land converted to forest land[b]	(109.4)	(109.7)	(109.9)	(110.2)	(110.4)	(110.6)	(110.6)	(110.6)
Harvested wood products	(123.8)	(112.2)	(93.4)	(106.0)	(69.1)	(92.4)	(95.7)	(98.8)
Woodlands remaining woodlands[c]	5.0	4.9	4.8	4.6	4.4	4.1	4.0	4.0
Urban trees in settlements[d]	(96.4)	(103.3)	(110.4)	(117.4)	(124.6)	(129.8)	(129.8)	(129.8)
Total Emissions and Removals	**(813.9)**	**(797.2)**	**(755.0)**	**(768.4)**	**(724.7)**	**(760.6)**	**(737.3)**	**(752.9)**

Total stocks	**53,423**	**54,419**	**55,380**	**56,239**	**57,124**	**58,362**	**58,539**	**58,720**

Emissions and removals, 2018

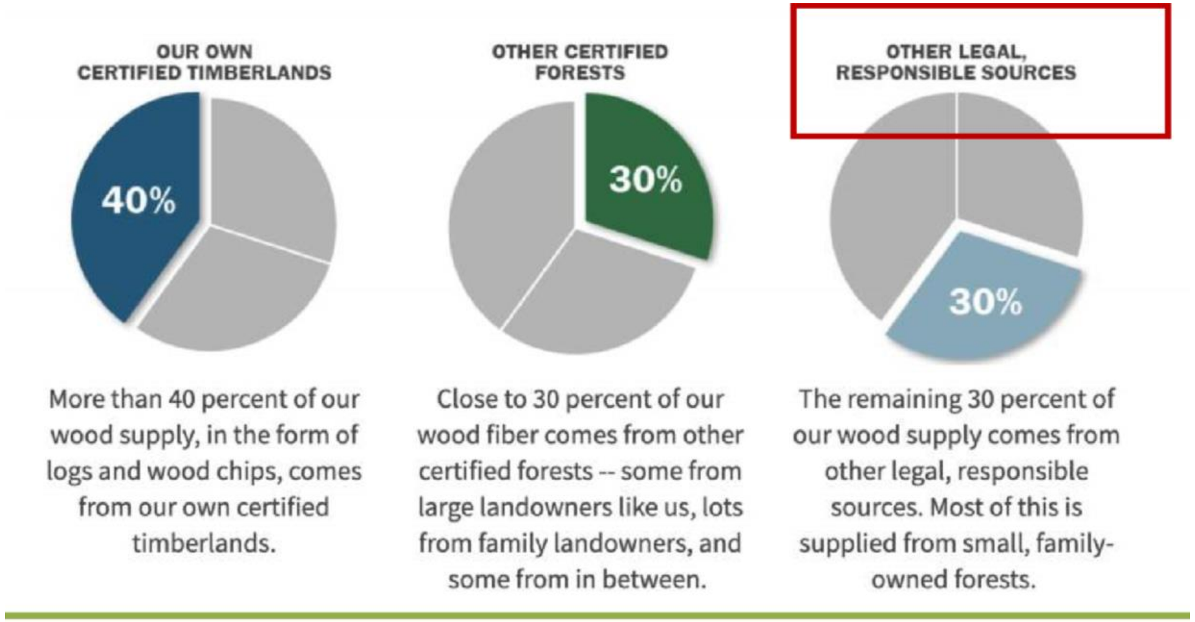


Domke, Grant M.; Walters, Brian F.; Nowak, David J.; Smith, James, E.; Ogle, Stephen M.; Coulston, J.W.; Wirth, T.C. 2020. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2018. Resource Update FS-227. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. https://doi.org/10.2737/FS-RU-227.

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

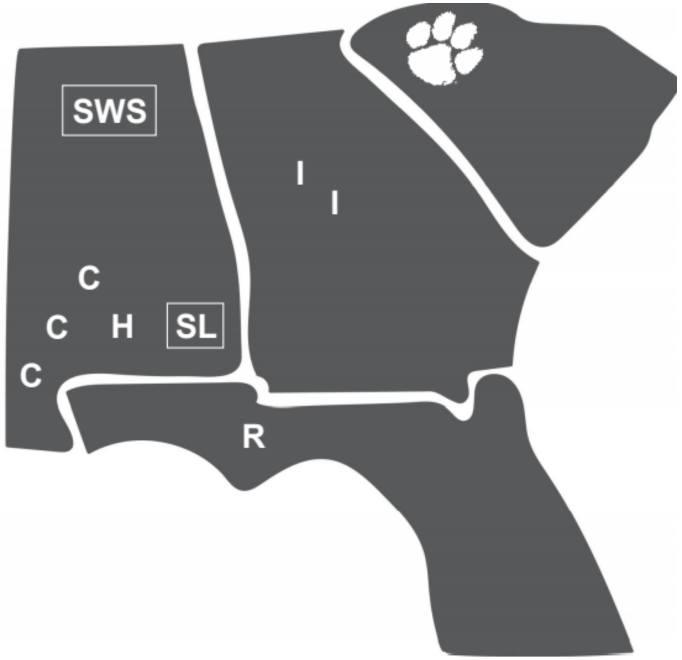
SmartLam (SL) - CLT

- C = Canfor (60%)
- R = Rex Lumber (20%)
- I = Interfor (15%)
- H = Harrigan Lumber (5%)

% = percentages of lumber used in CLT

Structural Wood Systems (SWS)

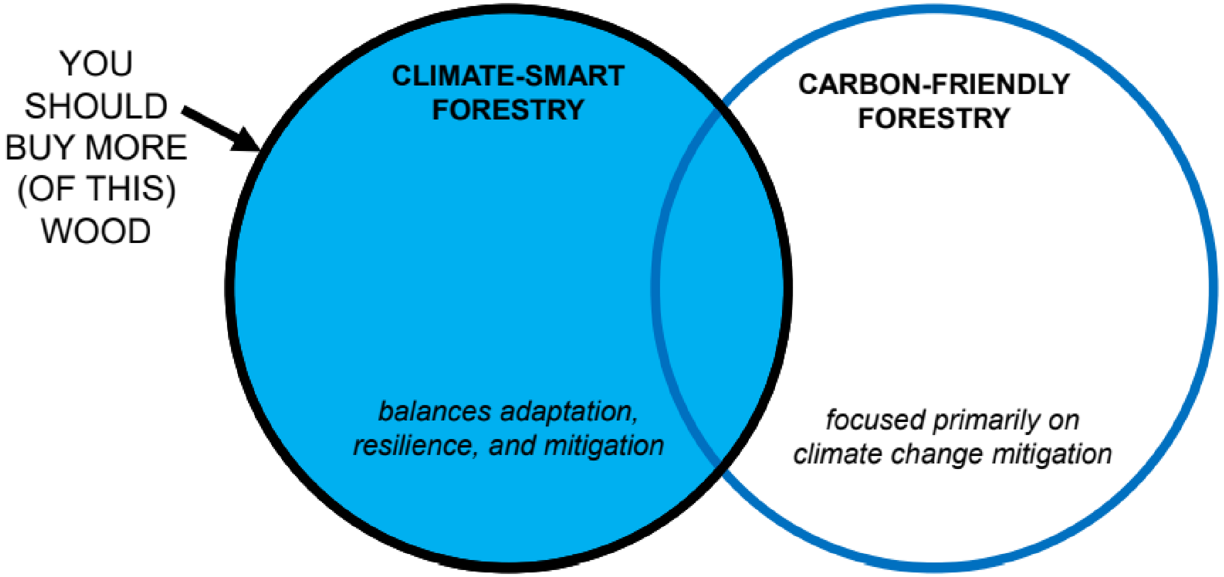
- All glulam lumber provided by Canfor in Fulton, AL



CLF Carbon Leadership Forum   Wood Carbon Seminars, Pat Layton

CARBON-FRIENDLY vs. CLIMATE-SMART

Carbon is the tail, not the dog



CLF Carbon Leadership Forum   Wood Carbon Seminars, David Diaz

Today and Beyond

Continuation of Discussion of this week

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