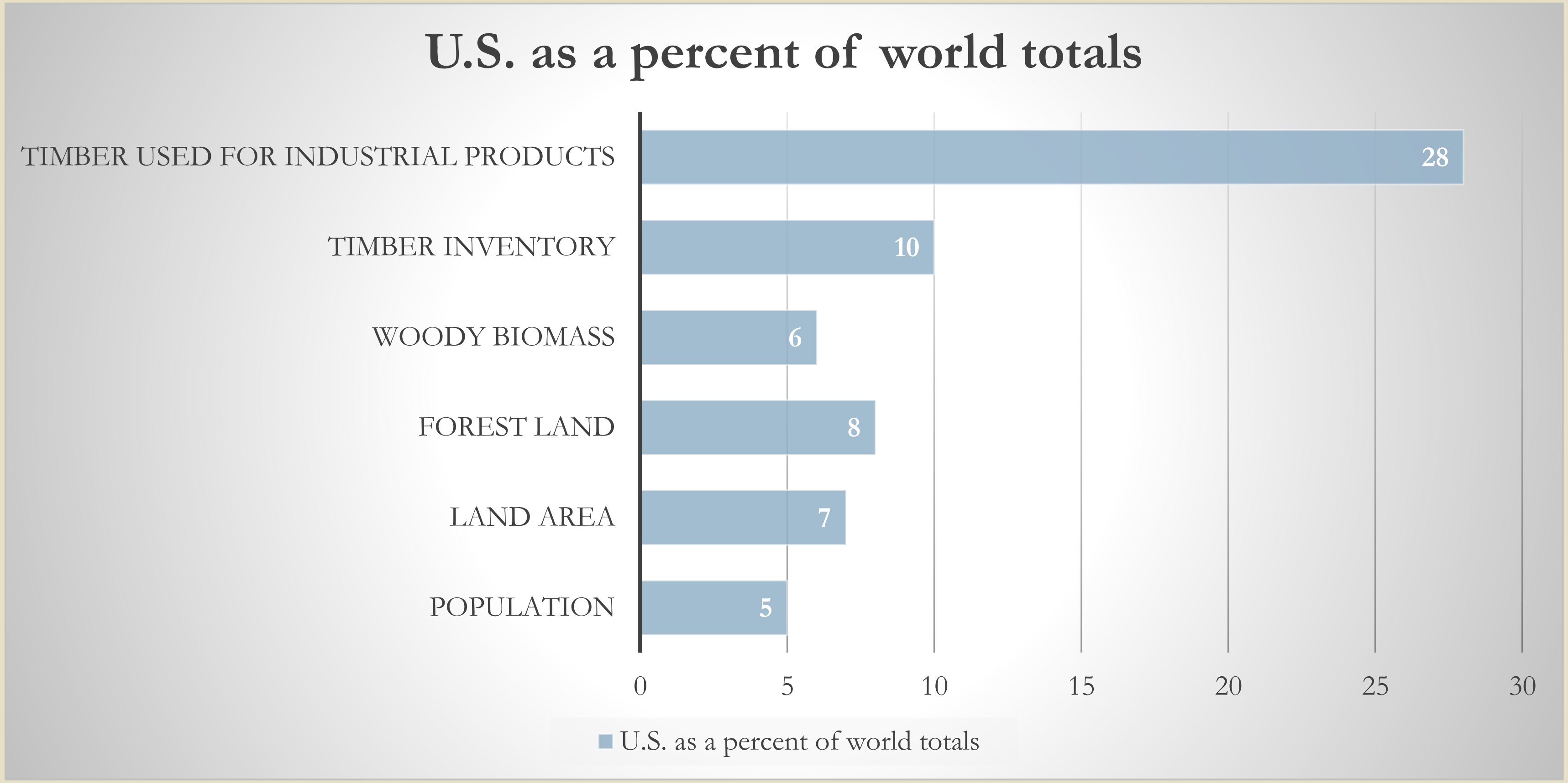
WASHINGTON STATE FOREST SECTOR AND THE CARBON CYCLE

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

Overview

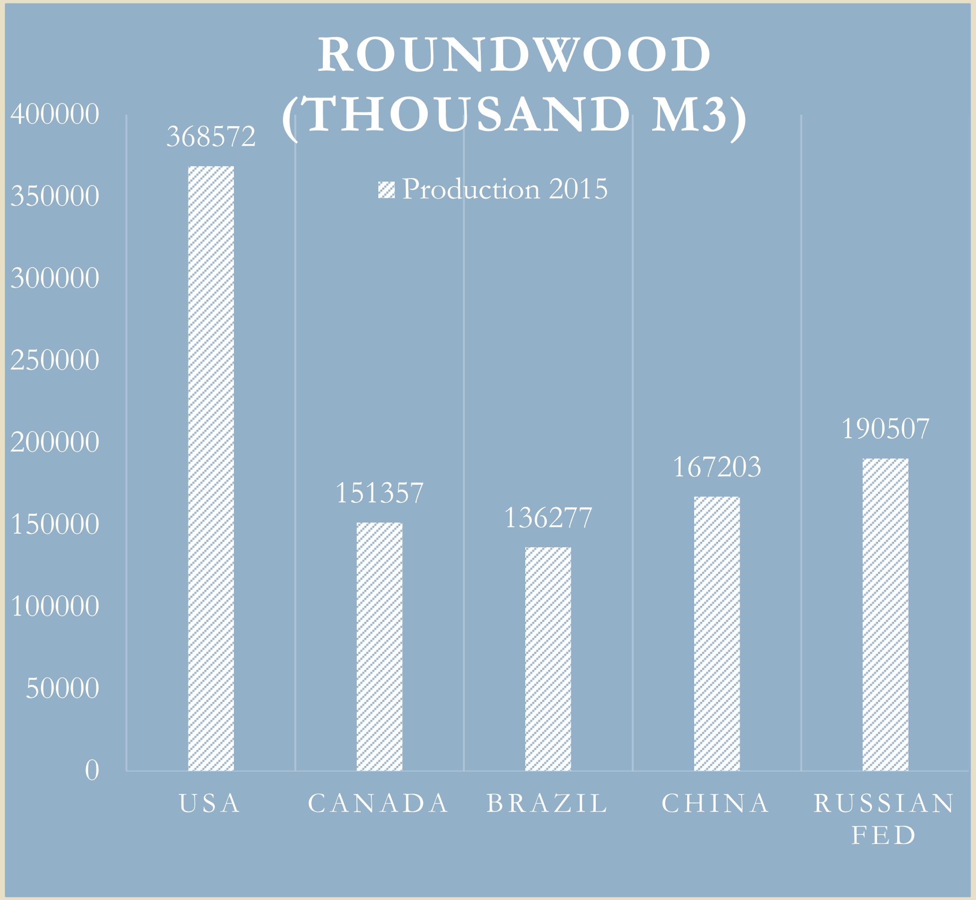
- Washington Forest Sector and its role in global production
- How does forest sector impact carbon cycle
  - In woods
  - Fossil fuel
- How can we measure
  - HWP accounting
  - Substitution
  - Overview of in forest trends
- Future trends

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

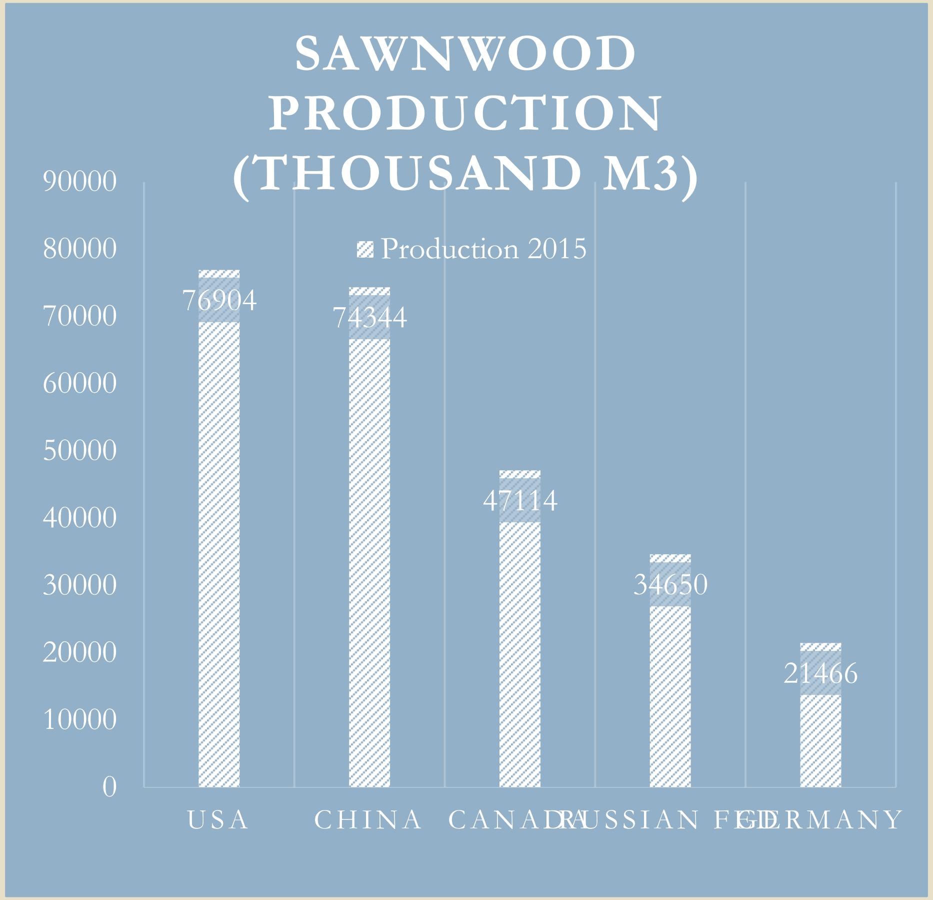


Source: USDA. 2014. Forest Resources Facts and Trends

U.S. Largest Producer Sawnwood and Industrial Roundwood



Source: FAO. 2015.



Washington: Global Producer and a Good Place to Grow Trees

Second largest producer of sawtimber in US

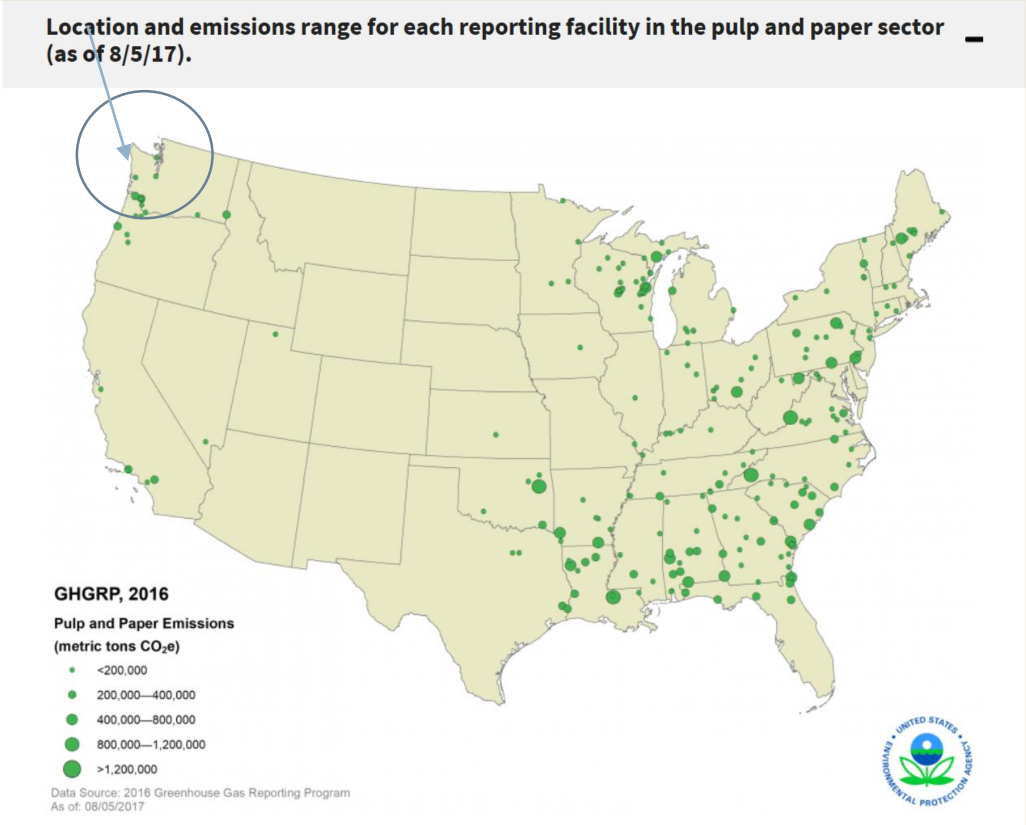
State	2015	% of US Total
Oregon	5,222	17%
Washington	3,745	12%
Georgia	2,454	8%

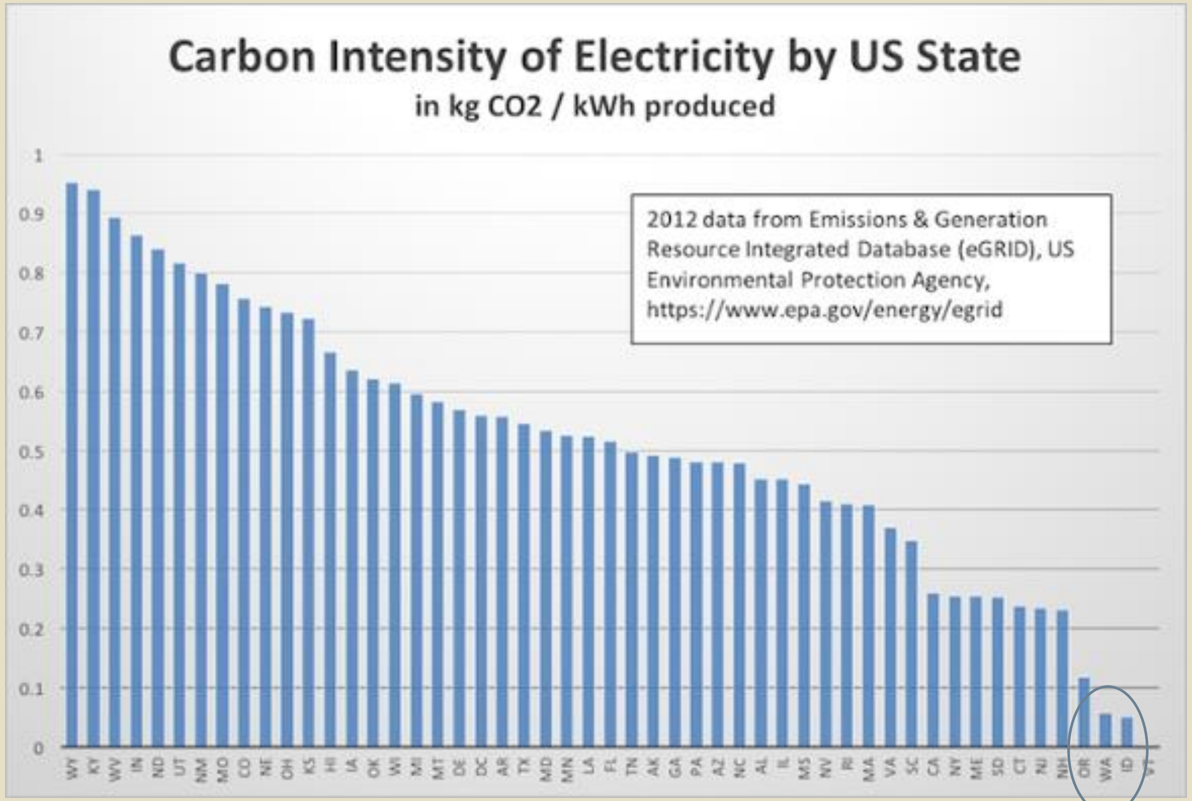
Has highest percentage of forestland in the highest site index of any state in the Continental US

Selected States	Total Forest Area (1000 acres)	Productivity Class >120' (1000 acres)	% Forest Area in Highest Productivity Class
Washington	22,174	8328	38%
Mississippi	19,380	6593	34%
Oregon	29,653	9266	31%
Louisiana	14,984	4664	31%

MMBF – Forest Economic Advisors 2014 (OFRI Forest Facts 2017-218)

Low Emissions Relative to Other Parts of the County





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

Washington State a Good Place to Manufacture Forest Products

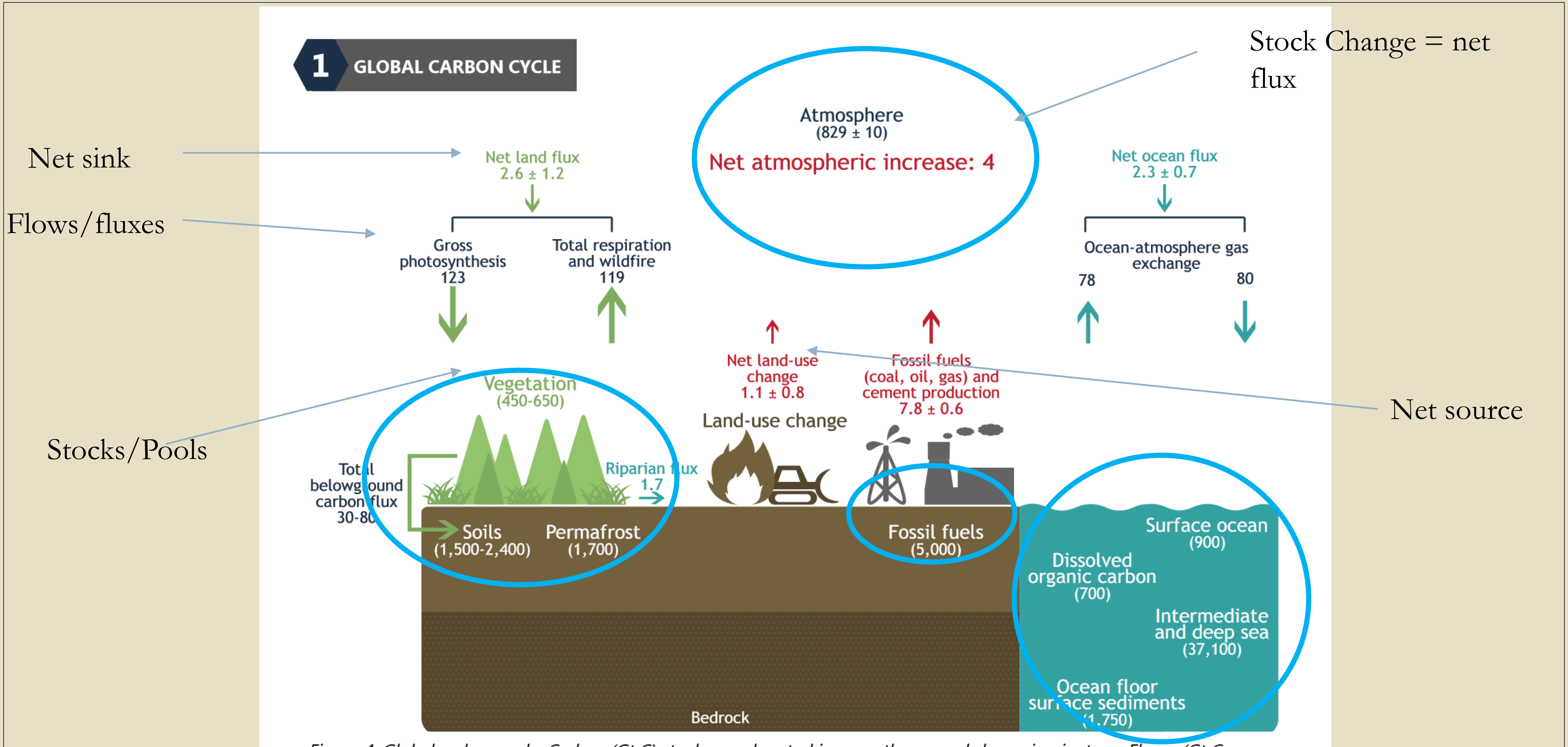
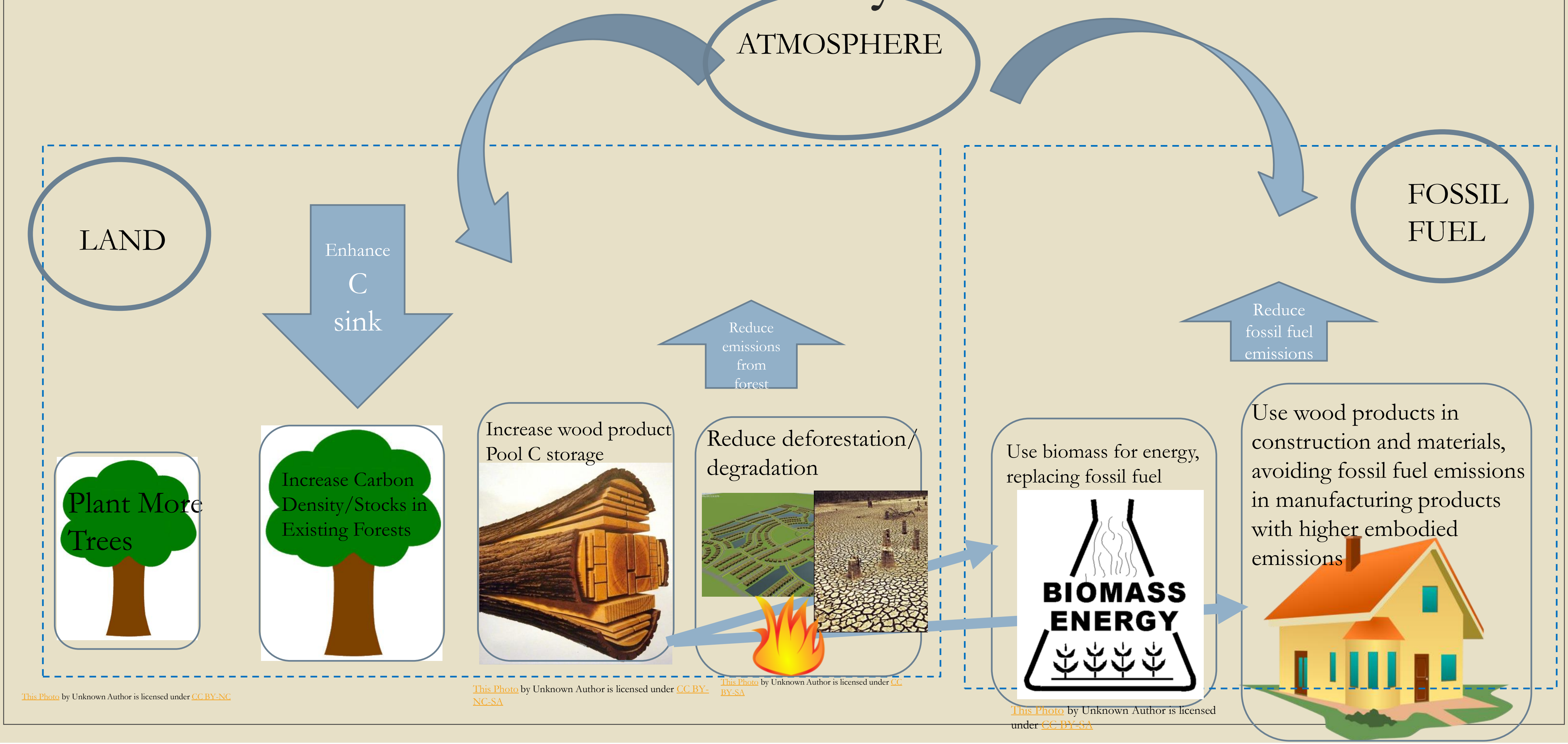


Figure 4. Global carbon cycle. Carbon (Gt C) stocks are denoted in parentheses and shown in gigatons. Fluxes (Gt C per year) are associated with arrows and shown in gigatons per year.

From: Janowiak, M., W. Connelly, K. Dante-Wood, M. Grant, C. Giardina, Z. Kayler, K. Marcinkowski, T. Ontl, C. Franco-Rodriguez, C. Swanston, C. Woodall, M. Buford. 2017. Considering Forest and Grassland Carbon in Land Management. USFS GTR WO-95.

Forest Sector Carbon Cycle



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

Harvested Wood Product Carbon Accounting

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

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

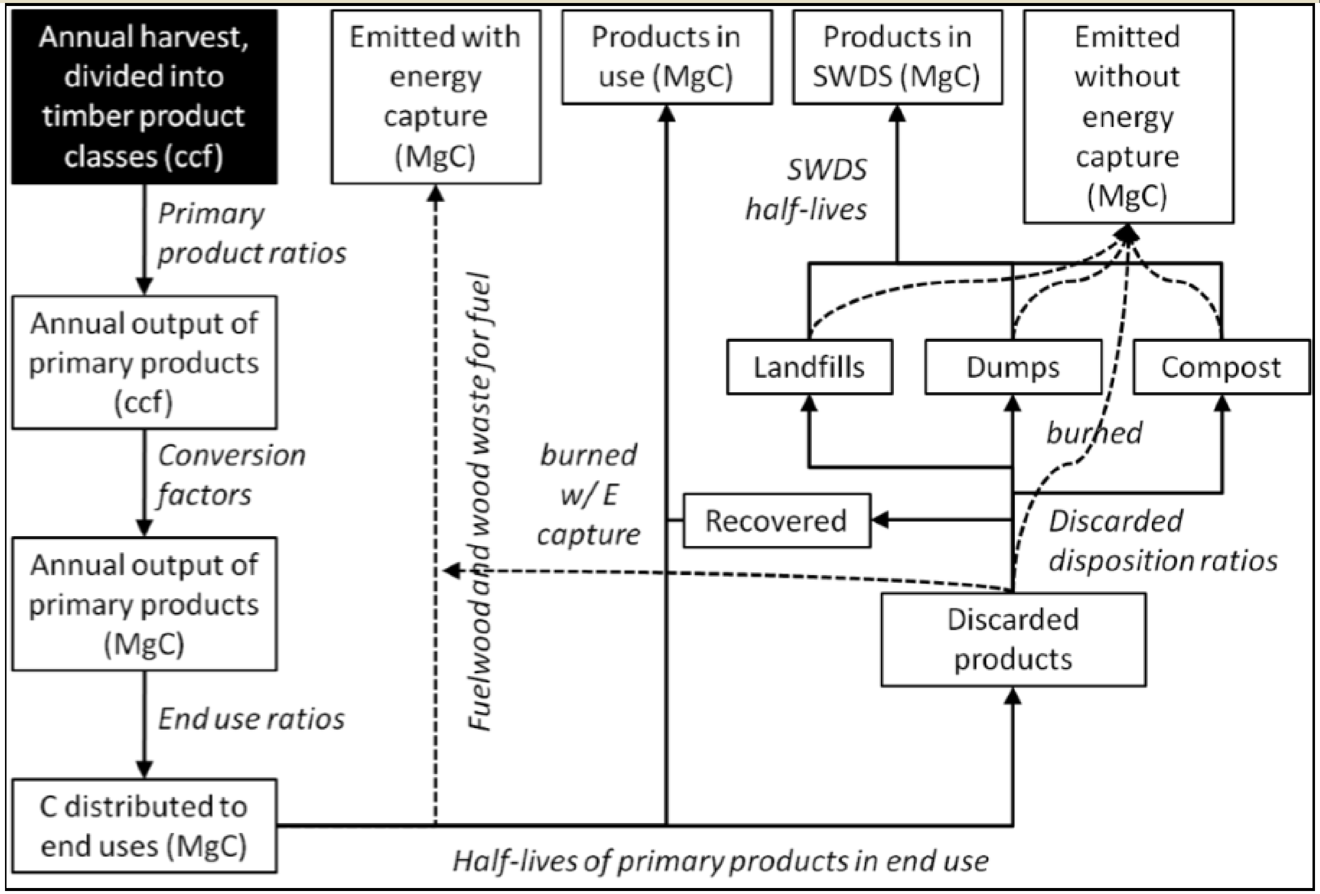


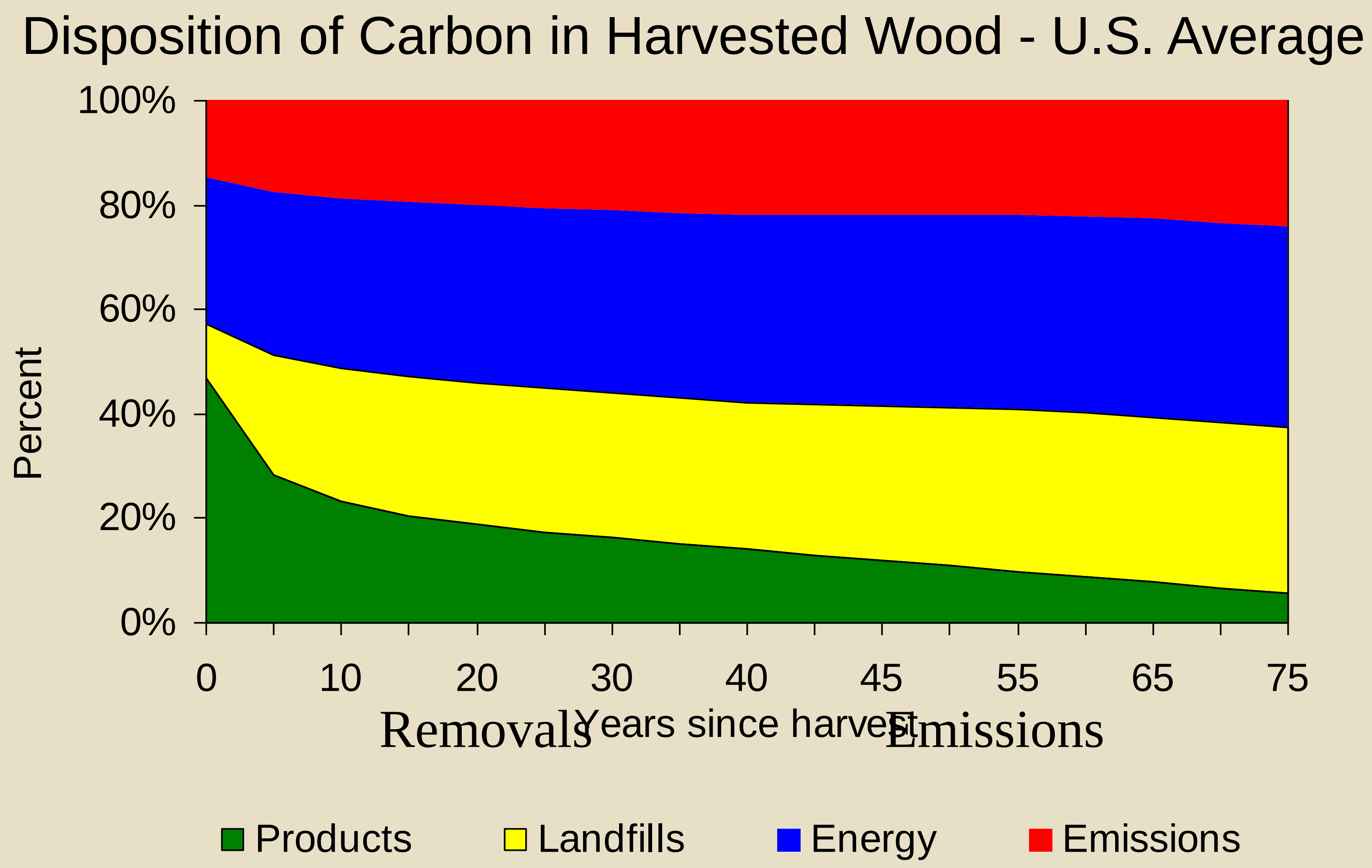
Figure 3. A schematic of calculations to quantify HWP storage and emissions. These calculations quantify HWP products in use, products in SWDS, emissions with energy capture, and emissions without energy capture using the IPCC/EPA approach.

USFS statistics- Distribution of Primary Products to Their End-Uses (From Smith et al 2006)

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

Harvested Wood Products: Methodology

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



Two Ways to Report HWP Carbon

EPA/IPCC Country Level Reporting

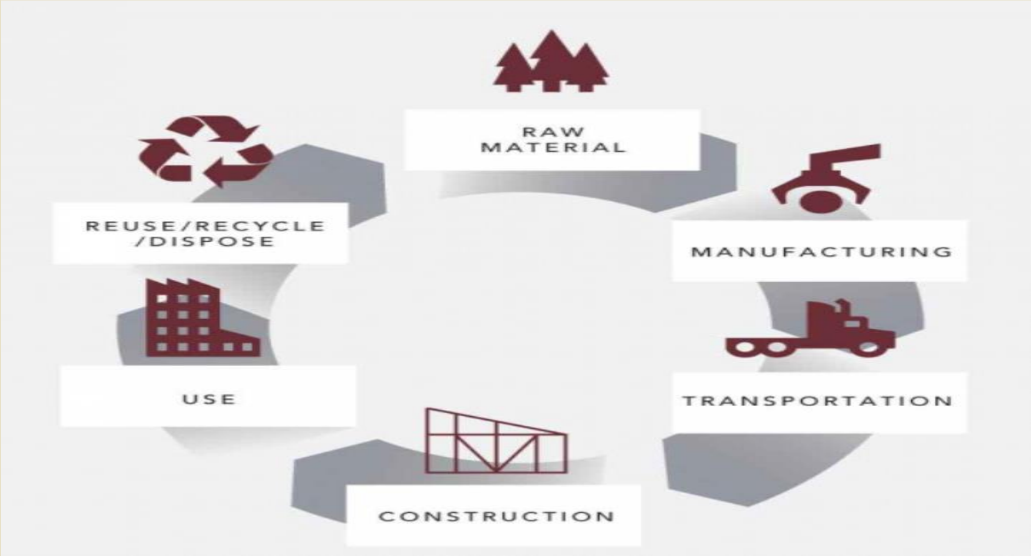
	Amount Placed in use	Remaining in use					
		1900	1901	1902		2001	2002
1900	10.2	9.2	9.1	9.0	…	3.5	3.4
1901	10.7		9.6	9.5	…	3.7	3.6
1902	11.2			10.1	…	3.9	3.8
x					…	x	x
x					…	x	x
2001	26.7				…	24.4	24.2
2002	27.3				…		24.7
Total		9.2	18.8	28.7	…	896.1	913.4
Change in carbon							17.3

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

100 Year Average

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

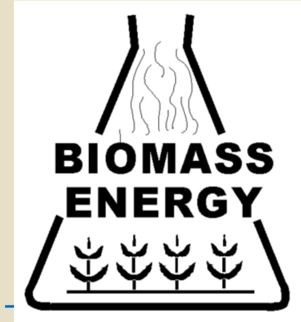
Avoided Emissions- Comparing the embodied emissions associated with manufacturing a wood product versus an alternative product that provides <u>same function</u>



FOSSIL FUEL

Reduce fossil fuel emissions

Use biomass for energy, replacing fossil fuel



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

Avoided Emissions- Substitution

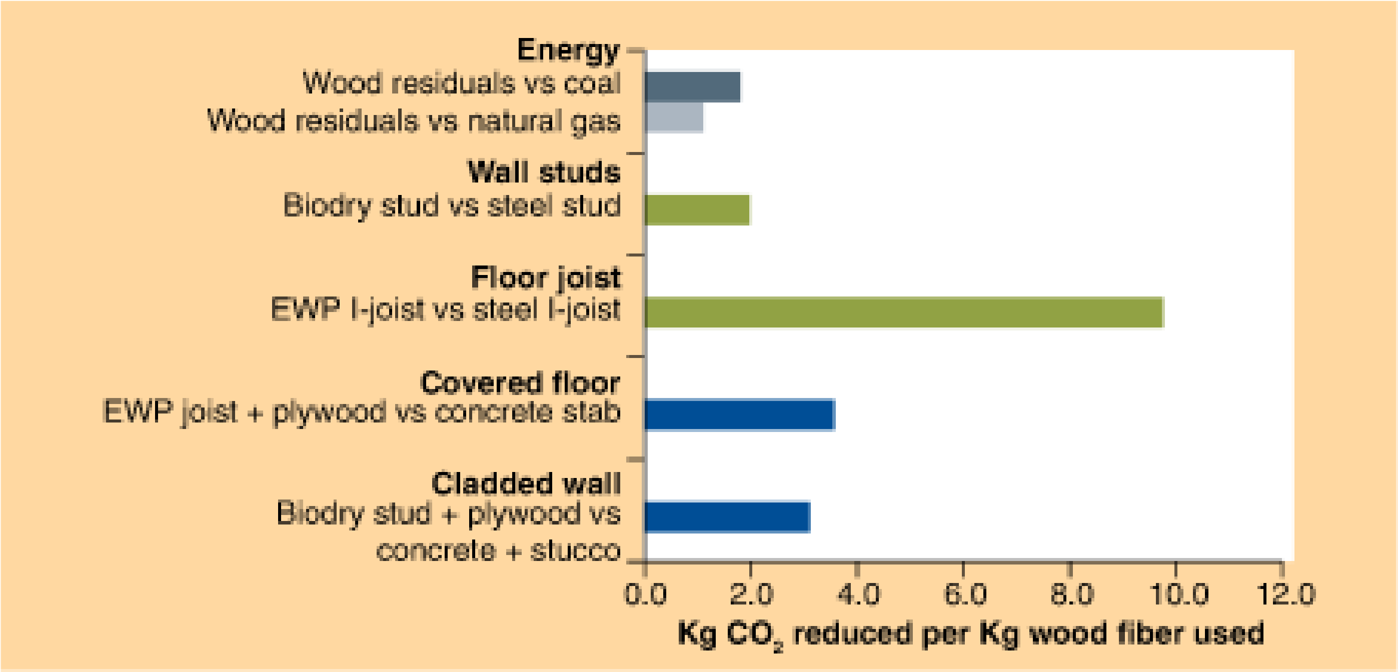


Figure 5. Carbon emission reduction by displacing non-wood products.
EWP: Engineered wood product.
Reproduced with permission to publish from CORRIM [107].

- Average **1 ton** of wood avoids the addition of **2.1 tons of carbon** (or 7.7 tons of CO2) to the atmosphere
- **The use of wood-based materials avoid emissions of 483 million tons CO2e annually, via substitution effects.** (FAO, 2016)
- **In Sweden, on average about 470 Kg carbon dioxide emissions are avoided for each cubic meter of biomass harvested.** (Lundmark et al. 2014)
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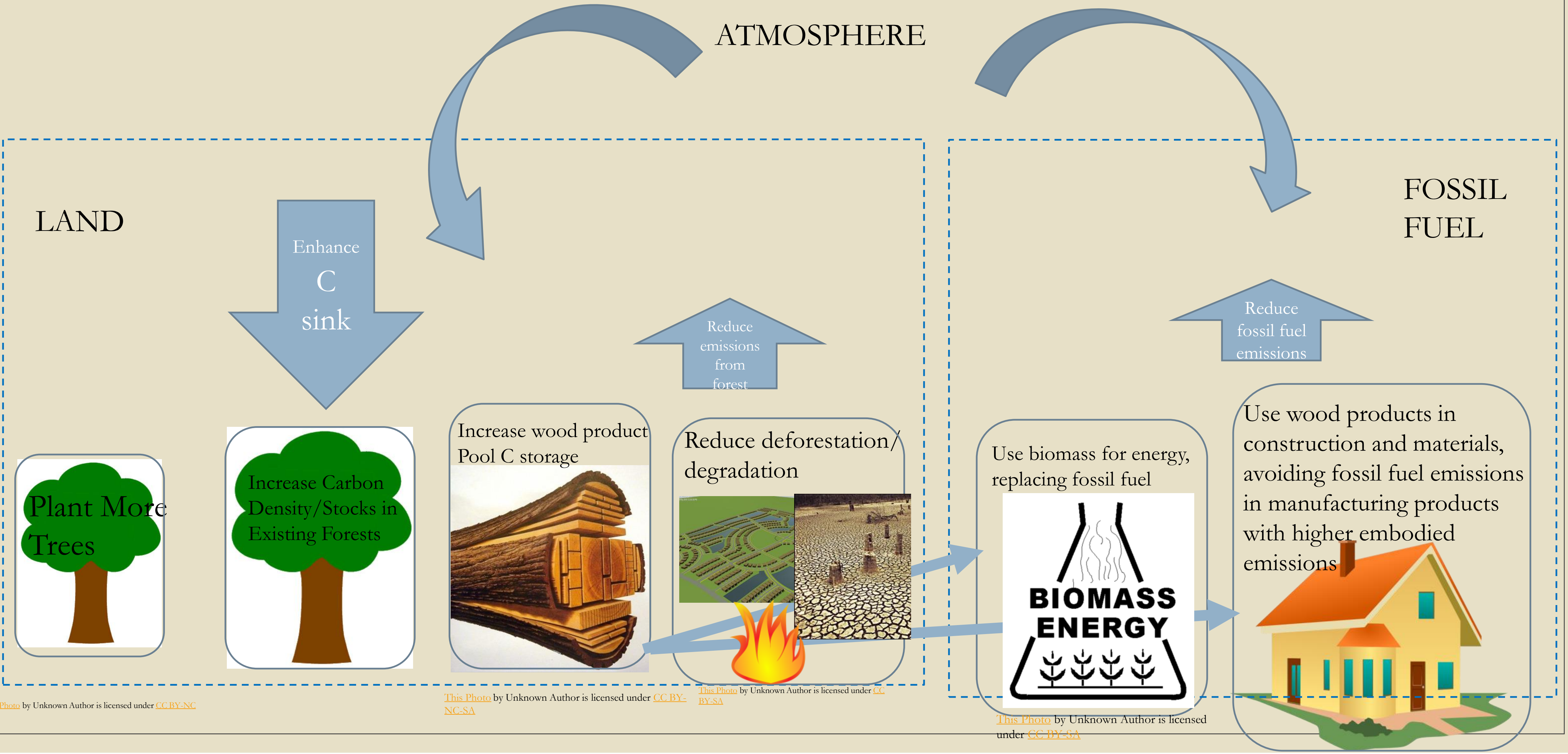
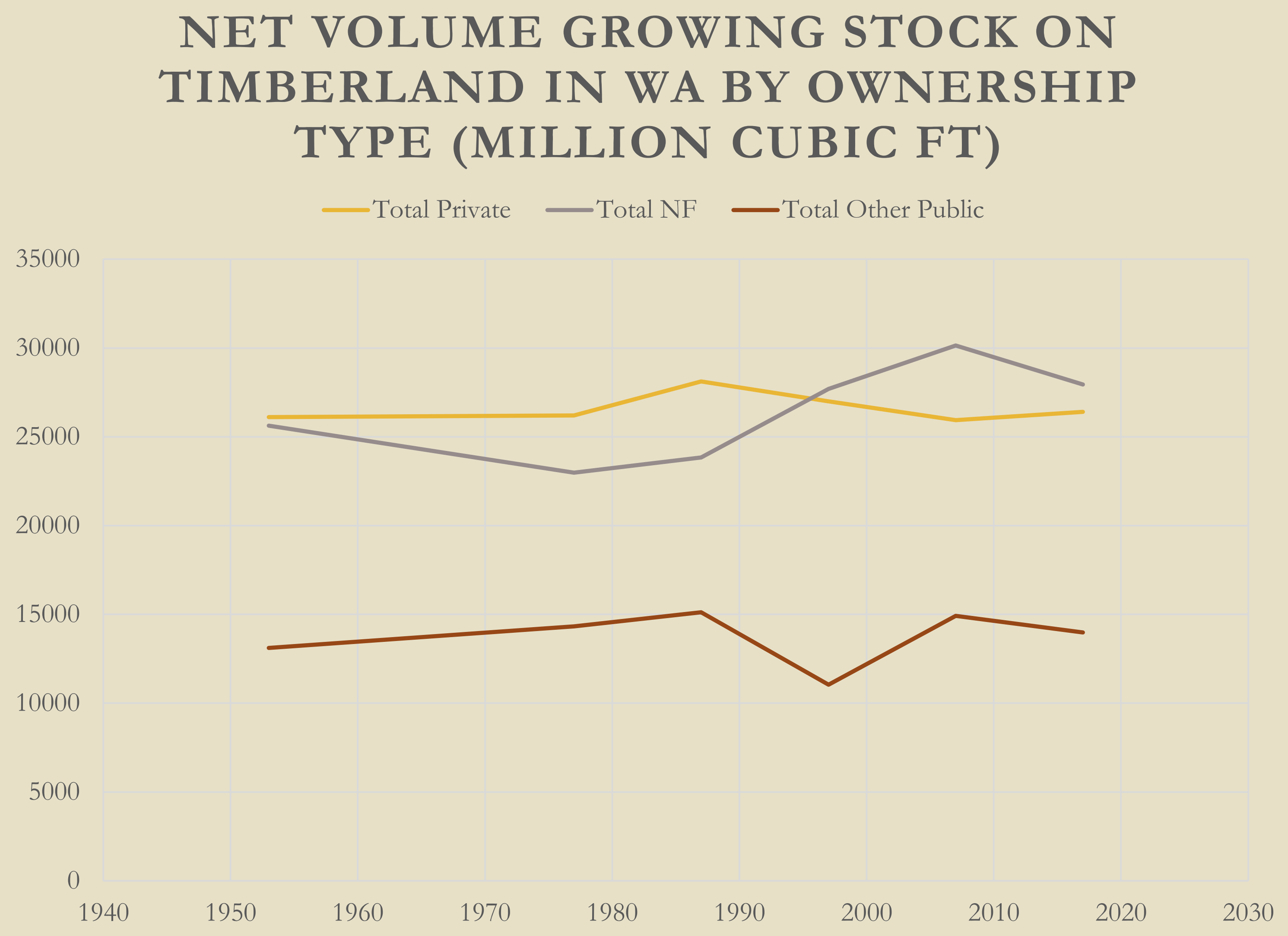
(Lippke et al 2011)

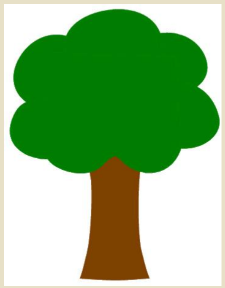
Washington State Forest Sector Carbon Cycle



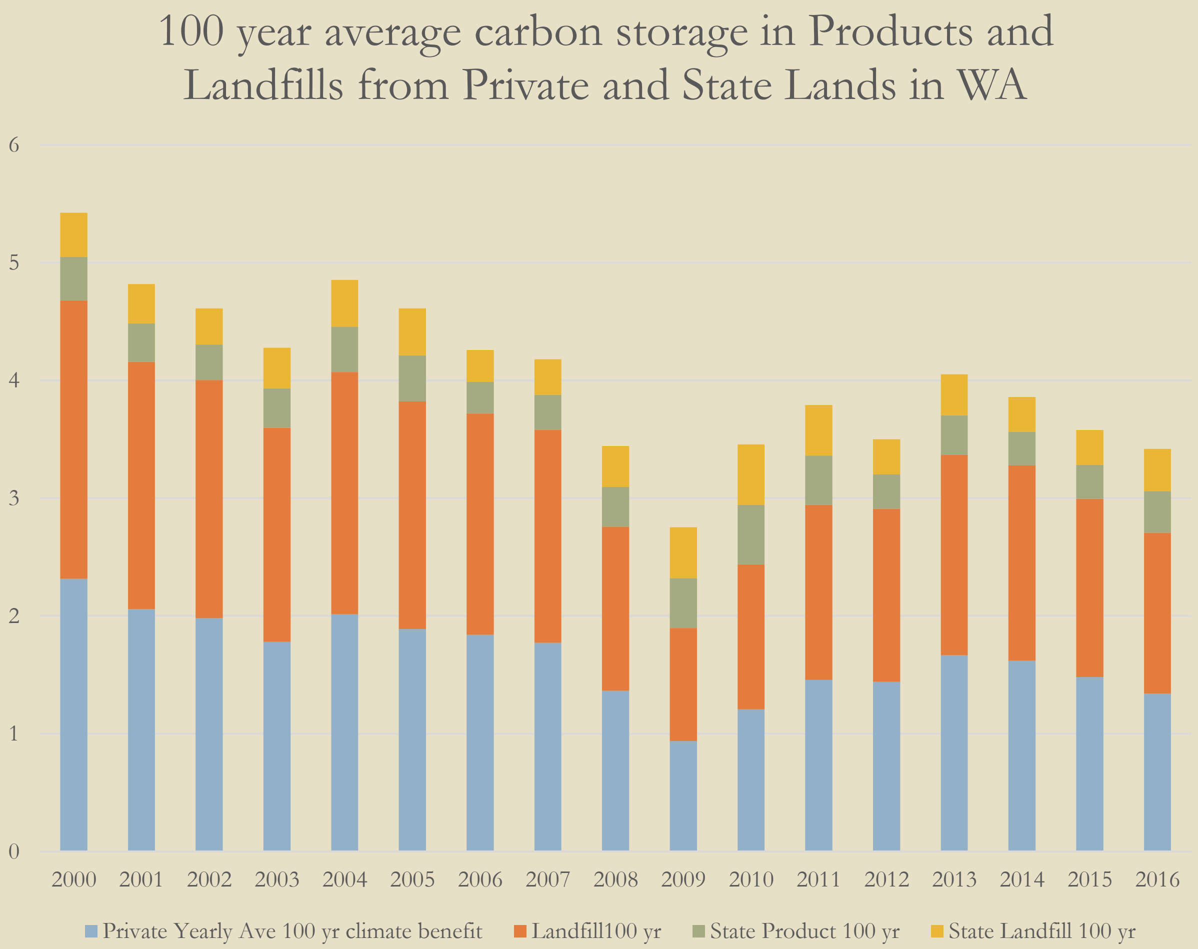
Adapted from FAO 2016. Forestry for a Low Carbon Future. Table 1- key forest mitigation options



National Forest Land Volume Has Increased since Low Point in 1977. Other public lands higher than 1950, after drop in mid-1990s. Private land has remained roughly the same.



Long-term C storage from Harvested Wood Products



Land-use Change in Washington State

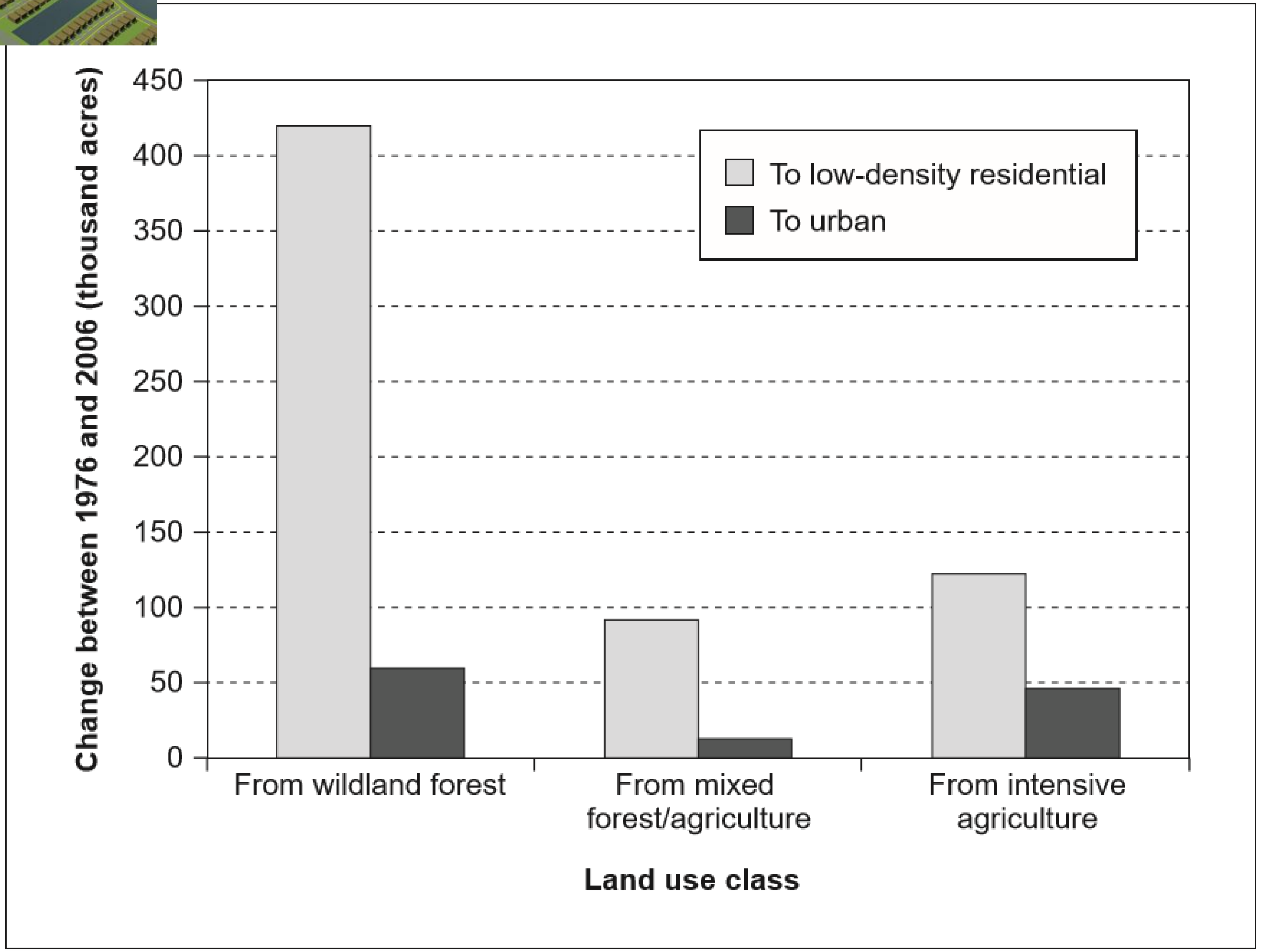
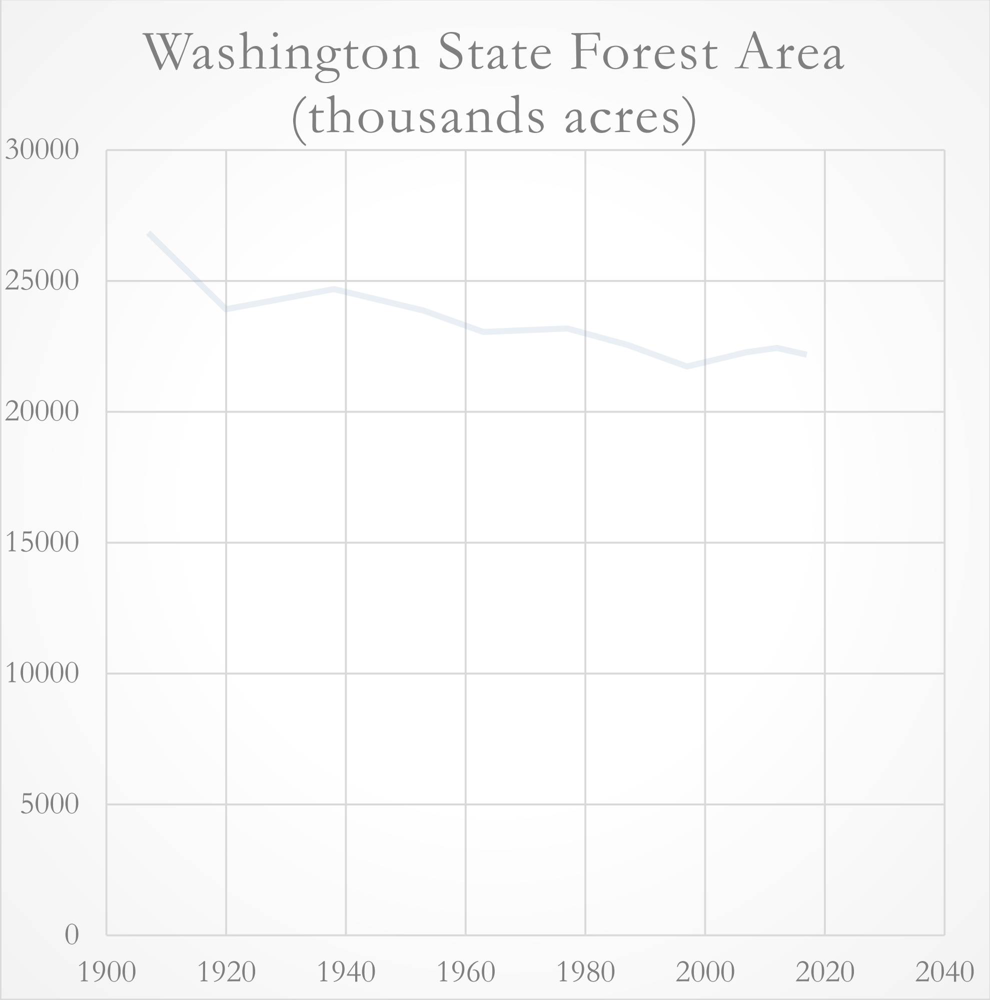


Figure 7—Western Washington net change in area from resource classes (forest land, mixed forest/agriculture, or intensive agriculture) to developed classes (low-density residential or urban) from 1976 to 2006.



RPA supplement 2018. Table 3

Gray, Andrew; David Azuma; Gary Lettman; Joel Thompson; and Neil McKay. 2013. Changes in Land Use and Housing on Resource Lands in Washington State, 1976-2006.

Carbon Implications of Land-Use Change

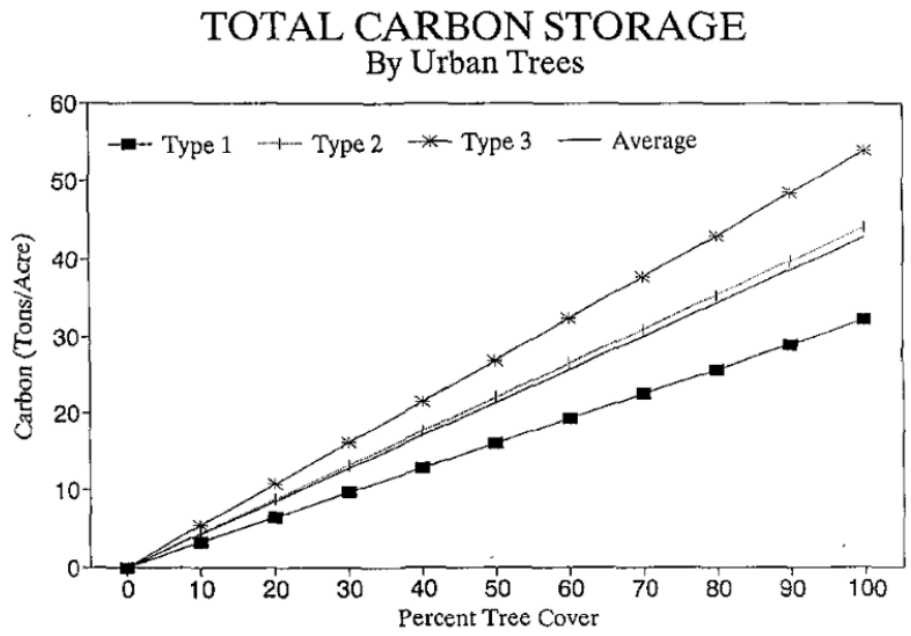


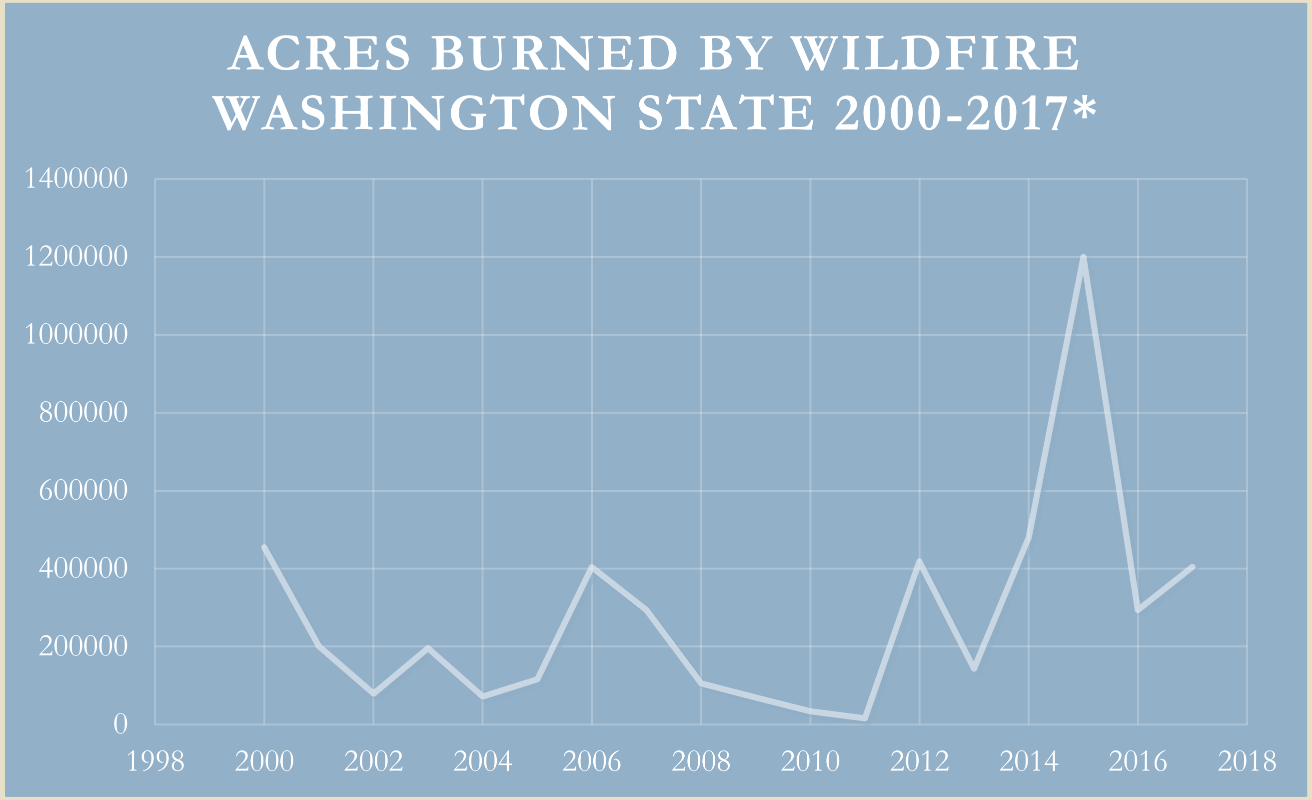
Figure 1. Estimates of tons of carbon stored per acre for urban forests of varying tree cover. Estimates are given for 4 different diameter distributions (Type 1-3 and Average - see Table 1).

	Acres Lost 1976-2006	Average Carbon Loss
Forest to Low Density	419,678	55.4[1] -25= 30.4
Forest to Urban	59,646	55.4-10=45.4
Forest to mixed forest/ag	6,935	55.4-40=15.4
Forest to intensive ag	1,761	55.4-3=52.4
Forest to other	5,074	55.4-30=25.4
Average		32 tC/acre

Acres lost 1997-2017	Total Carbon Lost	Carbon Lost/yr	CO2e/yr
447,000	14.3 million t C	715,883 C/yr	2.6 Mt CO2e/yr

[1] Average Carbon Storage for WA state Forestland = 55.4 C/acre. Washington's Forest Resources, 2002-2006; Five Year Forest Inventory and Analysis Report. ONW-GTR-800 April 2010. Table 23

Carbon Implications of Wildfires



*Years 2000-2015 from MTBS Project.
Years 2016-2017 from NIFC

* Wildfire estimates highly variable depending on methodology. FIA data may under-estimate because re-measurements are 10 years apart (so there is growth)

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

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

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

Carbon Implications of Forest Product Demand

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

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

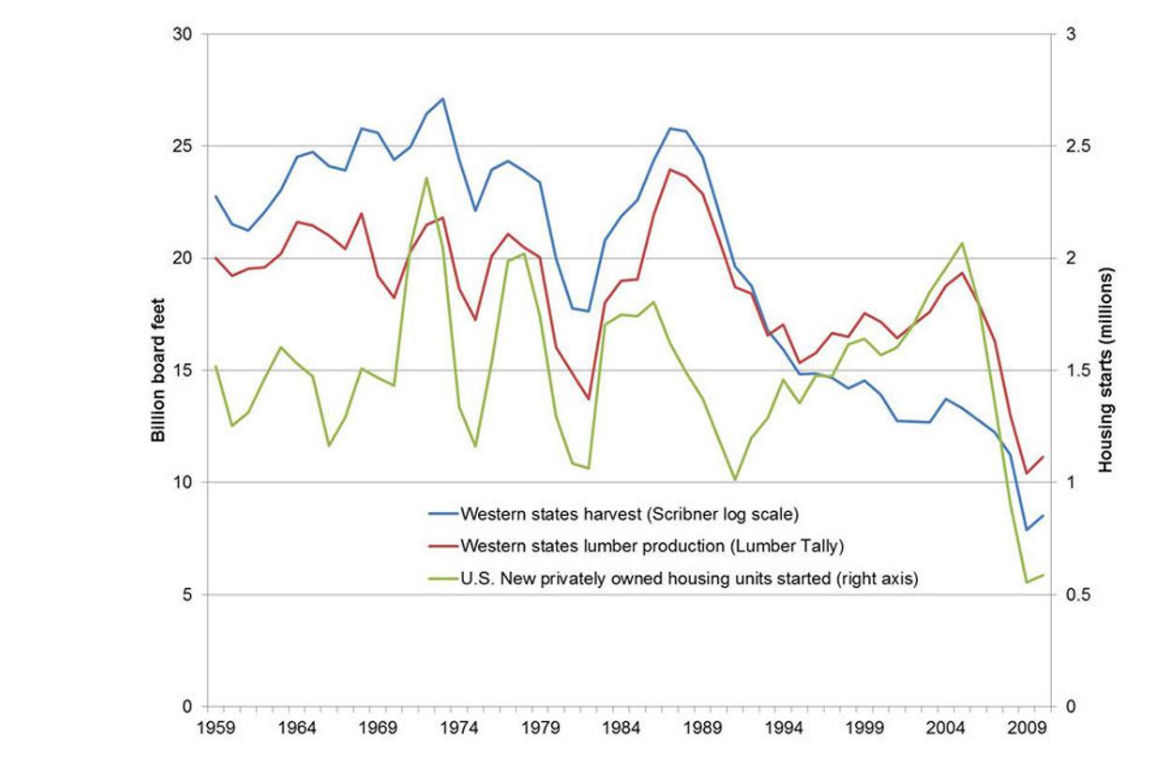
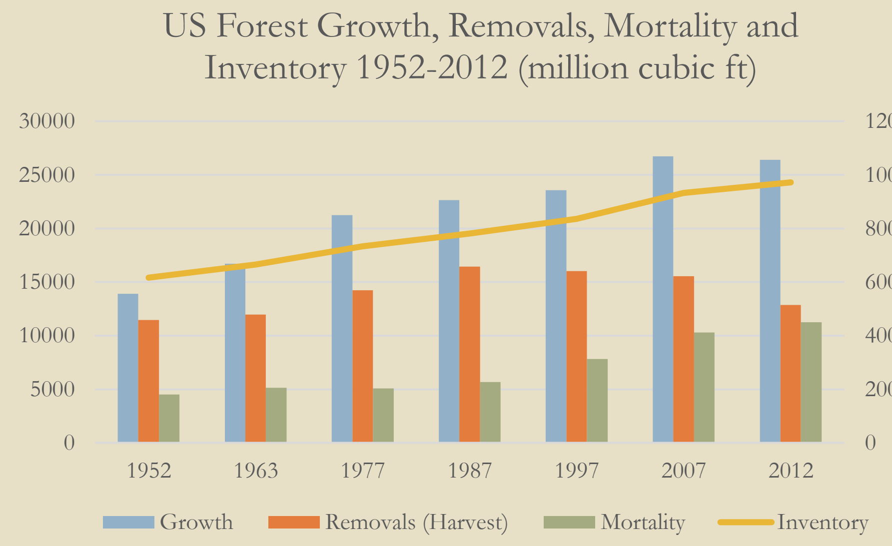


Figure 2.—New U.S. home construction and western states timber harvest and lumber production, 1959-2010.

Keegan et al 2012

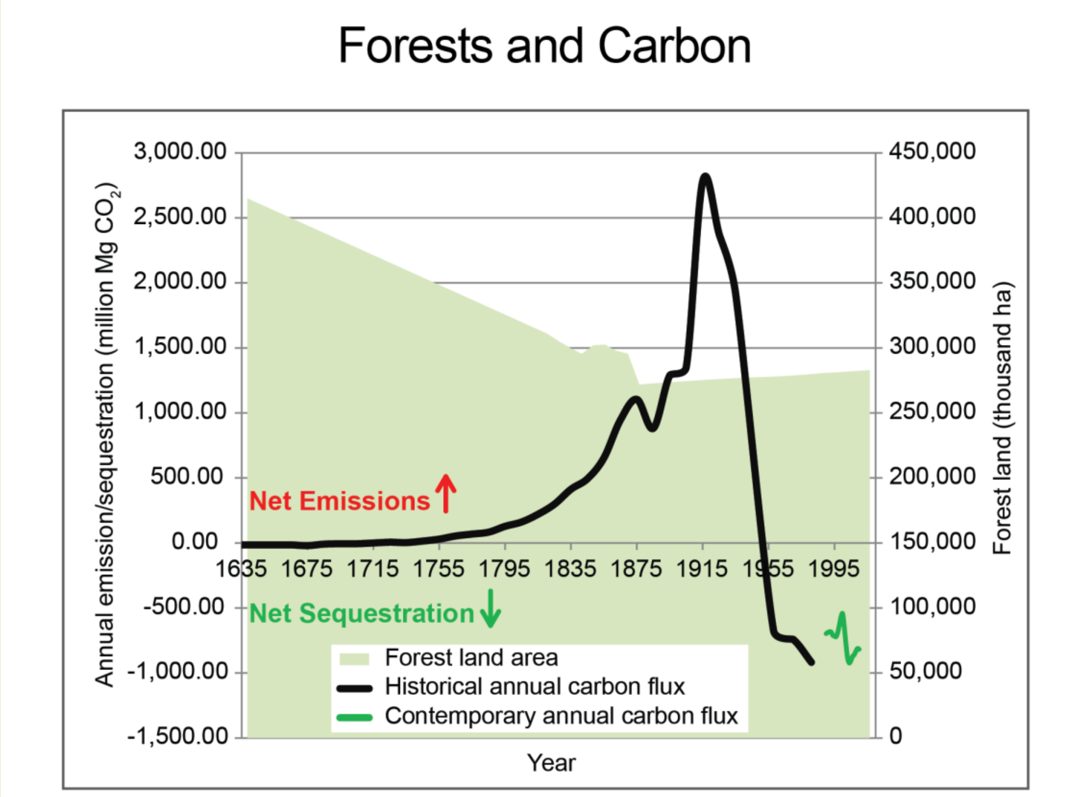


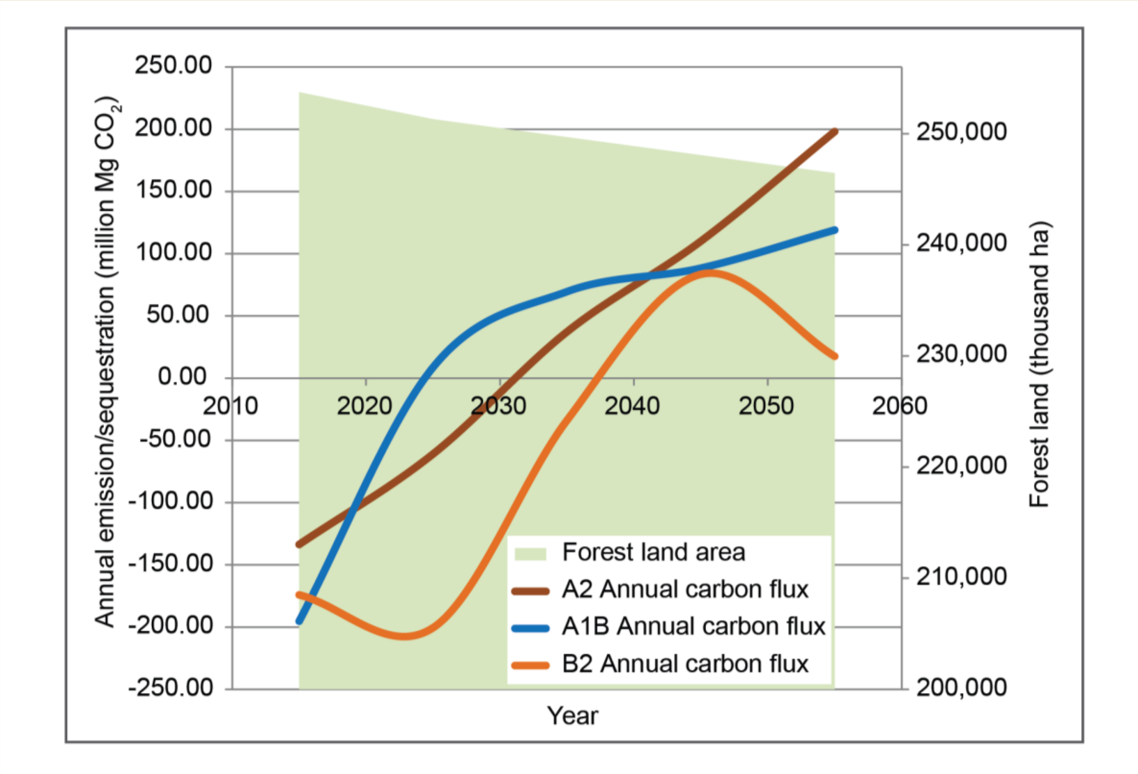
USFS 2014

Putting it all together

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

Future Projections of US Forests





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

Main Take-Aways from RPA Assessment

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

Decline due to following drivers

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

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

Main Take-aways from Washington Forest Sector

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

Any Questions?