School of Environmental and Forest Sciences

UNIVERSITY of WASHINGTON

College of the Environment

CINTRAFOR

Center for International Trade in Forest Products

The role of Washington's private forests in mitigating global warming

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Background of the study

MOTIVATION
Role of Forests, Management, and Forest Products on **Carbon Mitigation**
Work done by
Lippke, Oneil and Perez Garcia

SCIENTIFIC BACKGROUND
Multiple bioenergy papers focusing on **Radiative Forcing** analysis of wood based bioenergy
Work done by
Pierobon and Ganguly

Interest by various state agencies and NGOs in trying to get a better understanding on the **global warming mitigating potential** of WA wood products industry
like
WA-DNR, WA-Commerce, WA Carbon, FORTERRA etc

Need for a series of studies investigating various aspects of the role of Washington's working forests in mitigating global warming

WFPA's interest in having a **fair and honest** understanding of the role of WA's forest products sector.
Based on discussions with Mark, John, Jason and Cindy

The role of Washington's private forests in mitigating global warming

The phases of the study

Temporal GHG modeling developed by CINTRAFOR

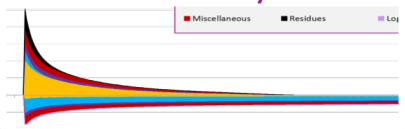
USDA report on wood products in end uses up to 100 years

WA-DNR survey on WA state forestry industry

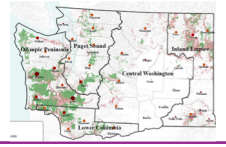
UW-WA state FVS modeling developed by Luke and Co

Single Plot multiple rotation: GWP analysis

Wood products mix: GWP analysis



Actual harvest and growth in WA's forests



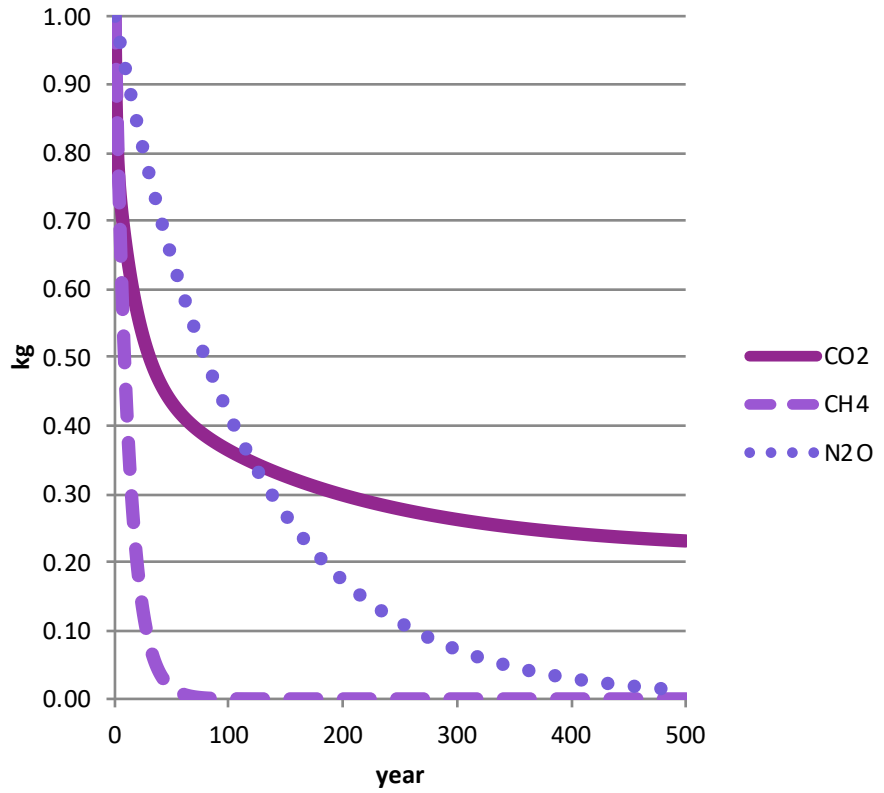
Phase I
Plot Level Analysis

Phase II
State Level Analysis

Technical Note (CO_{2e})

In this paper all the Green House Gases are converted to Carbon Dioxide equivalence (CO_{2e}) based on a combination of factors:

1. Residence time of the gas in the atmosphere

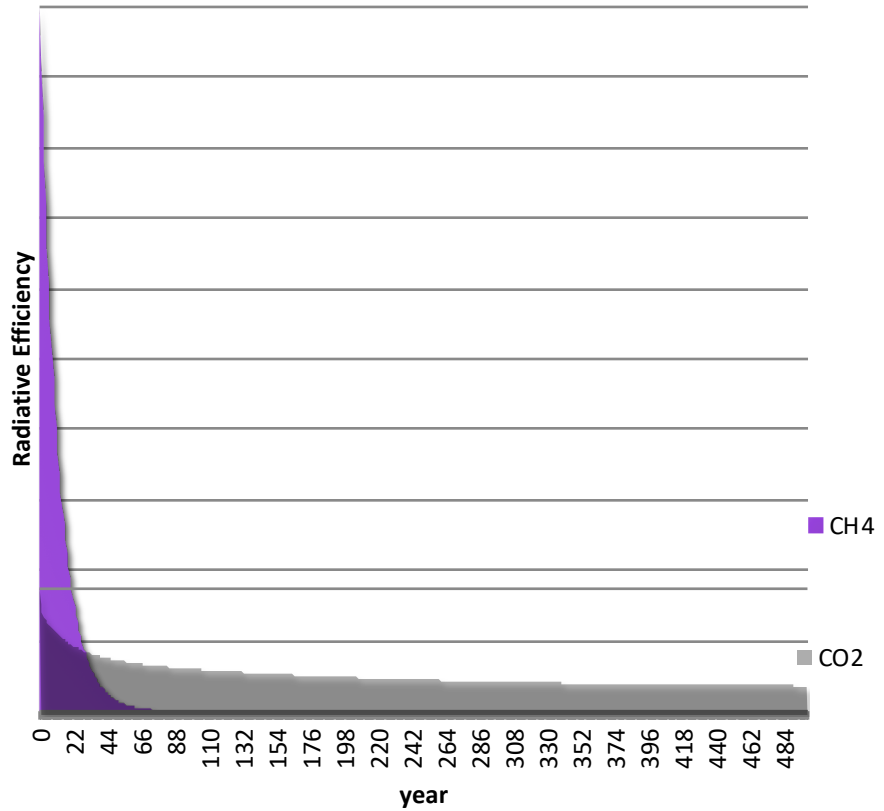


Technical Note (CO_{2e})

In this paper all the Green House Gases are converted to Carbon Dioxide equivalence (CO_{2e}) based on a combination of factors:

1. Residence time of the gas in the atmosphere

2. Relative radiative efficiency of the gas as compared to CO_2
   - The decay of a pulse emission of CO2 is calculated using the revised version of the Bern Carbon cycle model ($C_{CO2}(t)$).
   - GWP is then calculated, using CO_2 as the reference GHG, which has a relative radiative efficiency of one.

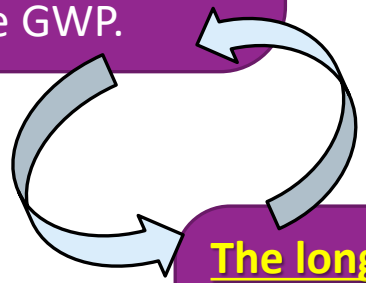


Technical Note (wood products)

Methodology for factoring-in impacts of wood products

Sequestered Carbon in Products: To quantify the benefits of carbon storage in a forest product, we applied the Bern Carbon cycle model over the lifetime of the product and then calculated a negative GWP.

Production Emissions: The LCA based Global Warming Potential (GWP) associated with production emissions were subtracted from GWP benefits of storing carbon in the product.



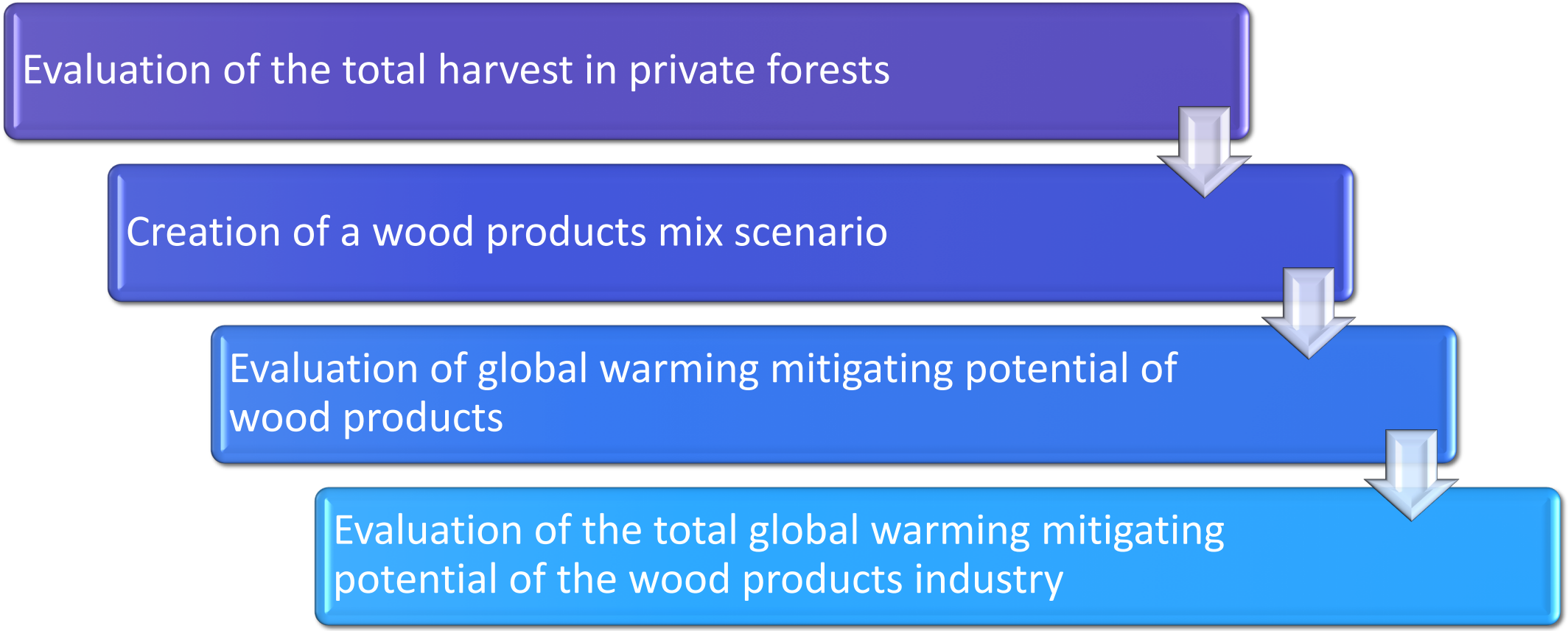
Environmental Impact

The longevity of the product: To analyze the data of products in use over the life-span of the product, we applied the CO_2 decay curve at each time interval, taking into account the proportion of product still in use.

Landscape level analysis

Objective: Estimate the total global warming mitigating potential of Washington state's wood products industry for private forests using a temporal model

Methodology



Evaluation of the total harvest in private forests

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We calculated the total aboveground and harvest biomass (merchantable and residues components) over a **20-year period**, between 2010 and 2030, at parcel level

- The **model** used was developed by the University of Washington over the course of a 5-year project (2008-2012) funded by DNR for the development of the Washington Forest Biomass Supply Assessment tool (http://wabiomass.cfr.washington.edu).

- Forested plots were simulated using the appropriate **Forest Vegetation Simulator** (FVS) variant, including a total of six variants to capture the variation in growth and yield in the state.

Total harvest in Washington State's private forests in 2015

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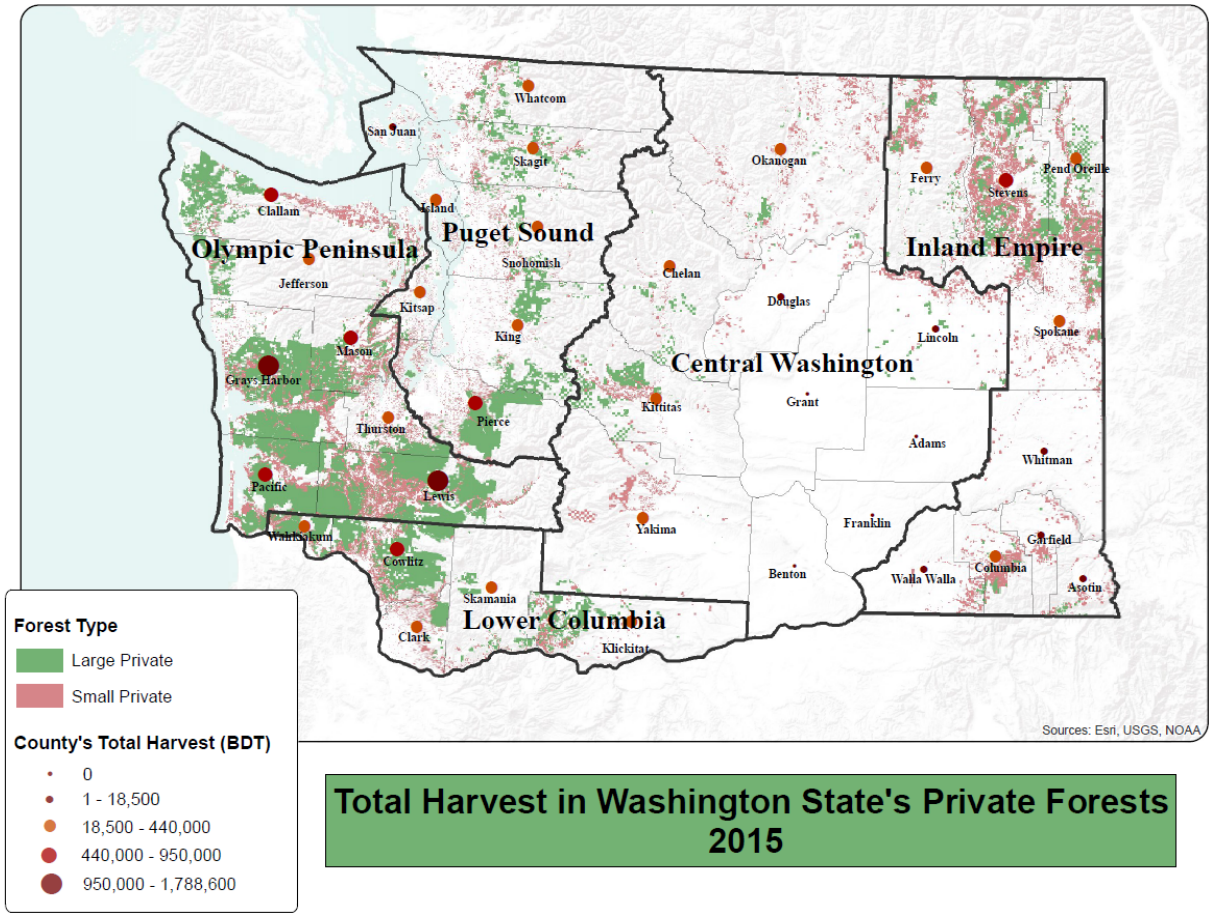
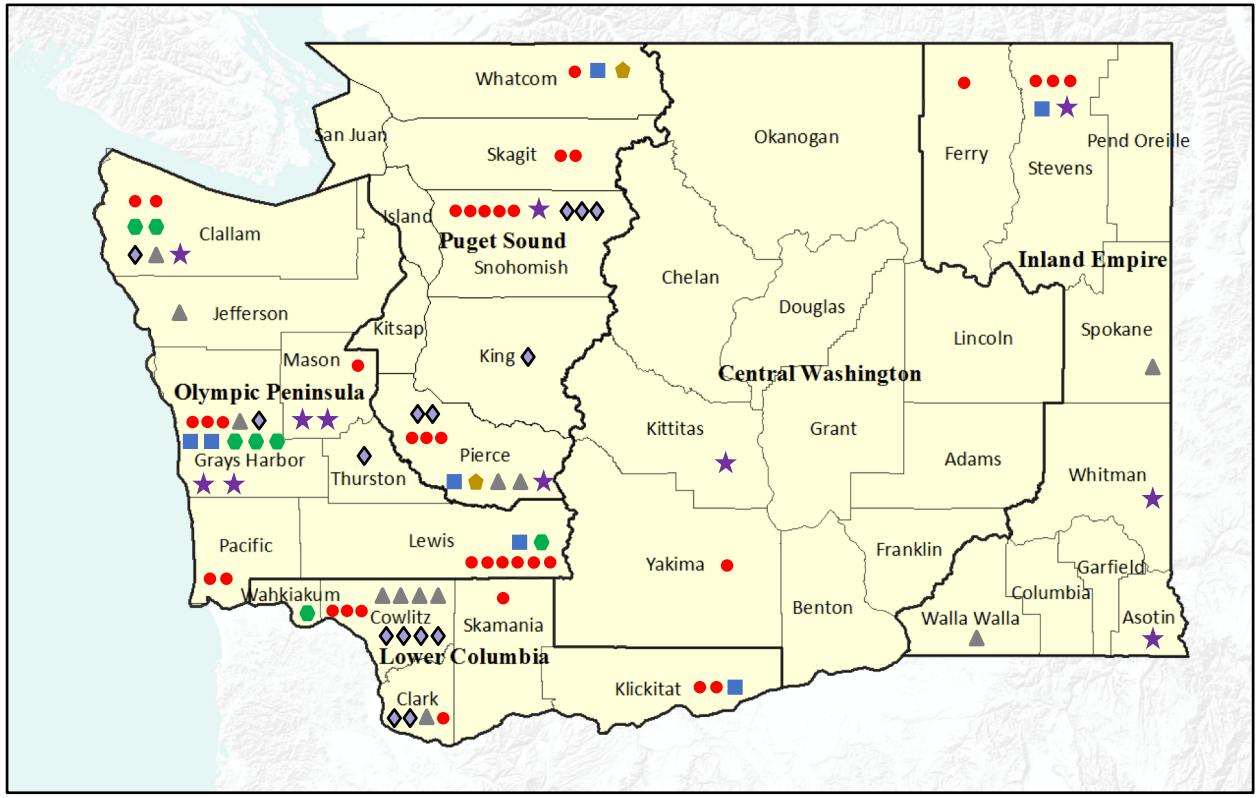


Total Harvest in Washington State's Private Forests 2015

Total harvest in private forests by economic area for 2015.

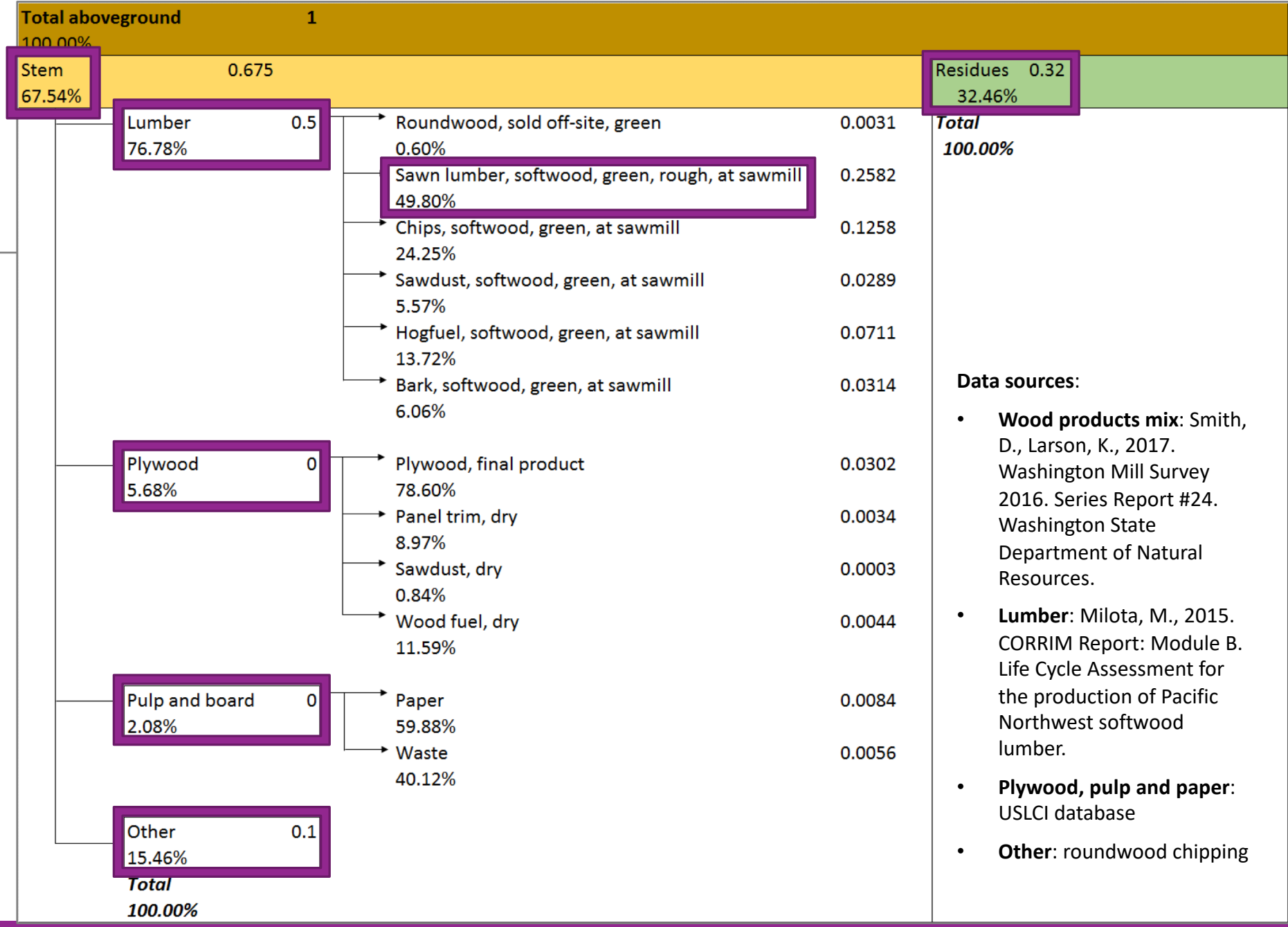
Economic Area	Total merchantable [BDT]	Total forest residues [BDT]	Total harvest [BDT]
Puget Sound	1,465,710	725,782	2,191,492
Olympic Peninsula	4,145,488	1,919,038	6,064,525
Lower Columbia	1,196,921	578,787	1,775,709
Central Washington	245,546	125,760	371,307
Inland Empire	859,107	453,797	1,312,904
Total Washington	**7,912,772**	**3,803,164**	**11,715,937**

Creation of a wood products mix scenario



Sawmill production data was used to create a wood products mix scenario, including different uses of the merchantable harvest extracted from private forests in Washington State in 2015.

Creation of a wood products mix scenario



Data sources:

- **Wood products mix**: Smith, D., Larson, K., 2017. Washington Mill Survey 2016. Series Report #24. Washington State Department of Natural Resources.
- **Lumber**: Milota, M., 2015. CORRIM Report: Module B. Life Cycle Assessment for the production of Pacific Northwest softwood lumber.
- **Plywood, pulp and paper**: USLCI database
- **Other**: roundwood chipping

Creation of a wood products mix scenario

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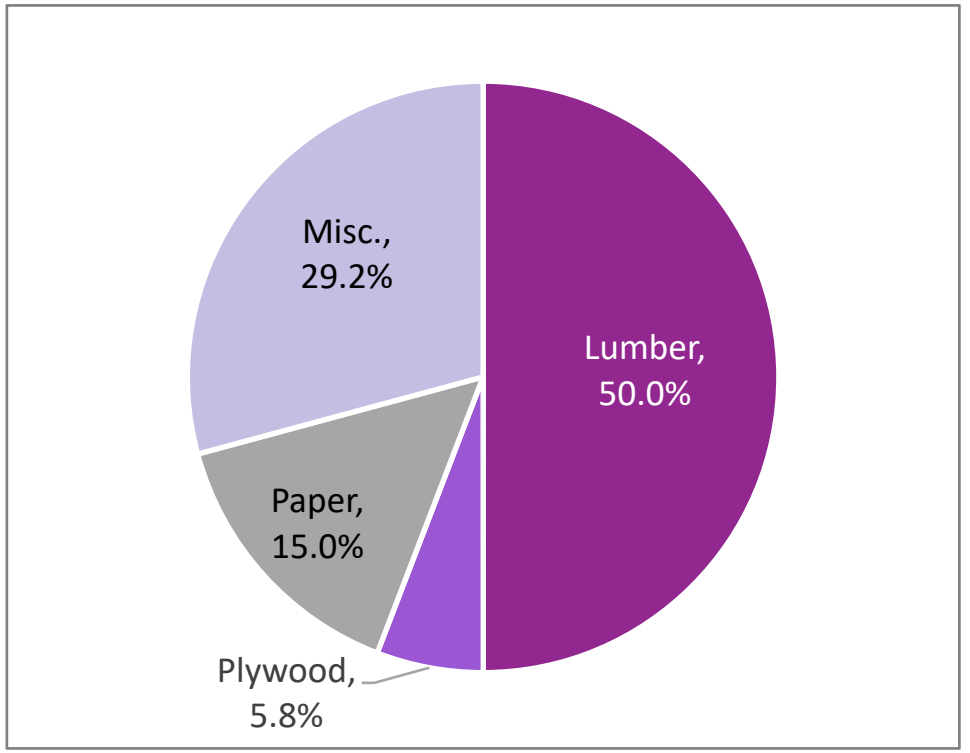
- It was assumed that **50% of the chips** produced during lumber production and 50% of the chips produced in chip mills (classified as “other”) were used for **paper** production.
- The remaining **50% of the chips** and **100% of the sawdust** produced during lumber production and plywood were assumed to be used for **miscellaneous engineered wood products**.
- Hogfuel, bark and wood fuel were considered as hogfuel. Hogfuel and waste were excluded from the evaluation because lifetime < 1 year

Wood products mix (lifetime > 1 year).



Evaluation of the global warming mitigating potential

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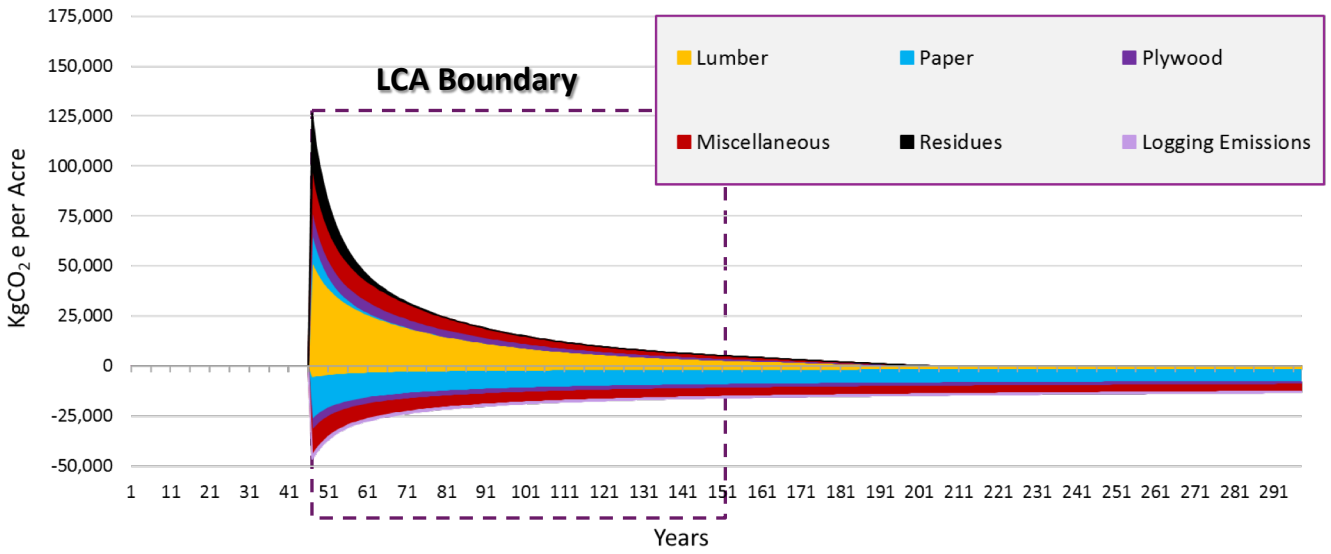
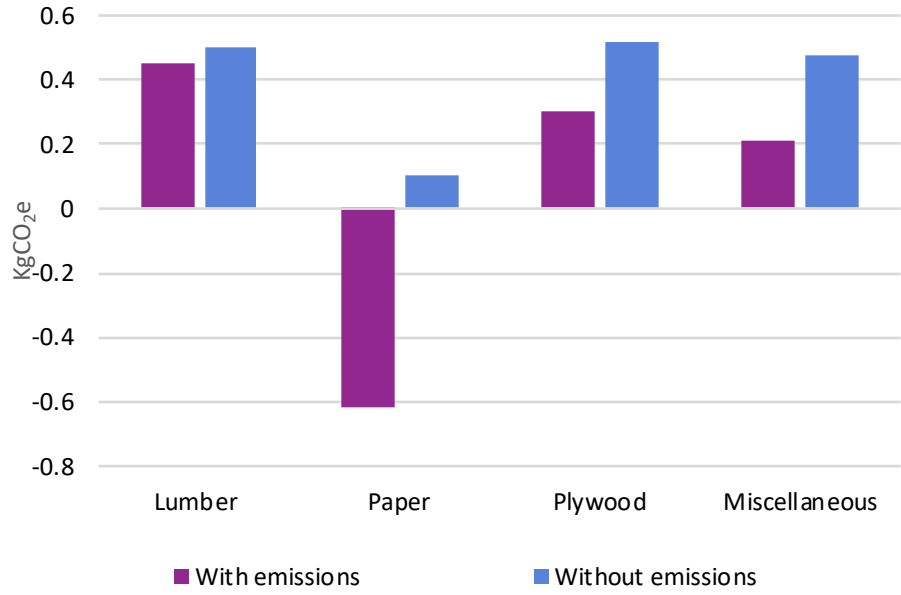
A Radiative Forcing analysis was performed to estimate the overall global warming potential of Washington's wood products over **100 years**, with and without production emissions.



Wood products half-life based on USFS:

- Lumber: 40 years
- Paper: 5.5 years
- Plywood: 40 years
- Miscellaneous: 35 years



Global warming mitigating potential Washington state's wood products from private lands

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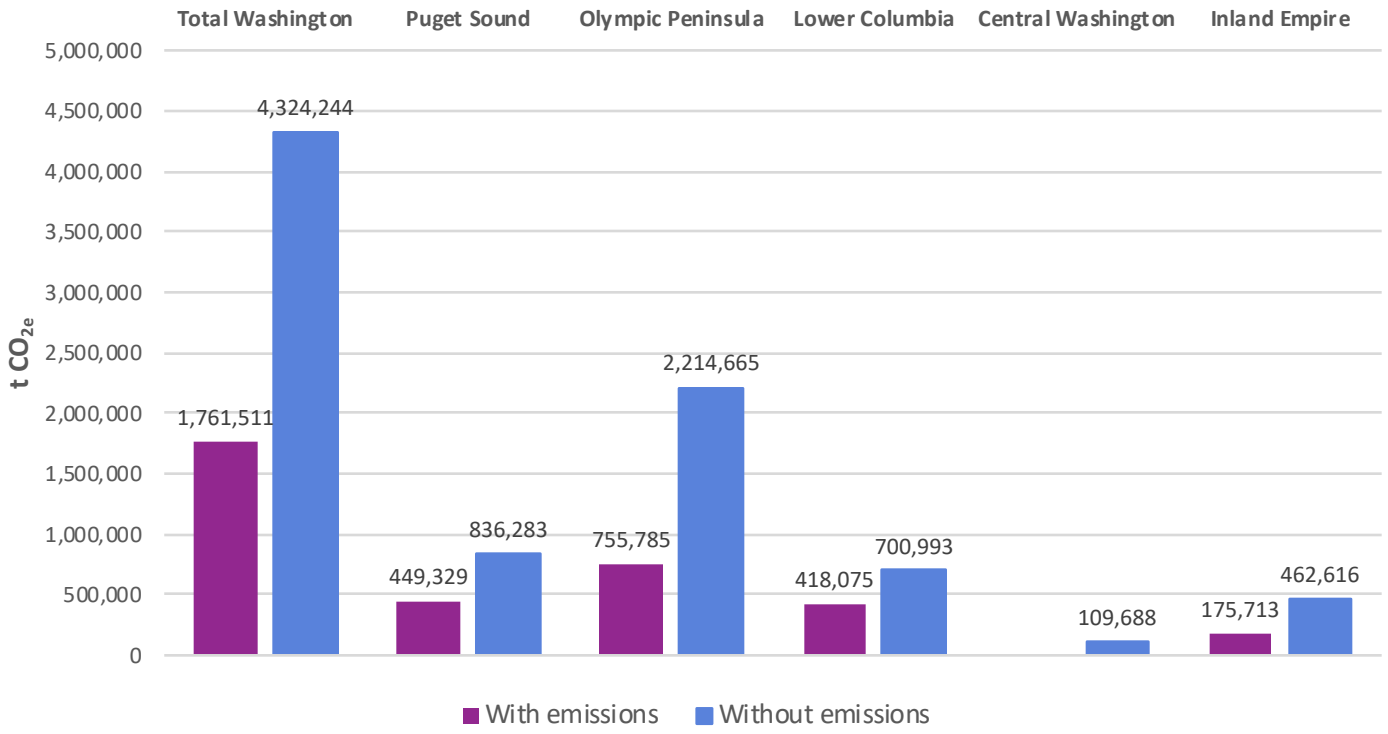


The **overall benefit** on global warming of storing carbon in wood products from private land in Washington state is:

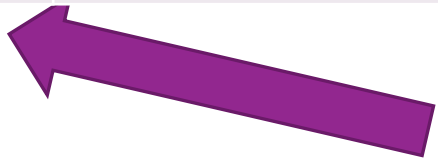
- Without production emissions: **~ 4.3 million tCO_{2e}**
- With production emissions: **~ 1.8 million tCO_{2e}**

Interpretation of the results

Comparison with 100-year average method for calculating long-term wood product climate benefit.

*100-year average method is common approximation of radiative forcing method and is explained in Hoover et al. 2014. Chapter 6: Quantify GHG Sources and Sinks in Managed Forest Systems. In *Quantifying GHG Flues in Agriculture and Forestry: Methods for Entity-Scale Inventory.* Technical Bulletin Number 1939. Office of the Chief Economist, USDA, Washington Dc. 606 pg.
*It is used in the California Forest Carbon Offset Protocol to measure long-term carbon storage from wood products produced in the project.

Method	Lumber	Plywood	Paper
Radiative Forcing	.504	.516	.103
100-year ave	.466	.468	.06

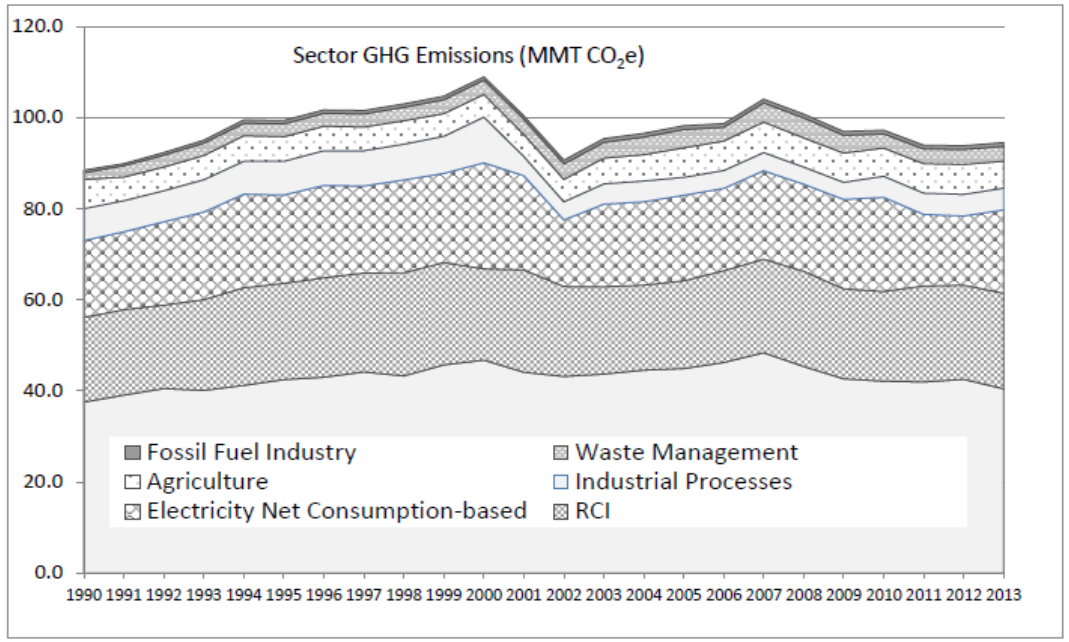


Chapter 6: Quantifying Greenhouse Gas Sources and Sinks in Managed Forest Systems

Table 6-A-2: Fraction of Carbon in Primary Wood Products Remaining in End Uses up to 100 Years After Production (year 0 indicates fraction at time of production)

Year after Production	Softwood Lumber	Hardwood Lumber	Softwood Plywood	Oriented Strandboard	Non-Structural Panels	Misc. Products	Paper
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.908	0.909	0.908	0.908	0.908	0.903	0.880
2	0.892	0.893	0.893	0.896	0.892	0.887	0.775
3	0.877	0.877	0.878	0.884	0.876	0.871	0.682
4	0.863	0.861	0.863	0.872	0.861	0.855	0.600
5	0.848	0.845	0.848	0.860	0.845	0.840	0.528
6	0.834	0.830	0.834	0.848	0.830	0.825	0.465
7	0.820	0.815	0.820	0.837	0.816	0.810	0.354
8	0.806	0.801	0.807	0.826	0.801	0.795	0.269
9	0.793	0.786	0.794	0.815	0.787	0.781	0.205
10	0.780	0.772	0.781	0.804	0.774	0.767	0.156
15	0.718	0.705	0.719	0.753	0.708	0.700	0.040
20	0.662	0.644	0.663	0.706	0.649	0.639	0.010
25	0.611	0.589	0.613	0.662	0.595	0.583	0.003
30	0.565	0.538	0.567	0.622	0.546	0.532	0.001
35	0.523	0.492	0.525	0.585	0.501	0.486	0.000
40	0.485	0.450	0.487	0.551	0.460	0.444	0.000
45	0.450	0.411	0.452	0.519	0.423	0.405	0.000
50	0.418	0.376	0.420	0.490	0.389	0.370	0.000
55	0.389	0.344	0.391	0.462	0.358	0.338	0.000
60	0.362	0.315	0.364	0.437	0.329	0.308	0.000
65	0.338	0.288	0.340	0.413	0.303	0.281	0.000
70	0.315	0.264	0.317	0.391	0.280	0.257	0.000
75	0.294	0.242	0.296	0.370	0.258	0.234	0.000
80	0.276	0.221	0.277	0.351	0.238	0.214	0.000
85	0.258	0.203	0.260	0.333	0.220	0.195	0.000
90	0.242	0.186	0.244	0.316	0.203	0.178	0.000
95	0.227	0.170	0.229	0.300	0.188	0.163	0.000
100	0.213	0.156	0.215	0.285	0.174	0.149	0.000
Average	**0.466**	**0.430**	**0.468**	**0.526**	**0.441**	**0.424**	**0.059**

Total Washington state's greenhouse gas emissions in 2013



Washington State's 2013 greenhouse gas emissions by sector.

Sectors	Million tCO_{2e}	%
Transportation	40.4	42.8%
Residential, commercial and industrial	21.0	22.2%
Electricity	18.2	19.3%
Agriculture	5.9	6.3%
Industrial processes	4.8	5.1%
Waste management	3.3	3.5%
Fossil fuel industry	0.8	0.8%
Total	94.4	100.0%

Source: Sandlin G. Report to the Legislature on Washington Greenhouse Gas Emissions Inventory 2010 – 2013. 2016;19

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Total Washington state's greenhouse gas emissions vs carbon sequestration

Private forests & corresponding wood products

Year	Million tCO_2	Forest (private)	Wood products from private land	Total
2015	7.4	8.0%	4.7%	12.7%
2020	9.4	10.6%	4.5%	15.1%
2025	8.2	10.1%	5.4%	15.5%
2030	7.1	9.6%	5.7%	15.3%

All forest types & wood products

Year	Million tCO_2	Forest (all forest types)	Wood products from private land	Wood products from State, Federal and other public (est.)	Total
2015	27.9	30.1%	4.7%	1.2%	36%
2020	30.3	34.2%	4.5%	0.8%	39.5%
2025	29.1	35.9%	5.4%	0.7%	42.0%
2030	27.3	37.0%	5.7%	0.7%	43.4%

Washington state's wood products output from private forests has a global warming mitigation potential equivalent to about **5% of the total state greenhouse emissions**, while the net forest growth of private forests after harvesting corresponds to an additional 8% (30% considering all forest ownerships).

Conclusions

- A temporal analysis was conducted to evaluate the role of Washington state's private land and forest products on global warming
- Overall, the wood products industry has a **net global warming mitigating benefit**
- For wood coming off private lands, this overall global warming mitigating benefit is **~ 4.3 million tonnes of CO_2.** For all wood in Washington State- the overall benefit is **~ 5.9 million tonnes of CO_2**
- When manufacturing emissions are including, there is STILL a net benefit from just the wood products alone, equivalent to **~ 1.8 million tonnes of CO_2** from the private land wood products.
- **And, all these benefits are underpinned by net carbon sequestration on Washington State lands.**

Conclusions

- Overall, the Washington state's **wood products** industry global warming mitigation potential is **about 6% of the total greenhouse gas emissions** (without considering the production emissions)
- Including the net forest growth of **private forests** after harvesting, the global warming mitigation potential is **13.5% of the total greenhouse gas emissions** in 2015
- Including the net forest growth of **all forests types** after harvesting, the global warming mitigation potential is **36% of the total greenhouse gas emissions** in 2015

Practical Considerations

1. Validation of WFPA assertion that Washington's forests and forest products annually offset ~35% of state's GHG emissions
2. Validation that harvest on Washington State private lands, which supply bulk (but not all) of state's harvest, has a net global warming mitigation benefit, even when emissions from manufacturing are considered. What other industry can say this?
3. Validation that 100-year average method roughly approximate's the radiative forcing impact of temporary carbon storage, as explained in Hoover et al, 2014.

Future Research

- ✓ Factor in substitution effect to develop a comprehensive understanding of the net beneficial impacts of WA forest products industry
  - ✓ Apply various end-of-life/recycling scenarios in an analysis of global warming mitigating potential.
- ✓ Evaluate the environmental benefits of extending lifetimes of forest products (like CLT), taking into consideration scenarios which would have the greatest climate benefit.
  - ✓ Substitution effect in various tall building construction, including end-of life scenarios
- ✓ Apply this method to different forest growth rates, harvest patterns and product mix scenarios, carbon market scenario and compare relative impacts.
  - ✓ Incorporating different aspects from the plot level analysis into a landscape analysis to evaluate how these factors affect the overall impact on Washington state.
  - ✓ *Scenario analyses to influence public policy:* 1. Impacts associated with loosing forest-land to non-forestry uses; 2. Gaining forest-land from non-forestry uses

Thank you for your attention!