September 24, 2018

Senate President Peter Courtney
900 Court St. NE, S-201
Salem, OR 97301

House Speaker Tina Kotek
900 Court St. NE, Rm 269
Salem, OR 97301

CC: Joint Interim Committee on Carbon Reduction Committee Members- Co-Vice Chair Senator Cliff Bentz, Co-Vice Chair Senator Michael Dembrow, Co-Vice Chair Representative Karin Power, Co-Vice Chair Representative David Brock Smith, Members Senator Lee Beyer, Senator Fred Girod, Senator Alan Olsen, Senator Elizabeth Steiner Hayward, Representative Ken Helm, Representative John Lively, Representative E. Werner Reschke, Representative A. Richard Vial

Sent via Email

Dear Joint Committee on Carbon Reduction Co-Chairs President Courtney and Speaker Kotek:

We are a group of carbon accounting experts writing to provide a science context grounded in the operational realities of the Pacific Northwest (PNW) forest sector. The signatory scientists are well versed in the development of national greenhouse gas (GHG) inventories and national and internationally accepted protocols for reporting carbon changes from land, land-use change, and forestry. We have developed methodologies for conducting life cycle assessments of harvested wood products (HWP) and published extensively in peer-reviewed literature. We understand the challenges of integrating multiple fields of inquiry to arrive at credible, scientific answers to the complex questions surrounding forest sector carbon accounting. Our intent is to highlight areas requiring close consideration as you construct policy around carbon emissions and sequestration in the forest sector.

Carbon accounting is based on assumptions about scope (what is included within the boundary of assessment), time-period, and type of data. The more closely these assumptions reflect reality, the more realistic the assessment of forest sector impacts on the carbon cycle.

We believe that seemingly opposing viewpoints regarding the role of Oregon's forest sector in the carbon cycle often result from differences in the underlying assumptions. We want to clarify **four elements in a forest sector carbon accounting framework** that must be understood to characterize the eventual carbon impacts of forest operations.

1. **The current sequestration rate of Oregon's forests is influenced by past disturbances, including harvesting and fire.** For managed lands, the growth rate also reflects almost 80 years of investment in advanced forest management to increase forest productivity and yield.

2. **A forest carbon accounting system must examine *net* carbon changes on the landscape, including tree growth, mortality, fire losses and harvest.** International protocols report net carbon changes on the landscape in the Land Use, Land-Use Change and Forestry Sector.[1]
    a. Under this IPCC accounting framework, biomass carbon that is no longer in the forest (e.g. harvested) is assumed to have been emitted into the atmosphere, excepting carbon stored in wood products. This accounting explains why biomass emissions in the energy sector have already been accounted for and are treated separately from fossil fuel emissions.
    b. Harvested materials that go into long-term wood products like lumber are accounted for in the harvested wood product (HWP) carbon storage pool. The HWP carbon pool is real and can be calculated using USFS statistics at the state or national level.
3. **If a carbon assessment extends to the full life cycle, internationally accepted ISO standards require they include (1) a goal and scope definition including a functional unit, system boundaries, assumptions and limitations, allocation methods, and impact categories; (2) a life cycle inventory analysis; (3) a life cycle impact assessment; and (4) an interpretation of results.**
4. **Substitution—the emissions avoided by manufacturing and using a wood product instead of a more energy-intensive alternative—is both a permanent benefit and independent of building longevity.**

Climate change mitigation strategies should be aimed at *reducing atmospheric* carbon dioxide. This can be accomplished by reducing fossil fuel use (e.g. substituting bio-based products for fossil-intensive products), increasing carbon storage by using more wood products in long-term building materials, increasing carbon storage on the land through management strategies that optimize biomass growth, and reducing emissions from land-use change.

Mitigating climate change is an enormous challenge that requires organizations and governments around the globe to examine how they can best contribute given their specific resources and talents. The PNW has tremendous capacity to meet the challenge. It is blessed with highly productive forests; a robust infrastructure and legal system that supports private investment in activities that provide inherent climate mitigation benefits; a clean energy grid that results in reduced manufacturing emissions; and a clear pathway to provide overall carbon mitigation using a scientifically developed, engineered system that supports carbon mitigation goals while also contributing economic and social benefits to the state. Clarity in accounting will help make policy choices that drive toward the goal of reduced atmospheric carbon dioxide.

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[1] IPCC. 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Edited by Jim Penman, Michael Gytarsky, Taka Hiraishi, Thelma Krug, Dina Kruger, Riitta Pipatti, Leandro Buendia, Kyoko Miwa, Todd Ngara, Kiyoto Tanabe and Fabian Wagner.

Attached please find further discussion of each of the four points. We are happy to answer any follow-up questions.

Thank you for grappling with this complex subject.

Sincerely,

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Edie Sonne Hall, Ph.D. Founder and Principal, **Three Trees Consulting**

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Appendix

1. **Current rates of forest carbon sequestration are determined by past disturbances and net sequestration does not continue forever.**

Trees take in carbon dioxide (CO_2) and use it to build their roots, trunks, branches, leaves, and needles, such that on average the dry weight of a tree is made up of 50% elemental carbon. The rate of uptake (called sequestration) is correlated to the growth rate of trees, with the ultimate storage capacity (called a "sink") dictated by species and climate. Due to our climate and species mix, Oregon has some of the fastest sequestration rates on the planet and some of the highest storage capacities, but only in certain regions of the state. Regardless of Oregon forests' remarkable growing capacity, at some point a forest's growth slows down and eventually reaches a saturation point (Fig. 1). At the growth saturation point, any new growth is offset by mortality so that net sequestration is essentially zero—the sink is full.

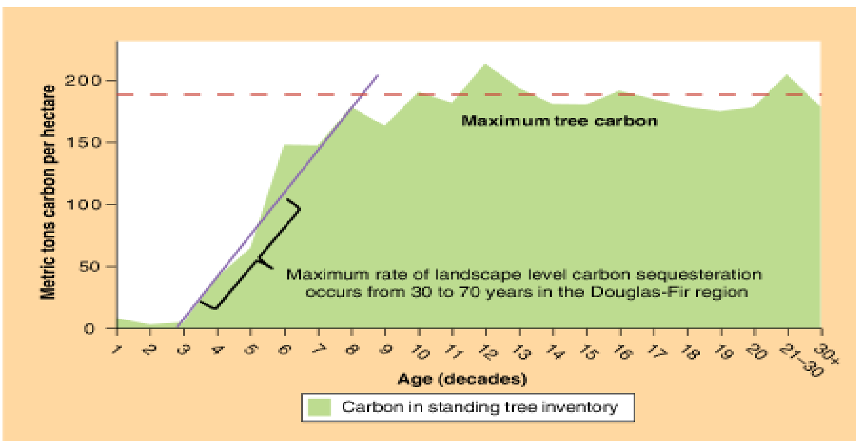

Figure 3. Forest-carbon growth rate decreases with age in western Washington. From US Forest Service – Forest Inventory and Analysis inventory plot data. Forest carbon growth rates begin to slow before the age of 100 years with little to no growth beyond the age of 100 years.
Data from US Forest Service Forest Inventory [13].

Figure 1. Forest-carbon growth rate (average tree carbon growth rate) for western Washington.[2]

Though naturally there are many instances of disturbances re-setting stand growth, nationwide, the carbon exchange between forests and the atmosphere were approximately in balance in the U.S. until the late 1700s, meaning there was zero net sequestration (Fig. 2). Land clearing for agriculture and fuelwood greatly transformed U.S. forests causing them to be a source of carbon emissions through the turn of the 20th century. Around this time, abandoned farms in the Northeast started converting back to forests. In the Southeast and Northwest, trees were re-planted, and the growth of younger trees began to offset the loss from harvest and land clearing. By 1955, growth volume exceeded removals and the U.S. has since been enjoying a large carbon sink, which currently offsets about 15% of yearly GHG emissions. The current rate of sequestration is based on

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[2] Lippke, B.R., E. Oneil, R.B. Harrison, and K.E. Skog. 2011. Life cycle impacts of forest management and wood utilization on carbon mitigation: Knowns and unknowns. Carbon Management 2(3):303-333

past harvesting and land-use change and should not be assumed to continue forever. In fact, United States Forest Service (USFS) predictions in the most recent Resources Planning Act (RPA) assessment (USDA 2016) report that this large sink will eventually diminish as trees in National Forests age and disturbances increase (e.g. fire).

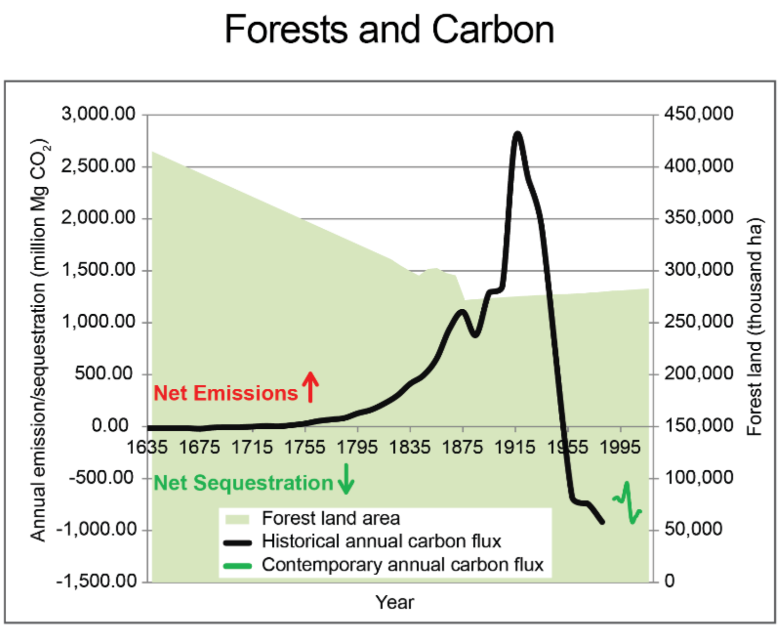

Figure 2. Historical Rate of Net Forest Carbon Emissions in the US, 1635-1900. [3]

Forests are a terrific way to remove CO_2 from the atmosphere, but they aren't always the best place to store carbon. In Oregon, growing stock (which correlates to carbon stock) on public lands is currently higher (10.5 MBF/ac) than for private lands (7.0 MBF/ac) that are actively harvested and managed. For public lands, there was a minor increase in growing stock after the harvest levels were reduced in 1993 in response to the listing of the Spotted owl under the Endangered Species Act, but the rate of growth has not been sustained (Fig. 3). On public lands where only a small portion of the state's harvest occurs, the sink is almost full, or not increasing at a rate faster than mortality. In contrast, PNW private forests lands are more akin to a factory than a storage facility in that they carry a third less growing stock relative to public lands but produce 5.2 times the harvest volume per acre. Overall, 34% of all softwood lumber and 31% of all softwood plywood grown in the U.S. comes from the PNW where over 80% of the harvest occurs on private lands.[5] Tree farming has now been implemented for almost 80 years in the PNW, where native, purpose-grown trees are grown using scientific management principles to maximize yield, which has a co-benefit of high carbon sequestration rates.

As long as the world continues to demand wood products, there will be an economic value to retain forests, and that value will be an incentive for landowners to invest in forest management. This is particularly true in the PNW, where forest land is so productive relative to most other locations in

[3] USDA Forest Service. 2016. Future of America's Forests and Rangelands: Update to the 2010 Resources Planning Act Assessment. Gen. Tech. Report WO-GTR-94. Washington, DC. 250 p.

the U.S. and globally. Oregon produces the most softwood lumber and softwood plywood in the U.S, and the U.S. is the largest sawtimber producer in the world.[4]

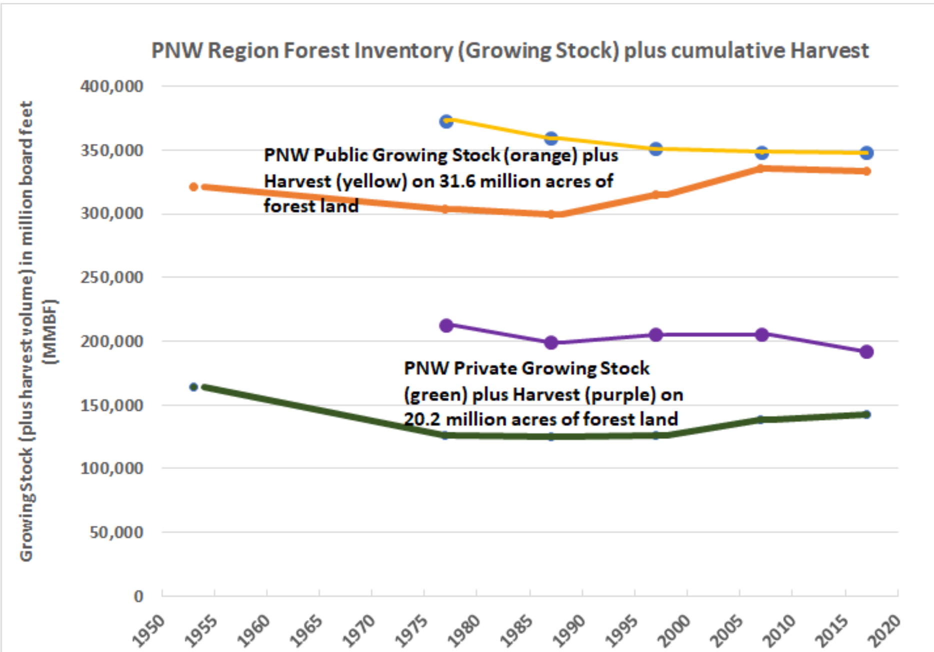

Figure 3. Net Growing Stock and Growing Stock plus Harvest over time by Public and Private Owners in Oregon[5]

2. **A forest carbon accounting system should look at *net* changes on the landscape, which is the sum of all fluxes that may have contributed to the change, including tree growth.**

Stock change accounting is used to measure changes in forest stocks between two points in time.[6] This can be an empirical measurement (when using FIA inventory data) and is the sum of all the fluxes that may have contributed to the change (e.g. growth, mortality, harvest, fire). Measuring

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[4] Oregon Forest Resource Institute. 2018. *Oregon Forest Facts: 2017-2018 edition.* http://oregonforestfacts.org/#harvest-production

[5] Derived from 2017 RPA data from Oswalt, Sonja N.; Miles, Patrick D.; Pugh, Scott A.; Smith, W. Brad. 2018. Forest Resources of the United States, 2017: a technical document supporting the Forest Service 2020 update of the RPA Assessment. Gen. Tech. Rep. WO-xxx. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. Xxx p. https://www.fia.fs.fed.us/program-features/rpa/docs/2017RPAFIATABLESFINAL_050918.pdf and Oregon Timber Harvest Data, data.oregon.gov open data portal at https://data.oregon.gov/Natural-Resources/Timber-Harvest-Data-1942-2016/9cuv-nijj

[6] Woodall, Christopher W., John W. Coulston, Grant M. Domke, Brian F. Walters, David N. Wear, James E. Smith, Hans-Erik Anderson, Brian J. Clough, Warren B. Cohen, Doublas M. Griffith, Stephen C. Hagen, Ian S. Hanou, Michael C. Nichols, Charles H. Perry, Matthew B. Russell, James A Westfall, and Barry T. Wilson. 2015. The U.S. Forest Carbon Accounting Framework: Stocks and Stock Change, 1990-2016. USFS GTR NRS-154.

only emissions from harvest and not tree growth does not result in an accurate account of the change in carbon on the landscape. As explained in Section 1, these fluxes are not independent of each other. The growth rate is directly related to past harvest and investment in planting because growth rate is age dependent. Fire and mortality also can be related to past fuel build-up in the forest in addition to changes in climate.

a. **According to the Intergovernmental Panel on Climate Change accounting rules,[7] CO_2 from biomass burned for energy is not included in the Energy Sector emissions because it is accounted for in the Land Use, Land-Use Change and Forestry sector.** Stock change accounting, which measures net carbon changes on the landscape, implicitly subtracts emissions from harvesting. As a result, this accounting framework allows for harvested wood product (HWP) carbon accounting to focus on the carbon remaining in a product or landfill over a long period of time (see next section). The benefits of HWP carbon or biomass for energy can be monitored by examining growing stock trends through time and accepted if landscape level carbon stocks are stable or increasing. Similarly, this accounting approach also captures cases where carbon stocks are declining, thus allowing for policy to monitor and address HWP and biomass combustion appropriately.

b. **Long-term wood product carbon storage can be calculated based on detailed information on US wood product production, end-uses, and half-lives for end-uses.** Not all carbon removed from a forest site is immediately emitted to the atmosphere. Harvested logs that are manufactured into wood products can store carbon for building lifetimes--decades or longer. Virtually 99% of harvested logs are used—either as lumber, as a co-product that is incorporated into engineered wood products, or as a source of energy in place of fossil fuels. There are many methods to account for the carbon stored long-term in wood products and landfills and multiple published data sources on end-use and wood product half-lives.[8] The HWP carbon pool is real and can be calculated.

Forest inventory data from the USDA Forest Inventory & Analysis (FIA) program should be used as a basis for determining the impact of forest operations on forest carbon stocks and utilization, or more land specific data where it is available. FIA data are an essential element of any land-based carbon accounting approach because they are grounded in actual measurements of forest conditions across a statistically sound sample of field plots. FIA data provide the most credible option for assessing the impacts of harvesting, wildfires, and other disturbances at the spatial and temporal scales needed to truly understand net emissions of forest carbon. Survey data covering all

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[7] Land use, land-use change, and forestry (LULUCF), also referred to as Forestry and other land use (FOLU), is defined by the United Nations Climate Change Secretariat as a "greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use such as settlements and commercial uses, land-use change, and forestry activities." http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=6

[8] Hoover, Coeli; Richard Birdsey; Bruce Goines; Peter Lahm; Gregg Marland; David Nowak; Stephen Prisley; Elizabeth Reinhardt; Ken Skog; David Skole; James Smith; Carl Trettin; and Christopher Woodall. 2014 Chapter 6: Quantifying Greenhouse Gas Sources and Sinks in Managed Forest Systems. In *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory.* Technical Bulletin Number 1939. USDA.

operational aspects of forest management, harvest, and production should be used to arrive at the true emission profiles of forest operations[9],[10].

3. Life Cycle Assessment Methodology

According to international standards (ISO 14040 and 14044) (ISO 2006)[11], a life cycle assessment (LCA) must include (1) a goal and scope definition which identifies the functional unit, system boundaries, assumptions and limitations, allocation methods, and impact categories; (2) a life cycle inventory analysis; (3) a life cycle impact assessment; and (4) an interpretation of results**.** These are internationally agreed on methods for LCA and should be followed for studies of forest systems.

LCAs that do not explicitly address these elements are not complete life cycle assessments and may lead the reader to erroneous conclusions.

4. Avoided emissions are a permanent benefit and are independent of building longevity.

Avoided emissions are emission reductions that occur outside of a product's life cycle or value chain that are directly attributable to the use of that product. Doing something that avoids fossil fuel combustion has a permanent benefit. Changing our behavior, like using renewable fuels and reducing fossil fuel use at a manufacturing facility, is like taking one more car off the road. These "avoided emissions" are the substitution benefit associated with using a wood product versus a fossil intensive product in a building to perform a function. The avoided emission benefit is dependent on the embedded emissions associated with producing the wood product and the equivalent use alternative non-wood product. The benefit will vary depending on the type of wood product and what it is used for. Sathre and O'Connor's (2010)[12] meta-analysis determined **an average substitution benefit of 2.1 tons C/ton C in wood products** used for building materials and other long-lived products based on 21 studies. Another way of stating this is for every ton of carbon in wood used, 2.1 tons of carbon emissions were avoided compared to an equivalent non-wood material.

In the Pacific Northwest, building codes are set for high seismic standards and the avoided or displaced carbon emissions of using wood over an equivalent non-wood material are often higher than average. For example, in recent work from Puettmann and Lippke, carbon-to-carbon benefits reached over 6 kg of avoided carbon emission for each kg of C in the wood in the Pacific Northwest when wood framing was used instead of concrete block (Fig. 4).

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[9] Oneil, E. and M. Puettmann. 2017. A lifecycle analysis of forest resources of the Pacific Northwest, USA. Forest Products Journal. CORRIM Special Issue, Vol. 67, No. 5/6:316-330
[10] Sonne, E. 2006. Greenhouse gas emissions from forestry operations: A life cycle assessment. J. Environ. Qual. 35:1439–1450.
[11] ISO. 2006. Environmental management - life-cycle assessment - requirements and guidelines. ISO 14044. International Organization for Standardization, Geneva, Switzerland, pp. 54 pp.
[12] Sathre, R. and J. O'Connor. 2010. Meta-analysis of greenhouse gas displacement factors of wood product substitution. Environmental Science & Policy, 13(2010):104-114

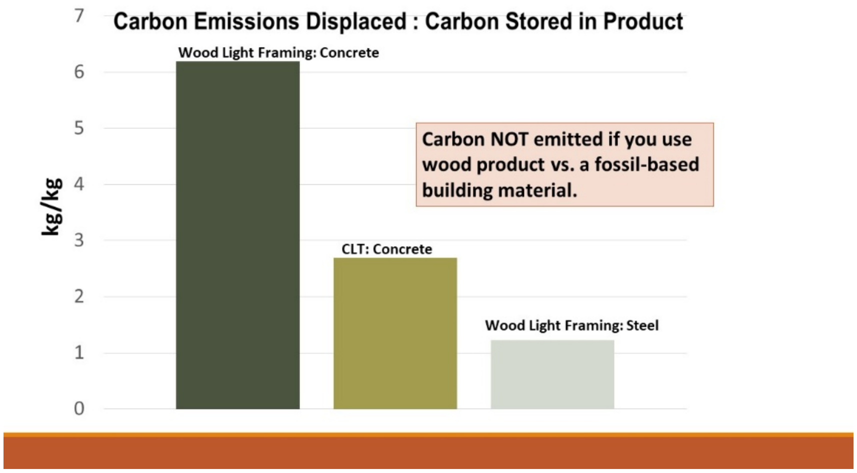

Figure 4. Carbon emission benefit from using wood-based building materials versus equivalent non-wood materials in both wall and floor applications.[13]

Substitution benefits should not be discounted according to the building lifespan as the benefits occur at each decision point. When a building is replaced there is another opportunity for a substitution benefit because there is another chance to choose a building material. The actual avoided emission benefit, however, implicitly includes longevity for each material as the functional unit of comparison includes a product lifespan. Incidentally, survey data show that wood buildings can have the longest lifespans, though that may also be influenced by building types (e.g. residential versus commercial) (Fig. 5).

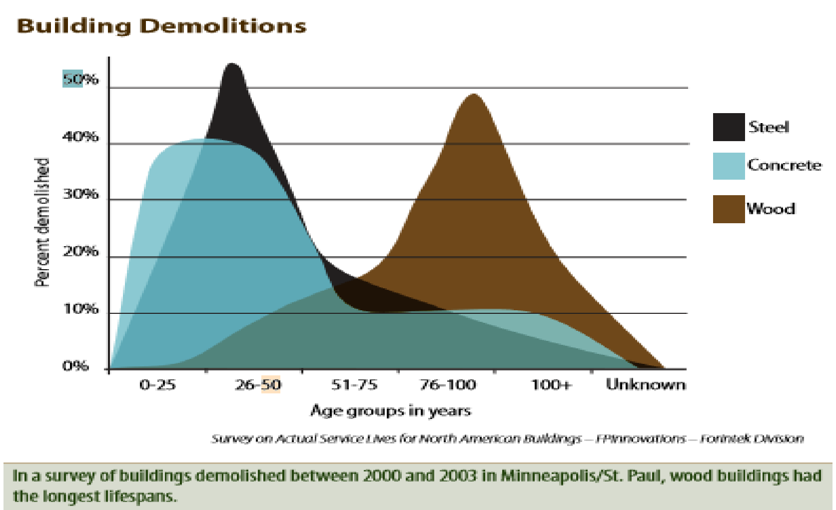

Figure 5. Survey on actual service lives for North American Buildings in 2004. [14]

[13] CORRIM. 2018. Carbon Cycling, Environmental and Rural Economic Impacts of Collecting and Processing Specific Woody Feedstocks in Biofuels. Progress Report FY18Q2. DOE-EE0002992. July 31, 2018.
[14] Source of data: FP Innovations survey on actual service lives for North American Buildings, 2004. Source of Graphic: BC Forestry Climate Change Working Group and California Forestry Association. 2009. Tackle Climate Change: Use Wood.

Conclusion

The forest sector impacts both land–atmosphere and fossil fuel–atmosphere relationships. It can enhance the carbon sink by increasing forest area, increasing carbon stocks in existing forest area, and increasing the wood product carbon pool. It can also reduce emissions to the atmosphere from both land and fossil fuel by reducing deforestation and land degradation, using biomass to replace fossil fuel, and using wood products in construction instead of other products with higher embodied GHG emissions (Fig. 6).

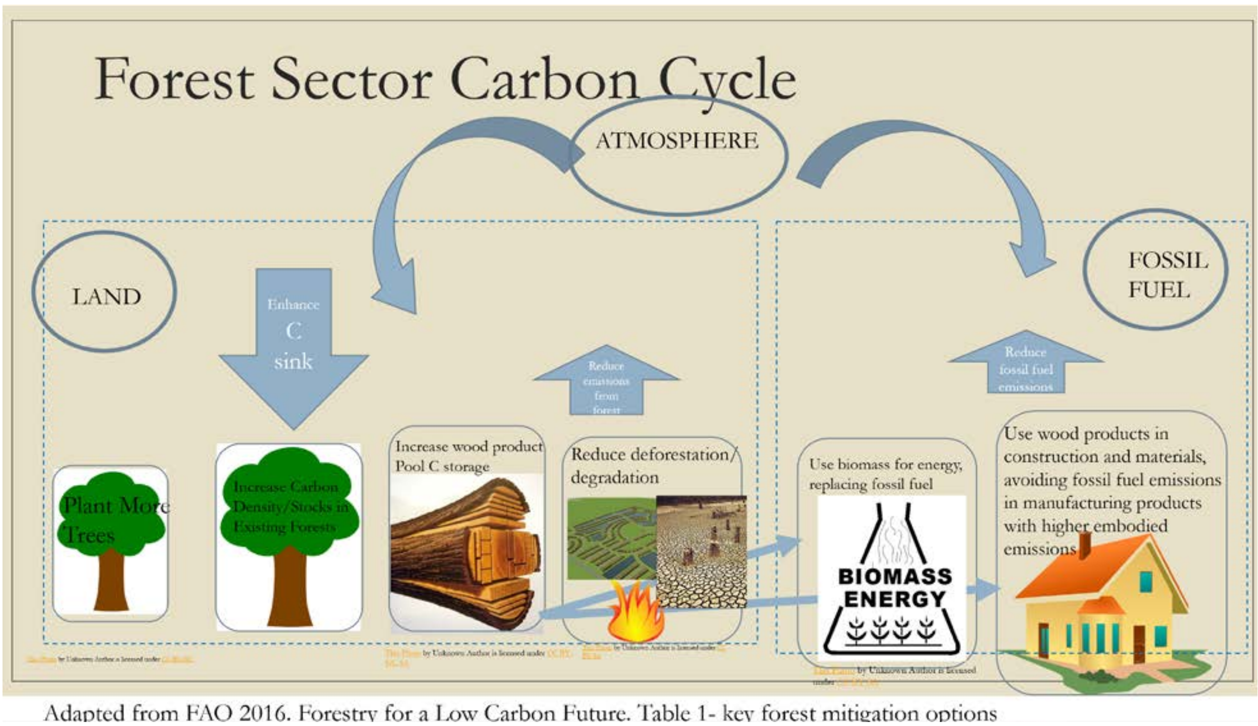

Figure 6. The Forest Sector Carbon Cycle Interactions between land and atmosphere.[15]

While avoided emissions are important to identify because they help understand the full impact to atmospheric GHGs, they are difficult to credit back to a specific land base. Substitution is important in understanding policy choices but would be difficult to measure in an inventory.

An atmospheric carbon reduction strategy that includes the forest sector is complex because of the interplay between the land-atmosphere and fossil fuel-atmosphere relationship over space and time, and because of the emerging impacts of climate change on the forest itself. For example, while increasing tree growth rates are predicted with more CO_2 in the atmosphere, we are also experiencing more frequent droughts, wildfires, pest infestations, and diseases.

When evaluating policy options for increasing the GHG reduction potential of forests, it is important to not only look at the land-atmosphere interactions but also at the relevant fossil fuel impacts generated by using renewable materials and reducing the use of non-wood building materials where applicable.

[15] From Sonne Hall. 2018. *Global Climate Change and the Impacts of Washington's Forest Sector*. Presentation for Northwest Natural Resources Group Conference: Forests for Resiliency and Climate Change. June 2018.

"Where else but in the Pacific Northwest can we store the most carbon in wood products and produce the most highly leveraged products to displace carbon emissions? Think about the regional economic impact of policies that should be enhancing the value of the carbon stored and the fossil emissions avoided. It is time to capitalize on our regional opportunities by greatly increasing our understanding of better practices and implementing them. Ironically science is not the limiting factor. Understanding how to better use the science to avoid unintended consequences requires educational outreach customized to each region's opportunities to gain the support of both the public and policy makers. The regional opportunities for better uses of our wood resources are enormous and especially a source for rural economic benefits." **–Bruce Lippke, Professor Emeritus, University of Washington and President Emeritus of CORRIM, the Consortium for Research on Renewable Industrial Materials, a research consortium with 20 research institutions that has spent 22 years examining the energy and carbon footprint of the forest sector.**