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Dr. Adam Daigneault Testimony to the House Committee on Small Business Subcommittee on Underserved, Agricultural, and Rural Development Hearing on "Sustainable Forestry's Role in Climate Solutions"

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Thank you, Chairman Golden, Ranking Member Hagedorn, and members of the subcommittee for holding this hearing today and for the opportunity to testify on this important topic. I am Dr. Adam Daigneault, Associate Professor of Forest Policy and Economics at the University of Maine. I have been working on issues related to forest management, economics, and policy for nearly two decades. Much of my research focuses on quantifying synergies and tradeoffs for sustainably managing forests for timber, carbon, and other co-benefits.

Forests across the globe are highly valued for the diverse ecosystem services that they provide, including the production of timber, fiber and fuel resources, carbon sequestration, climate change mitigation, freshwater, habitat, recreation, and preservation of cultural values. Across the U.S., forestry-related businesses support at least 2.9 million total jobs and generate about $108 billion per annum in GDP, nearly 6% of total manufacturing GDP[1]. In Maine, the forest sector as it accounts for nearly 5% of the total GDP (one of the highest in the U.S.) and has an annual economic impact of $8 billion, while also supporting other important sectors of Maine's economy such as recreation and ecotourism[2]. Forest resources across the country face increasing pressures from land use change, shifting markets, federal and state policy, and climate change. From ecological, economic, and social perspectives, there is a growing interest in the value of forest ecosystem services, and how these services can be enhanced through sustainable forest management. In this context, sustainability is generally understood as "the management of forests to meet the needs of the present without compromising the ability of future generations to meet their own needs."

U.S. forest ecosystems and the wood they produce are a large carbon sink. Forests and wood products currently sequester about 800 million metric tons of carbon dioxide equivalent per annum ($MtCO_2e/yr$) in the U.S., thereby removing 12% of annual greenhouse gas (GHG) emissions and making the total land sector a net sink (i.e., carbon sequestration is greater than emissions)[3]. For reference, wood products carbon accounts for about 15% of the total annual sequestration, although their contribution can vary by region and mix of products[4]. Forest carbon sequestration levels in the U.S. have been relatively steady in recent years, but it is uncertain to

[1] https://nafoalliance.org/wp-content/uploads/2018/11/Forest2Market_Economic_Impact_of_Privately-Owned_Forests_April2019.pdf
[2] https://maineforest.org/wp-content/uploads/2021/09/The-2019-Statewide-Economic-Contribution-of-Maines-Forest-Products-Sector.pdf
[3] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019
[4] https://crsf.umaine.edu/forest-climate-change-initiative/ncs/

what degree this trend will persist in the future, especially under changing socioeconomic and climatic conditions[5,6].

Forests have immense potential to help mitigate climate change. Already a large sink, U.S. forests can sequester even more carbon if landowners are provided the adequate incentives and technical assistance. Recent studies indicate that there's the potential for 190-675 $MtCO_2e/yr$ increase in forest sequestration from our forests, a 24-84% increase over recent annual estimates[7,8,9]. Further, a large proportion of this additional carbon could occur at relatively low economic cost, thereby making it an effective option to help achieve regional, national, and global climate change mitigation targets. In response, several public and private initiatives to protect and enhance forest carbon sequestration have emerged. For example, Maine's forest ecosystems and harvested products currently remove about 70% of the state's annual GHG emissions[10]. Further, the state has a goal of being net zero by 2045, and that goal should be achieved ahead of time Maine's forests can maintain current sequestration rates while the state continues to meet its fossil fuel GHG emissions reduction target of an 80% reduction below 1990 levels by 2050[11,12].

Well managed forests can simultaneously provide a wide range of co-benefits to society. These include wood production, carbon sequestration, recreation, clean air and water, and wildlife habitat. It is possible for all these ecosystem services to be provided at the landscape-level through a holistic management perspective. Doing so would require managing towards a balance of species and age class diversity, including a mix of early and late successional forests, timber plantations, and ecological reserves. Further, the pressures of climate change and growing demands of society mean that letting nature do what it has in the past is not a viable option to sustainably maintain the full suite of services that our forests provide.

Sustainable forest management and harvests are key to enhancing forest carbon sinks. Active management over the past century has helped our forests sequester and store more carbon than they would otherwise[13]. Without active management, forests are less resilient to climate change, grow slower, can become saturated, and are sequestering less carbon than otherwise. The annual mortality of standing timber in the U.S. has increased over the past few decades due to over maturity and increases in wildfire, insect infestations, and disease. For example, Maine has

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[5] Tian, X., Sohngen, B., Baker, J., Ohrel, S., & Fawcett, A. A. (2018). Will US forests continue to be a carbon sink?. *Land Economics*, *94*(1), 97-113.

[6] Nepal, P., Ince, P. J., Skog, K. E., & Chang, S. J. (2012). Projection of US forest sector carbon sequestration under US and global timber market and wood energy consumption scenarios, 2010–2060. *Biomass and Bioenergy*, 45, 251-264.

[7] Fargione, J.E., Bassett, S., Boucher, T., Bridgham, S.D., Conant, R.T., Cook-Patton, S.C., Ellis, P.W., Falcucci, A., Fourqurean, J.W., Gopalakrishna, T. & Gu, H., 2018. Natural climate solutions for the United States. *Science Advances*, *4*(11), p.eaat1869.

[8] Austin, K. G., Baker, J. S., Sohngen, B. L., Wade, C. M., Daigneault, A., Ohrel, S. B., Ragnauth., S., & Bean, A. (2020). The economic costs of planting, preserving, and managing the world's forests to mitigate climate change. *Nature Communications*, 11(1), 1-9.

[9] VanWinkle, C., Baker, J.S., Lapidus, D., Ohrel, S., Steller, J., Latta, G., & Birur, D. (2017). *US Forest Sector Greenhouse Mitigation Potential and Implications for Nationally Determined Contributions* (RTI Press).

[10] https://crsf.umaine.edu/forest-climate-change-initiative/carbon-budget/

[11] https://www.maine.gov/future/initiatives/climate/climate-council/forest-carbon-taskforce

[12] 38 M.R.S. § 576A (2019). http://legislature.maine.gov/statutes/38/title38sec576-A.html

[13] Mendelsohn, R., & Sohngen, B. (2019). The net carbon emissions from historic land use and land use change. *Journal of Forest Economics*, 34(3-4), 263-283.

some of the highest densities of non-native forest pests in the U.S., and their impacts will continue to increase in the coming decades due to climate change[14]. Trees that are declining rapidly or dead can become carbon emitters. The efficacy of forests, forest products, and woody biomass in addressing climate change is highly dependent on sustainable forest management.

A wide range of sustainable forest management practices can be used to promote climate solutions while maintaining timber supply. First, forests should be made more resilient by harvesting and quickly regenerating sites with desired species that are resistant to climate change, managing competition from invasives and undesirable species, and reducing the risk of loss to natural disturbance. Second, more forests need to undergo intermediate treatments to increase their growth and yield, and investment in more intensive management should target high productivity sites. These include increasing stocking in understocked stands and conducting thinning in immature and overstocked stands to stimulate growth and health of the remaining trees. Doing so will increase the proportion of harvested materials for durable wood products, thereby increasing the amount of carbon stored over time. Third, sustainable harvesting should be done by professionals trained in climate-friendly practices to minimize stand damage and soil disturbances. Last, some forests should be conserved or designated as reserves, particularly healthy sites with high carbon density and special ecological value.

Recent changes in the forest products industry have placed added pressure on the need to find new and diversified markets to support our rural economies and the forest resources upon which they rely on. These include advances in technology and changing demand over the past decade, which have resulted in the closure of pulp and paper mills and other wood manufacturing facilities. In Maine, this has reduced the total economic impact of the industry by several hundred million dollars with a concurrent loss of thousands of logging, forestry, and wood product manufacturing jobs. This has had a noticeable impact on several of Maine's rural communities, who are struggling to find ways to rebound from these recent closures. The aggregate market loss for the sector over recent years poses a challenge to the entire supply chain, raising concerns among landowners and industry stakeholders about the future economic outlook of the forest products industry. In response, communities across the country are working to identify new opportunities to sustainably utilize our abundant forest resources.

Continued research and development into new and more efficient uses of wood are critical to supporting our rural economies. Available timber supply exceeds wood product demand in many parts of the U.S., thereby impacting several parts of the forest sector supply chain. Identifying emerging uses and markets for wood can complement traditional forest products and increasing demand can provide landowners more opportunities for active management and harvesting for wide range of timber. Uses that are being actively explored include pellets and other forms of wood bioenergy, liquid biofuels, mass timber, nanocellulose-based products, and biochar. The University of Maine currently researching and developing the application and

[14] Arnold et al., (2020). Scientific Assessment of Climate Change and Its Effects in Maine. Maine Climate Council Scientific and Technical Subcommittee Report, August 2020. https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/GOPIF_STS_REPORT_092320.pdf

commercialization of many of these new innovations. Much of this research has been initiated through federal grants from the USDA, DOE, and NSF.

Forest markets are critical to maintaining the health and sustainability of our forests. Providing more consistent and increased demand for forest-based materials is good for both addressing climate change and increasing forest sequestration. A recent study from the University of Maine and U.S. Forest Service found that a significant portion of U.S. forests are reaching a critical biological tipping point where net sequestration of forests could decrease due to reduced growth and increased mortality[15]. The lack of low-grade markets is likely an important contributor to these observed trends. Finding new uses for wood and supporting rural communities to ensure a vibrant workforce can help improve the health of our forests. Robust and stable timber markets enable the carefully planned harvest of trees that is needed for forests to have appropriate stocking levels, balanced age classes, and species diversity. Innovative university-industry partnerships like NSF's Center for Advanced Forestry Systems (CAFS) are focusing on using technology to better refine and tailor management regimes across the US.

Markets play a key role in keeping forests as forests. Land is a commodity, and low value land is at risk of being converted to alternative uses. Thus, we need to promote all grades of wood markets as well as markets for other forest uses that will help maintain or increase its value and reduce deforestation. For context, nearly 50 $MtCO_2e$/yr in emissions is generated annually from forests being converted to cropland[16], equivalent to the annual GHG emissions of 11 million passenger vehicles[17].

Timber harvesting is necessary to meet societal needs and mitigate climate change. Nearly 20% of U.S. forest carbon sequestration is attributed to harvested wood products. In areas like Maine, timber products from managed forests contribute to about 30% of the annual carbon sequestration. Wood is also a renewable resource that can be substituted for more emissions-intensive materials such as steel and concrete. Further, reducing harvests in one area is likely to cause harvests to increase elsewhere, a term known as 'leakage', thereby resulting in less overall carbon benefits[18]. Incentivizing sustainable practices that maintain or increase both harvests and forest carbon will be a win-win for society and the climate.

Woody biomass and bioenergy are a part of the climate solution. The lack of low-grade markets has created challenges for active forest management and resulted in extensive forest areas at risk due to overstocking. Bioenergy is a logical and environmentally friendly use of forests, as it removes the low-grade material that would most likely die of natural causes and release carbon to the atmosphere. Capturing this mortality and putting it to use can reduce fossil-based energy and emissions. Increasing demand for biomass also increases the value of a forest, thereby incentivizing more investment in timberland and forest management. This investment

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[15] Woodall, C. W., & Weiskittel, A. R. (2021). Relative density of United States forests has shifted to higher levels over last two decades with important implications for future dynamics. *Scientific Reports*, 11(1), 1-12.

[16] https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-chapter-6-land-use-land-use-change-and-forestry.pdf

[17] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[18] Pan, W., Kim, M. K., Ning, Z., & Yang, H. (2020). Carbon leakage in energy/forest sectors and climate policy implications using meta-analysis. *Forest Policy and Economics*, 115, 102161.

can both positively impact forest health and carbon sequestration potential. A federal renewable energy standard for woody biomass harvested from sustainable forests is one way to improve markets for low-grade wood.

Forest climate solutions are vulnerable to climate change and other disturbances that could reduce their effectiveness as a climate solution. Climate change is already having direct impact on U.S. forests, significantly affecting the forest ecosystems and economy. These impacts are likely to grow in the future. Forestry and forest operations are already hampered overall with a heightened level of uncertainty due to variability in the weather and extreme events that makes managing the biology and operations of a forest increasingly difficult and often more expensive. We are already experiencing the impacts on wildfire frequency and intensity, particularly in the West. Climate change will also increase the likelihood of sustained drought in some regions. In other areas, it will result in more frequent and intense flooding. In places like Maine, it has made forest management and operations more difficult, particularly in the winter due to unfrozen and variable ground. Changing weather patterns can also introduce new pathogens and invasive species, thereby increasing the risk of tree mortality. Climate change could also have a positive impact on the growth and yield of some species, although those species are not always the most economically or environmentally desirable. More active management that focuses on reducing wildfire fuels and increasing forest health and resilience will help forests maximize their potential to be a reliable and cost-effective climate solution.

Several federal programs could be utilized to incentivize forest management and enhance carbon sinks, particularly with increased prioritization and funding. These include the Environmental Quality Incentives Program, the Forest Stewardship Program, the Forest Legacy Program, and the Forest Inventory and Analysis Program. Enhancing the funding and scope of these programs can increase both U.S. forest carbon stocks and the flow of timber products by helping improve forest conditions and wood utilization. Additional programs and funding must also be devoted to fuel treatment to help reduce the risk of wildfire. Further, maintaining or increasing federal tax incentives such as the management deductions and reforestation credits could further incentivize landowners to actively manage their land for timber, carbon, and other co-benefits. Expanding the type of woody material that qualifies for bioenergy would be a simple yet effective policy that would improve carbon sequestration and support more sustainable forest management too. In addition, we must continue to support R&D in the forest products and land management sectors through federal grants from the USDA, DOE, NSF, EDA, and more.

The opportunities and challenges for sustainably managing our forests for timber, carbon, and other ecosystem services are complex. Given the complexity of the changes to our forest ecosystem and forest products sector and the speed at which they can occur, there is more need than ever to employ the very best science to inform decision-making. The opportunities for forests and wood products to contribute to both carbon and sustainability goals have never been more critical. At the same time, careful analysis of both the carbon costs and benefits and the timeline of impacts is essential to assure that the forest contribution to eliminating anthropogenic greenhouse gas emissions is a net benefit to the global. This is particularly the case for the next several decades, as negative emissions technologies such as forest carbon sequestration will be

essential to mitigate the impacts of climate change. Further, we must continue to identify and promote sustainable opportunities to simultaneously improve the health of our forest ecosystems and the economies and people who are dependent on this important natural resource.

Thank you again for the opportunity to speak on this important topic. I invite you all to visit Maine and see all the great things that are going on at our universities and working forests to implement sustainable forest management and grow our forest economy.