STATEMENT OF

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CONCERNING

"WILDFIRE IN A WARMING WORLD: OPPORTUNITIES TO IMPROVE COMMUNITY COLLABORATION, CLIMATE RESILIENCE, AND WORKFORCE CAPACITY"

Mr. Chairman and members of the subcommittee, thank you for inviting me today to discuss wildfires and opportunities to improve climate resilience. I am Professor Emeritus of Global Change Biology & Terrestrial Systems Science at Oregon State University, where I have been working for 25 years. I am appearing today in my person capacity, not representing OSU. I am a Fellow of the American Geophysical Union. I served on the US Carbon Cycle Science Steering Group, and on IPCC expert panels. I was an editor for 8 years with Global Change Biology, one of the leading peer-reviewed journals. I have been a lead author of the National Climate Assessment, and co-author of National Research Council reports on verifying greenhouse gas emissions and air quality management. My research topics include multi-scale analysis of the effects of drought, fire and management on forest carbon and water processes, and land use strategies to mitigate climate change and benefit biodiversity. I will focus my remarks on forest carbon and biodiversity conservation for climate resilience and effects of fire and management on carbon.

Forest carbon stocks and accumulation have an important role in climate mitigation

Atmospheric carbon dioxide is 50% higher than preindustrial levels. The next 10 to 30 years are a critical window for climate action (IPCC 2018). We need to simultaneously reduce carbon dioxide emissions and increase carbon accumulation in land reservoirs of forests and other terrestrial ecosystems. Annual emissions from forest harvesting are slightly greater than emissions from the entire building sector in the U.S. Reducing this source of emissions could help the U.S. meet its climate goals.

Further, regional studies have shown that preserving western U.S. temperate forest with high carbon density and lower vulnerability to mortality would account for about 8 years of the region's fossil fuel emissions, supporting US climate goals (Buotte et al. 2019). This provides near-term opportunities to reduce carbon dioxide emissions and increase carbon storage and accumulation.

Forest protections are part of Nationally Determined Contribution (NDC) strategies, recognizing that increasing forest carbon stocks is important to the intent of the Paris climate treaty. The goal is "...

stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" [Article 2 UNFCCC 1992]. When allowed to grow longer, natural forests do more to mitigate climate than management activities that keep forest carbon stocks at a level below the potential carbon stock over time; a level that is insufficient to meet climate goals.

The ability of forests to pull carbon from the atmosphere and accumulate it in living trees and soil for decades to centuries will continue to play a major role in reducing the severity of climate consequences. Preserving high carbon density forests like those of the Pacific Northwest, and allowing them to continue to accumulate carbon could increase forest carbon stocks substantially by 2100 (Hudiburg et al. 2009, Law et al. 2018, Buotte et al. 2020). A comparison of strategies showed that restricting harvest by 50% on public forests to allow them to continue growing while lengthening current harvest cycles in forests with low vulnerability to drought and fire under future climate conditions contribute the most to increasing forest carbon and reduce emissions. Less effective are reforestation and lastly afforestation, which can have competing land uses for agriculture and urban development (Law et al. 2018). Thus, temperate forests with high carbon density and lower vulnerability to mortality have substantial potential for climate mitigation.

Reforestation can be part of the climate solutions, but is not the only solution. Young trees will eventually grow to have large carbon stocks that contribute to climate mitigation, but allowing some existing forests with their large carbon stocks to continue to accumulate carbon will accumulate far more carbon out of the atmosphere during the critical coming decades. It is also far more difficult and expensive to initiate a forest than to grow additional carbon stocks in existing forests.

Harvesting forests for wood products and bioenergy that is as carbon intensive as coal results in depletion of ecosystem carbon stocks and the regrowth of these stocks takes many decades to centuries into the future, creating a long-term carbon debt. More carbon is stored longer in forests than in wood products because about half of the harvested carbon is emitted soon after logging (Harmon 2019, Hudiburg et al. 2019, Harris et al. 2016). Of the accumulated carbon harvested from west coast U.S. forests since 1900, 65% has returned to the atmosphere while only 19% is in long-lived wood products, and the remaining 16% is in landfills. That is, 81% of the wood removed from west coast forests since 1900 has been emitted to the atmosphere as carbon dioxide or is in landfills (Hudiburg et al. 2019). Increased harvesting adds additional carbon dioxide to the atmosphere, accelerating climate change.

Forests with medium and high carbon per acre also have medium and high biodiversity, promoting ecosystem resilience to climate change

We are in the midst of an emergency to address both climate change and biodiversity loss (Ripple et al. 2019). We must consider both forest carbon *and* biodiversity when determining management strategies in forests. Studies estimate that at least one-third of American wildlife, more than 12,000 species, are at increased risk of extinction, with extinction risk being highest in the largest and smallest vertebrates (Ripple et al. 2017).

Under future climate projections, medium to high carbon density western U.S. forests with relatively low to moderate vulnerability of mortality from fire or drought also have high amounts of critical habitat and high species diversity (Buotte et al. 2020). If protected, these forests have a strong potential to support biodiversity into the future and to promote ecosystem resilience to a changing climate. These areas are primarily in the Pacific Northwest and northern Rocky Mountains in Idaho and Montana. A recent global study also strongly confirmed the spatial coincidence of areas important for carbon storage and biodiversity protection (Dinerstein et al. 2020).

Vulnerability to wildfire varies across the western US region in the next decades. Broad-scale thinning to reduce severity results in more carbon emissions than would be released by fire, creating a multi-decade carbon deficit that conflicts with climate goals.

Forests account for only about 40% of the area burned in wildfires in the U.S. Wet forests like the coastal forests of the PNW have longer fire return intervals (100-300 years). Strategically focusing on homes and communities is a smart place to start in fire-prone areas. At subregional to regional levels, roughly 1% of treatments (thinning, prescribed fires) experiences wildfire each year, and the effectiveness of treatments is only 10-20 year, so the treatments likely have little effect on wildfire (Campbell et al. 2012, Schoennagel et al. 2017).

Vulnerability of forests to wildfire varies spatially in the next decades. Wildfire is mainly a function of dryness, heat and wind. The warm, dry regions are expected to get warmer and drier. Projections show that burn area is expected to increase in the next few decades. Vulnerability to future fire is projected to be highest in the Sierra Nevada and portions of the Rocky Mountains, while high carbon-density forests in the coastal forests are expected to experience low vulnerability to fire (Buotte et al. 2018).

Wildfires have relatively little impact on forest carbon stocks as fires mainly combust surface litter and duff. If trees are killed, most of the carbon remains in the forest as dead wood that takes decades to centuries to decompose. Only a small portion of the total forest carbon is emitted to the atmosphere in wildfires – less than 10% of the total ecosystem carbon in live and dead trees, litter and soils combined has been found to enter the atmosphere as carbon dioxide in Pacific Northwest forest fires (Campbell et al. 2012; Law & Waring 2015).

Thinning to reduce fire severity or intensity is usually 30-50% of live tree biomass, and it puts much of the harvested carbon into the atmosphere quickly. A thinning study in a drought-prone young ponderosa pine plantation in Idaho found that removal of 40% of the live biomass from the forest would subsequently release about 60% of that carbon over the next 30 years (Stenzel et al. 2021). Enlarging the treated area more than would burn would further increase the carbon losses.

Local reduction of seedlings and saplings may be useful to protect the large trees in some fire-prone dry forests with high future vulnerability to fire. It will reduce whole ecosystem carbon, but can protect the large trees that store and accumulate the most carbon and are more drought- and fire-resistant than young trees (Irvine et al. 2004, Hurteau et al. 2019). Increasing the use of prescribed fires and managing wildland fires may promote resilience to more frequent fire (Schoennagel et al. 2017). Because climate change mitigation is expected to be part of decision-making, potential impacts of treatment options on forest carbon stocks should be assessed as part of a strategic decision-making process.

Broad-scale thinning of forests conflicts with carbon climate goals. The amount of carbon removed by thinning is much larger than that saved, and more area is harvested than would actually burn (Mitchell et al. 2009, Rhodes et al. 2009, Law & Harmon 2011, Campbell et al. 2012). The multi-decadal biomass carbon deficit following moderate to heavy thinning is supported by most analyses of mid to long-term thinning impacts on forest structure and carbon storage (Zhou et al. 2013). *There is no evidence that thinning forests increases biomass stored.*

Fire emissions are small relative to harvest emissions. Harvest-related emissions in the Oregon, Washington and California average about 5 times fire emissions (Hudiburg et al. 2019). In California, fire emissions are just a few percent of California's fossil fuel emissions.

Post-fire reforestation. Many western US forest fires are mixed-severity, meaning that a large portion of the fire burns at low and moderate severity in patches and a smaller portion burns at high severity where a majority of trees are killed (Law & Waring 2015). After fires, remaining trees and those on the periphery of burn areas provide seed source for natural regeneration (Donato et al. 2009). It is important to allow natural regeneration to occur because it provides the genetic and species diversity that existed prior to the fire, and that diversity makes the ecosystem more resilient. The complex early seral forest habitat that develops in the high severity patches is important to a host of species associated with these conditions (Donato et al. 2012). That is, both early- and late-successional forest canopies can support equally complex functioning and biodiversity. We can supplement with planting where regeneration fails.

Summary

The next 10 to 20 years are a critical window for climate action. Wildfires are an essential ecological process. They have relatively little impact on the total ecosystem carbon stock as fires mainly combust surface litter and duff, and if there is tree mortality the deadwood takes decades to centuries to decompose. In dry fire-prone forests projected to be vulnerable to fire-related mortality under future climate, it may be necessary to remove small trees in places. It would decrease ecosystem carbon but protect the large trees that are more fire-resistant and accumulate the most carbon. Impacts of tree removals on forest carbon stocks should be assessed as part of a strategic decision-making process. Preemptive broad-scale thinning will create a multi-decade carbon deficit that conflicts with carbon climate goals.

Deforestation and degradation reduce carbon stocks and other ecosystem benefits, create habitat loss that is a major cause of species extinctions, and are major sources of greenhouse gas emissions that further contributes to warming that amplifies risk of species extinction. Mature and old forests store more carbon in trees and soil than do young forests, and continue to accumulate it over decades to centuries making them the most effective forest-related climate mitigation strategy. High carbon density forests also have high biodiversity (species, critical habitat), promoting resilience to climate change.

Forest carbon, biodiversity and ecosystem type and integrity need to be considered concurrently when determining what to do with forests in the face of climate change. To meet zero net carbon goals and eventually halt climate change while also meeting biodiversity goals, some forests need to be protected.

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