Dear Rep. Khanna and Oversight Subcommittee Members and Staff,

During the March 16th hearing, "Fighting Fire with Fire", and in his written testimony, U.S. Forest Service Chief Randy Moore promoted increasing the intensity and scale of commercial logging, including commercial "thinning" and post-fire logging, ostensibly to facilitate forest carbon storage.

He indicated he had studies to support the plans to scale up logging to try to affect fire behavior over vast landscapes, but did not provide details. Experts at Oregon State and within the agency's research branch have been strongly questioning an approach that focuses on attempts to reduce vegetation.

Furthermore, the suggestion that forest carbon storage can be increased by more intensive and widespread removal of carbon from forests is strongly contradicted by a well-established and growing body of science. We have published numerous papers in this area, and I am in the top 1% of most cited authors on these subjects. I recently worked with other experts to produce a synthesis on the Status of Forest Carbon Management (attached document). I would know if there is science to support the claims.

I encourage you to hold a further hearing on the science, and to pose questions to Chief Moore asking him about the studies. In recent years, we have seen numerous field based studies make findings that are significantly at odds with the models and assumptions that the agency has been relying upon to support its management approach.

Sincerely,
Dr. Beverly Law
Professor Emeritus

# The Status of Science on Forest Carbon Management to Mitigate Climate Change and Protect Water and Biodiversity

March 9, 2022

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The next 10 to 20 years are a critical window for climate action and forests can play an important role in capturing and storing immense amounts of carbon. Reducing emissions from energy systems, deforestation, forest degradation and other sources while increasing accumulation of carbon by natural systems are the primary means by which we will control atmospheric $CO_2$. Preserving and protecting mature and old forests would not only increase carbon stocks and growing accumulation, they would address accelerating species loss and ecosystem deterioration and provide greater resilience to increasingly severe weather events.

As discussed in more detail below, functionally separating carbon, water and biodiversity and considering them independently leads to actions that inadvertently harm those values, and can increase carbon emissions. This is why the 2021 joint report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services and the Intergovernmental Panel on Climate Change (Pörtner et al. 2021) stresses that climate change and biodiversity need to be examined together as parts of the same complex problem when developing climate mitigation and adaptation solutions (Law et al. 2021, Law et al. 2018, Buotte et al. 2020).

The IPCC AR 6 report confirms the findings of a growing body of research that maintaining ecological integrity for biodiversity is essential to address climate change effectively (IPCC 2022). The Summary for Policy Makers, which is approved line by line by all IPCC member governments *including the United States,* summarizes current adaptation and mitigation climate science as follows:

> "SPM.D.4 Safeguarding biodiversity and ecosystems is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation (very high confidence). Recent analyses, drawing on a range of lines of evidence, suggest that maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near-natural ecosystems (high confidence)."

> "SPM.D.4.1 Building the resilience of biodiversity and supporting ecosystem integrity* can maintain benefits for people, including livelihoods, human health and well-being and the provision of food, fibre and water, as well as contributing to disaster risk reduction and climate

change adaptation and mitigation." The formal definition of ecosystem integrity refers to the ability of ecosystems to maintain key ecological processes, recover from disturbance, and adapt to new conditions."

Many current U.S. forest management practices are inconsistent with this scientific consensus, and are worsening both climate change and biodiversity loss.

Most forests in the U.S. have been harvested multiple times, and many managed forests are harvested well before reaching maturity. "In the South, where more acres of short-rotation yellow pine trees are planted, 51 percent of timber land is less than 40 years old compared with 20 percent in the North and 22 percent in the West. In contrast, 56 percent of northern timber land is more than 60 years old, compared with 27 percent in the South and 69 percent in the West." (U.S. Forest Service 2014). These forests have the potential to grow and accumulate additional carbon for centuries. This means that current forest carbon densities are much lower than their potential, and could be grown to accumulate much more carbon. Instead of regularly harvesting on all of the 70% of U.S. forest land designated as "timberlands" by the US Forest Service, setting aside sufficient areas as Climate and Biodiversity Strategic Reserves (30% by 2030, 50% by 2050) would significantly increase the amount of accumulated carbon between now and 2050 to 2100. Continuing commercial timber harvest on a portion of the remaining public lands and tens of millions of acres of private lands would continue to adequately supply a sustainable forest sector.

**Protecting forests is a key strategy in meeting net zero carbon goals and halting climate change.**

High carbon forests in the western US contain high biodiversity, store water, and are more resilient to climate change (Law et al. 2021). The U.S. Pacific Northwest and Alaska stand out as having mature and old forests with immense carbon stores and high biodiversity that meet the IPCC defined criteria need protection to accumulate significant additional carbon out of the atmosphere. A majority of these areas are on public lands with the potential for permanent protection at the highest international levels. These mature and old forests, whether or not they are vulnerable to disturbance, are critical for potential future carbon accumulation, and are an essential source of clean drinking water (Law et al. 2021, Mildrexler et al 2020). There are additional regions of the U.S. that qualify for protection as well.

Mature and old forests store more carbon in trees and soil than young forests, and continue to accumulate it over decades to centuries (Hudiburg et al. 2009) making them the most effective forest-related climate mitigation strategy. Converting mature and older forests to younger forests results in a significant loss of total carbon stores, even when wood products are considered (Harmon & Marks 2002, Hudiburg et al. 2019). Young plantation forests significantly decrease streamflow compared with that of mature and old forests, particularly in drier months (Perry & Jones 2016, Segura et al. 2020). Forests account for almost 60% of the most important areas for surface drinking water in the western US, yet only about 19% are protected at the highest levels (Law et al. 2021).

**Harvesting forests for bioenergy production conflicts with climate goals.**

Promoting wood biomass as a substitute for coal *increases* $CO_2$ emissions and *worsens* climate change for many decades or more. Meeting U.S. national emissions reduction goals requires net emissions to drop by approximately 50% by 2030, reach net zero by 2050 and be net negative beyond 2100 (IPCC 2018; IPCC 2021).

Although wood and coal release comparable amounts of carbon dioxide per unit of primary energy (EPA 2018), wood chips and pellets burn less efficiently. A 500-megawatt power plant burning wood pellets emits an estimated 437,300 tons of carbon as carbon dioxide annually, whereas the same plant burning coal would emit 392,000 tons/year (EPA 1997). The situation is worse if wood displaces other fossil fuels: wood releases about 25% more $CO_2$ per unit of primary energy than fuel oil, and about 75% more $CO_2$ than fossil (natural) gas (EPA, 2018). Further, greenhouse gas emissions from the wood supply chain exceed those of the coal supply chain: Approximately 27% of harvested carbon is used to produce dry pellets (Röder et al., 2015), while coal processing adds just about 11% to emissions (Sterman et al. 2018a). Therefore, the immediate impact of wood bioenergy is an increase in $CO_2$ emissions, even if the wood displaces coal, the most carbon intensive fossil fuel.

*Regrowth takes time:* The time between the combustion of wood and the potential, eventual removal of that excess $CO_2$ by regrowth is known as the carbon debt payback time to the atmosphere (Mitchell et al. 2012). For forests in the eastern U.S., which supply much of the wood for pellet production and export, carbon debt payback times range from many decades to a century or more, depending on the species and climate zone (Sterman et al. 2018a, 2018b).

Carbon debt payback times are increased because harvesting wood from growing forests also prevents the $CO_2$ removal that would have occurred had trees not been harvested and burned. If a 40-year old forest was harvested and burned, releasing its carbon immediately to the atmosphere, under ideal conditions, it would take another 40 years to remove the added carbon from the atmosphere and restore the initial carbon stocks in the regrown forest (Hudiburg et al. 2011, Schlesinger 2018). But if not harvested, the same forests would have continued to accumulate significantly more carbon, thereby further reducing the amount in the atmosphere. Shorter rotation times between harvests for bioenergy, leave the greatest amount of $CO_2$ in the atmosphere (Sterman et al. 2018b).

The forests of the southeastern and south central U.S. are among the most intensively harvested in the world, and the largest source of wood for commercial scale bioenergy, mostly in Europe. If allowed to regrow, they could remove significant additional atmospheric $CO_2$ and accumulate the carbon in trees and soils. These forests also harbor some of the highest biodiversity of any region in North America.

Note that wood bioenergy harvest worsens climate change even if the harvested forests are managed sustainably, because the total stock of carbon on the land stabilizes at a level lower than prior to harvest, and the carbon lost from the land is added to the atmosphere, worsening climate change (Sterman et al., 2018a; Sterman et al., 2018b).

*Eventual carbon neutrality* does not mean *climate neutrality*. The excess $CO_2$ from wood bioenergy worsens global warming immediately upon entering the atmosphere. The harms caused by that additional warming are not undone even if regrowth eventually removes the excess $CO_2$. Global average surface temperatures will not immediately return to previous levels (Solomon et al. 2009). The Greenland and Antarctic ice sheets melt faster, sea level rises higher, wildfires become more likely, storms intensify more, and extinction is greater than if the wood had not been burned. Even eventual full forest recovery will not replace lost ice, lower sea level, undo climate disasters, or bring back communities lost to floods or wildfires. Carbon neutrality is not climate neutrality.

To mitigate climate change, we must reduce energy consumption through greater end-use efficiency gains and shift to carbon-free energy sources (e.g., solar and wind) (Pehl et al. 2017), while protecting more mature and older forests so they continue to remove and accumulate atmospheric carbon.

**Broad-scale thinning to reduce fire severity results in more carbon emissions than would be released by fire, creating a multi-decade carbon deficit that conflicts with climate goals**.

The amount of carbon removed by thinning is much larger than the amount that might be saved from being burned in a fire, and far more area is harvested than would actually burn (Mitchell et al. 2009, Rhodes et al. 2009, Law & Harmon 2011, Campbell et al. 2011, Hudiburg et al. 2011, Hudiburg et al. 2013). Most analyses of mid- to long-term thinning impacts on forest structure and carbon storage show there is a multi-decadal biomass carbon deficit following moderate to heavy thinning (Zhou et al. 2013). A thinning study in a young ponderosa pine plantation vulnerable to drought 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). Although thinning is commonly used to reduce fire severity and associated tree mortality, a comparison of thinned with adjacent unthinned stands in the burn area of a large California wildfire showed that thinning resulted in more tree mortality than unthinned stands, i.e. fire killed more trees than thinning prevented from being killed (Hanson 2022).

As to the effectiveness and likelihood that thinning might have an impact on fire behavior, a multi-year study of forest treatments like thinning and prescribed fire across the western US found that only 1% of those treatment areas experience wildfire each year. The potential effectiveness of treatments lasts only 10-20 years, diminishing annually (Schoennagel et al. 2017). There are high forest carbon losses associate with thinning, only minor differences in the combustive losses associated with high severity fire and the low-severity fire that fuel treatment is meant to encourage, and a low likelihood that thinned forests will be exposed to fire during treatment effectiveness (Campbell et al. 2011).

While moderate to high severity fire can kill trees, most of the carbon remains in the forest as dead wood and it will take decades to centuries to decompose that wood. 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. 2011, Law & Waring 2015). Recent field studies of combustion rates in California's large megafires show that carbon emissions were very low overall at the stand- (0.1-3.2%) and landscape-level (0.6-1.8%) because larger trees with low combustion rates comprise the majority of biomass and high severity fire patches are less than half of the area burned (Stenzel et al. 2019, Harmon et al.

2022). The results are consistent with field studies on Oregon's East Cascades wildfires and the large Biscuit Fire in southern Oregon (Campbell et al. 2007, Meigs et al. 2009), where most of the material that combusts is forest floor litter and the underlying duff. A small fraction of stemwood burns, and deadwood remaining onsite slowly decomposes.

The vulnerability of forests to wildfire will increase in future climates, but this will vary spatially in the next 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). Put into context, fire emissions are small relative to harvest emissions. Harvest-related emissions in Oregon, Washington and California average about 5 times fire emissions (Hudiburg et al. 2019). In California, fire emissions are just a few percent of the state's fossil fuel emissions. In the lower 48 states, harvest-related emissions are 7.5 times those from all natural causes (fire, insects, windthrow) (Harris et al. 2016).

**Focus efforts from the home out, not the forest in.**

Over the past century, public agencies have borne the primary responsibility for managing and mitigating cross-boundary fire risk and protecting communities, with their efforts focused on prevention, fuel reduction and suppression. However, of all the ignitions that crossed jurisdictional boundaries (greater than 22,000 fires), more than 60% originated on private property and 28% ignited on national forests (Downing et al. 2022). The finding contradicts the common narrative of wildfires igniting on remote public land and then spreading to communities.

The Forest Service strategy for reducing the severity of wildfires is focused on thinning public lands to prevent wildfire intrusion into communities, even though the far greater and growing portion of the wildfires begin in populated areas. For example, intensive forest management including fuel reduction failed to stop the spread of the 2021 Dixie Fire in California (DellaSala et al. 2022). The best science is telling us to work from the home out, not the forest in. Community safety experts and wildfire risk managers are all telling us that focus should be on addressing the home ignition zone by utilizing fire resistant design and zoning, and fuels management on adjacent private lands (Syphard et al. 2019).

**Post-fire cutting versus natural regeneration**.

Many western US forest fires are mixed-severity, meaning that a large portion of the fire burns in patches of low to moderate severity and a smaller portion burns at high severity where a majority of trees are killed (Law & Waring 2015). After fires, the remaining live and dead trees in the burn area and those on the periphery provide seed sources for natural regeneration (Donato et al. 2009). Allowing natural regeneration to occur ensures that the genetic and species diversity that existed prior to the fire will continue, and the diversity increases the resilience of the ecosystem to future disturbance.

The complex early seral forest habitat that develops in high severity burns is important to a broad range of wildlife associated with these conditions (Fontaine et al. 2009). Both early- and late-successional forests can support complex functioning and biodiversity. Post-fire harvest and felling of live and dead trees can negatively affect soil integrity, hydrology, natural regeneration, slope stability, and wildlife habitat (Beschta et al. 1995). Large standing dead, live yet possibly dying, and downed trees help forests recover and provide habitat for more than 150 vertebrates in the Pacific Northwest (Rose et al. 2001).

By adding another stressor to burned watersheds, post-fire logging worsens degraded conditions that have accumulated from a century of human activity (Thorn et al. 2018, Karr et al. 2004). In sum, the current body of research indicates that the loss of ecosystem services that can result from post-fire treatments is significant (Beschta et al. 2004).

**Summary**

Many of the existing forest management practices allegedly to protect forests and homes from wildfire are having severe adverse effects on forest integrity, and resilience and are worsening climate change and diminishing biodiversity. Forest bioenergy adds significantly more $CO_2$ to the atmosphere than fossil fuels. Its use is based upon a mistaken assumption that it is necessary to shift to renewable energy rather than to reduce emissions from all sources including forest bioenergy. Climate change mitigation and biodiversity protection are an essential part of forest management decision-making, therefore potential impacts of treatment options on forest carbon and biodiversity must be assessed. Actions taken to reduce fire risk and restore post-fire forest lands are instead creating significant adverse consequences for forests, climate and people. It is essential to utilize the full range of knowledge that has been developed and refrain from many present management practices.

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