STATEMENT OF

DR. BEVERLY LAW

PROFESSOR EMERITUS

OREGON STATE UNIVERSITY

BEFORE THE

UNITED STATES HOUSE OF REPRESENTATIVES

SUBCOMMITTEE ON NATIONAL PARKS, FORESTS AND PUBLIC LANDS

APRIL 29, 2021

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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May 4, 2021

Dr. Beverly Law
Professor Emeritus, Global Change Biology & Terrestrial Systems Science
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Dear Dr. Law:

I am writing to thank you for appearing before the Subcommittee on National Parks, Forests, and Public Lands oversight hearing on April 29, 2021, to present testimony on *"Wildfire in a Warming World: Opportunities to Improve Community Collaboration, Climate Resilience, and Workforce Capacity."* Your testimony was extremely helpful in defining the Committee's understanding of the issue.

As a follow-up to your testimony, please find enclosed additional questions submitted by members of the Committee for inclusion in the final hearing record. Please provide your written responses to: Lily Wang, Subcommittee Policy Aide, **no later than May 13, 2021**. Committee Rule 3(o) requires responses within 10 business days of the last day of the hearing.

We appreciate your time and insight, and we remain grateful for your contribution to the Committee's work. Should you have any questions, please contact the Subcommittee Policy Aide, Lily Wang, at (202) 875-0409 regarding this request.

Sincerely,

Joe Neguse
Chair
Subcommittee on National Parks, Forests, and Public Lands

Questions for the Record by Democratic Members

Questions from Representative Ruben Gallego

1. Dr. Law, you've testified that intact natural landscapes are critical for carbon sequestration, biodiversity, and climate resilience. Do you believe that National Forest areas as protected by the Roadless Area Conservation Rule should qualify as conservation lands based on those criteria?

2. Last year, the Trump administration issued a rule to exempt the Tongass National Forest from all protections provided by the Roadless Rule. Do you believe that the Alaska Roadless Exemption supports carbon, biodiversity, or climate goals?

3. With nearly 100 of my Democratic colleagues, I have introduced the Roadless Area Conservation Act. The bill would reverse the Alaska Roadless Exemption and permanently protect nearly 60 million acres of Roadless National Forest System land. Do you believe this bill could support climate and conservation goals? Do you think there are opportunities to strengthen Roadless or other climate-smart protections?

Questions for the Record by Republican Members

Questions from Ranking Member Bruce Westerman

1. During the hearing, Chairman Neguse said the following: "*With respect to Mr. Westerman's point, he's right in the sense that we ought not focus simply on what we need to do from a suppression standpoint, and of course that has to be a big part of the conversation.*" Later he stated: "*We also need to focus on how to prevent these wildfires from happening in the future. Obviously, a part of that is better forest management. As I said, you'll have a partner in me in approaching that conversation in good faith as we've done previously. But, let's also not divorce what's happening from climate change.*"

   Do you agree with Chairman Neguse's statements?

2. In her written testimony, your fellow panelist Dr. Schultz stated: "*There is broad scientific agreement that our primary goal should be to restore natural conditions and processes, like fire, which allow forests to adjust and be more resilient to climate change. Where fire has been excluded, forest restoration can involve thinning small trees and reducing fine fuels in the forest so that we can see the return of more low-to-moderate severity fire, which historically was more frequent in our fire-prone forests. Thinning is typically most effective when followed by prescribed fire, which reduces fine fuels.*"

   Do you agree with Dr. Schultz's statement that there is broad scientific agreement for the need to conduct forest management activities like thinning and prescribed burning in forests that have fuels build-ups due to decades of fire suppression?

3. In her testimony, your fellow panelist Dr. Schultz stated: "*Forest restoration and fire hazard reduction can serve to reduce fire intensity, stabilize carbon stores, and prevent the conversion of forests to grasslands or shrublands, which could be even more fire-prone and fail to provide key ecosystem services.*"

   Do you agree with Dr. Schultz that forest restoration and fire hazard reduction can serve to stabilize carbon stores?

4. Your testimony included an uncited statement that: *"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."*

    a. What is the source for this statement?
    b. According to data from the EPA, buildings accounted for 13% of overall domestic greenhouse gas emissions in 2019, while the forestry and land use sector was considered a net sink. Please explain the discrepancy between this data and your statement above.

5. In your testimony you stated: "*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)."*

    In contrast, Dr. Schultz stated in her written testimony: "*While most fuels treatments never see fire, when planned in a meaningful way, they can make a difference, particularly near communities.*"

    a. In light of Dr. Schultz's testimony, do you still agree with your original statement that treatments have little effect on wildfire?
    b. In what regions of the country in particular do you believe that fuels treatments are unnecessary or will have little effect on wildfire?

6. In your testimony, you stated: *"In California, fire emissions are just a few percent of California's fossil fuel emissions."*

    However, according to recent studies, "Because pandemic restrictions limited travel and other activities, fine-particle pollution from the burning of fossil fuels dropped 13 percent between March and July compared to the previous year and dipped again in November and December, said Lauri Myllyvirta, lead analyst at the Centre for Research on Energy and Clean Air, who collaborated on IQAir's annual World Air Quality Report.

But the 2020 historic wildfire season more than made up the difference. Overall, the U.S. average for the deadliest type of air pollution rose nearly 7 percent over 2019 because of smoke from fall fires, primarily those in California, Oregon and Washington." [emphasis added]

Would you like to amend your original statement, in light of the most recent data on the 2020 wildfire season?

7. According to a report from the EPA: "*Though harvesting forests removes much of the [carbon] C in aboveground biomass (and possibly changes C density in other pools), on average, the estimated volume of annual net growth in aboveground tree biomass in the conterminous United States is about double the volume of annual removals on timberlands (Oswalt et al. 2019).*"

   Given that net growth in aboveground biomass is double the volume of annual harvesting removals, would you agree that timber harvesting is not having an overall net negative effect on aboveground biomass and associated forest carbon stock?

8. Your testimony cites your own paper, Law, et al. 2018, on several occasions. This paper specifically ignored the 2002 Biscuit Fire impact on Western Oregon carbon stocks. In 2020, over 1 million acres burned in Oregon during yet another historic wildfire season.

   a. How would the inclusion of the Biscuit Fire modified the results of your research?
   b. How would the inclusion of data from recent fire seasons, including the 2020 wildfire season, modify the results you previously found in your report?

9. According to Forest Service data, "*By maintaining current harvesting practices and regeneration activities on these forested lands, along with continued input of harvested products into the HWP pool, C stocks in forests are likely to continue to increase in the near term, though possibly at a lower rate. Because most of the timber harvested from U.S. forest land is used in wood products and many discarded wood products are disposed of in SWDS rather than by incineration, significant quantities of C in harvested wood are transferred to these long-term storage pools rather than being released rapidly to the atmosphere (Skog 2008).*"

   a. Do you agree with the Forest Service?

b. Please explain any discrepancies between the Forest Service's data and your own research on the cycle of harvest, regeneration, and utilization.

10. In your testimony you stated: "*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).*"

A recent Forest Service report stated, in regards to Pacific Northwest forests: "*Of all disturbance factors, wildfires occurring from 1990 to 2011 have had the most significant effect on C storage, causing the loss of about 1.4 percent of nonsoil C stocks by 2011 (fig. 1). Timber harvests reduced nonsoil C storage by approximately 0.9 percent since 1990, while insect outbreaks have also resulted in tree mortality and C losses in parts of the region. Although there has been significant interannual variability in both temperature and precipitation, between the 1950s and 2011 the climate has on average become much warmer and somewhat drier, but has had little effect on C stocks in recent years.*"

The report further stated, in regards to California's forests: "*Fires were particularly large in 2000 and 2008, when they affected more than 1 percent of the region's forest land. Fires from 1990 to 2011 resulted in the loss of about 2.1 percent of nonsoil forest C stocks by 2011 (fig. 1). The C impact of harvest within the region was relatively stable from 1990 through 2011, causing the removal of about 0.7 percent of nonsoil C stocks.*"

Please explain the discrepancy between your testimony and data from the Forest Service.

11. The Forest Service currently estimates that the harvested wood products pool sequesters 98.8 million metric tons of CO2, the largest source of forest carbon sequestration behind aboveground biomass.

    a. Is the methodology used to evaluate the carbon sequestration potential of harvested wood products cited in your testimony the same methodology used by the Forest Service?
    b. If your methodology differs from the Forest Service, how does your research account for carbon sequestration in long-lived harvested wood products and the use of wood products as building materials?

c. If your methodology differed in the evaluation of the harvested wood products pool, did your methodology also differ from the Forest Service in your analysis of carbon pools in the forest ecosystem?

12. In your testimony you stated: *"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."*

a. What is your source for the claim that forests with large existing carbon stocks will have a rate of accumulation "far more" than the rate of carbon accumulation in young trees?

b. Are carbon accumulation rates of old forests with large carbon stocks generally increasing or decreasing on federal lands? Please cite any answer you provide to this question, and note whether the data was derived from the Forest Service or another source.

c. How does your statement above account for overstocked forests and the increasing risk of wildfire on our federal lands?

13. In your testimony you stated: "*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."*

a. Which public forests are you specifically referring to that have a "low vulnerability to drought and fire"? What percentage of these forests are located in the West?

b. Have any of the public forests studied in the comparison of strategies you cited experienced a wildfire since the study was published?

c. Do you believe that the current drought conditions in the West will increase the likelihood and severity of catastrophic wildfire this year?

14. Please provide the Committee with data on the total carbon emissions in millions of metric tons associated with thinning and catastrophic wildfires on National Forest System lands for the past

10 years that you believe supports the claim that "*broad-scale thinning to reduce severity results in more carbon emissions than would be released by fire*."

15. In your testimony you stated: *"Wildfire is mainly a function of dryness, heat and wind."*

What differences would be seen in the severity, likelihood, and intensity of catastrophic wildfires in a managed forest versus an unmanaged forest in similar climates?

16. Regarding the 2020 wildfire season:

    a. What were the total carbon emissions from wildfires in 2020?

    b. What were the total carbon emissions from thinning activities in 2020?

    c. In your opinion, would forest management activities like hazardous fuels reductions in areas that experienced catastrophic wildfires in 2020 have helped prevent those wildfires from occurring?

17. Your previous research cited in your testimony primarily focused on forest carbon and timber harvesting in the State of Oregon. According to Forest Service data on forest carbon stocks in Oregon, the total amount of annual net carbon flux from timber harvesting was -1,557 thousand metric tons of CO2 while fires accounted for -1,922 thousand metric tons of CO2.

    In light of this data, do you believe that timber harvesting on federal lands in Oregon has more of an effect on emissions than wildfires?

18. Many discussions of wildfire prevention have focused exclusively on catastrophic wildfire in the wildland-urban interface.

a. What are the consequences of catastrophic wildfire outside the wildland-urban interface on water quality, air quality, outdoor recreation, wildlife habitat, and local economies?
b. What are the benefits of forest management activities for reducing fire risk and severity within the wildland-urban interface?
c. What are the benefits of forest management activities for reducing fire risk and severity outside of the wildland-urban interface?

Questions for the Record by Republican Members
Questions from Ranking Member Bruce Westerman

1. During the hearing, Chairman Neguse said the following: "*With respect to Mr. Westerman's point, he's right in the sense that we ought not focus simply on what we need to do from a suppression standpoint, and of course that has to be a big part of the conversation.*" Later he stated: "*We also need to focus on how to prevent these wildfires from happening in the future. Obviously, a part of that is better forest management. As I said, you'll have a partner in me in approaching that conversation in good faith as we've done previously. But, let's also not divorce what's happening from climate change.*"
Do you agree with Chairman Neguse's statements?

Response: I would need to speak with Chairman Neguse to understand his specific thinking and positions to be able to respond. The data and recent events show that increasing drought and wind is driving an increase in fire activity, and that the driving factor in these fires is not the availability of fuels. In my home state of Oregon, half of the 60 million acres of land is forestland. Over a million acres in Oregon burned last year, primarily on the west side of the Cascades. These forests have fire return intervals between 150-300 years. Reports from local residents, firefighters and statewide newspapers are that many of these fires were ignited by power lines. This occurred during Red Flag conditions of high wind and extreme drought. Furthermore, in the Holiday Farm fire, 74% of the landscape that burned was heavily managed, logged and roaded. My colleagues at Oregon State University have found that intensively managed young plantations burn at higher severity than older natural forests. In these events, suppression was not possible, as the fires grew over 100,000 acres in a 24 hour period. Climate change has increased the frequency of extreme heat and drought events.

The takeaway from the 2020 fires in Oregon is that we will always have available fuel in the forests that can burn. Grasslands and shrublands can burn too. We are not going to be able to cut our way to less fire, nor are we going to be able to suppress all fire. We need to be prepared for the large fire events by hardening our homes and protecting our communities. We may need to improve forest management, and that discussion needs to include how we manage industrial forestlands so they do not pose increased risks to communities.

2. In her written testimony, your fellow panelist Dr. Schultz stated: "*There is broad scientific agreement that our primary goal should be to restore natural conditions and processes, like fire, which allow forests to adjust and be more resilient to climate change. Where fire has been excluded, forest restoration can involve thinning small trees and reducing fine fuels in the forest so that we can see the return of more low-to-moderate severity fire, which historically was more frequent in our fire-prone forests. Thinning is typically most effective when followed by prescribed fire, which reduces fine fuels.*"

Do you agree with Dr. Schultz's statement that there is broad scientific agreement for the need to conduct forest management activities like thinning and prescribed burning in forests that have fuels build-ups due to decades of fire suppression?

Response: Dr. Schulz appears to be referring to doing work in forests areas where low to moderate severity fires were historically more frequent. In Oregon, these are typically dry lower-elevation forests and woodlands. This is not true in all forests. As I stated in my testimony, "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)." However, the scope and scale of this work is very expensive, and thinning vast landscapes has not been shown to have a high-probability of success in encountering fire or altering fire behavior. In Oregon, we have millions of acres of dry forests, and just addressing a portion of this landscape will costs billions of dollars. Because of the short period of treatment effectiveness (10-20 yr), the treatments will need to be repeated into the future. It is important for policymakers to know that there are ecological and carbon costs from landscape scale thinning, and that it is not an effective tool to ensure community safety. Rather, as Dr. Jack Cohen has demonstrating, working from the home outward is the best approach to ensuring fire safe communities.

3. In her testimony, your fellow panelist Dr. Schultz stated: "*Forest restoration and fire hazard reduction can serve to reduce fire intensity, stabilize carbon stores, and prevent the conversion of forests to grasslands or shrublands, which could be even more fire-prone and fail to provide key ecosystem services.*"

Do you agree with Dr. Schultz that forest restoration and fire hazard reduction can serve to stabilize carbon stores?

Response: See response to #2 above, which was in my written testimony. The answer in part depends on what Dr. Schultz means by "forest restoration" and where the "fire hazard reduction" occurs. However, there is no guarantee that thinning across vast landscapes will stabilize carbon stores. Rather the best available scientific study has shown that thinning reduces carbon stores more than fire itself and reduces carbon stores whether or not fire burns that particular forest.

4. Your testimony included an uncited statement that: *"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."*

a. What is the source for this statement?

Response: The sources are Harris et al. (2016) for forest harvest emissions (citation is in the testimony) and the US EPA GHG emissions, where data were downloaded from the following links:

https://cfpub.epa.gov/ghgdata/inventoryexplorer/#residential/entiresector/allgas/category/all

https://cfpub.epa.gov/ghgdata/inventoryexplorer/#commercial/entiresector/allgas/category/all

Harris et al. (2016) includes US Forest Service authors who are involved in the forest carbon accounting for the EPG GHG emissions estimates. The Harris et al. CO_2 emissions data were for 2001 to 2006, and the EPA CO_2 emissions data for Economic Sectors and the same period are required for apples to apples comparisons. The harvest emissions estimate averaged 594 MMT CO_2e, and the EPA residential + commercial CO_2 emissions estimate averaged 559 MMT CO_2e over the same period.

b. According to data from the EPA, buildings accounted for 13% of overall domestic greenhouse gas emissions in 2019, while the forestry and land use sector was considered a net sink. Please explain the discrepancy between this data and your statement above.

Response: See explanation above.

5. In your testimony you stated: "*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)."*

a. In contrast, Dr. Schultz stated in her written testimony: "*While most fuels treatments never see fire, when planned in a meaningful way, they can make a difference, particularly near communities.*" In light of Dr. Schultz's testimony, do you still agree with your original statement that treatments have little effect on wildfire?

Response: Top experts support focusing investments from the home outward. This means that first you harden the home, then you create defensible space up to 100 feet outward, and then you consider creating operable space for firefighters around homes and communities. In Oregon, if we focus efforts to reduce fuels around census-designated places, experts tell us that we would only need to address between 100-150,000 acres of land. If "planned in a meaningful way" means focusing from the home outward, then I would support that approach. My statement was intended to address efforts to change fire behavior across vast landscapes by thinning a portion of those landscapes. My response is supported by a comprehensive synthesis of wildfire research in the western US. See Schoennagel et al. PNAS 2017 section titled, "Managing Fuels – Limiting Reliance on Fuels Treatments to Alter Regional Fire Trends," which added to an earlier synthesis on the topic (Campbell et al. 2012).

In areas of the Western US with wildfire risk, the most strategic actions we can take are to focus our limited resources on homes and communities, and emphasis needs to be on hardening homes, following guidelines for creating defensible space from the homes outward (e.g. California Fire Safe Council), and dealing with the problem of ignitions caused by power lines.

b. In what regions of the country in particular do you believe that fuels treatments are unnecessary or will have little effect on wildfire?

Response: If your goal is to keep people, homes and communities safe, the most proven approach is to focus from the home outward. In western Oregon's Cascade forests, there is no scientific basis to attempt to reduce fuels, as they just grow back rapidly and it is not possible to reduce their flammability. Other regions with relatively low vulnerability to future fire are identified in Buotte et al. (2019), and include mesic coastal forests.

6. In your testimony, you stated: *"In California, fire emissions are just a few percent of California's fossil fuel emissions."*

However, according to recent studies, "Because pandemic restrictions limited travel and other activities, fine-particle pollution from the burning of fossil fuels dropped 13 percent between March and July compared to the previous year and dipped again in November and December, said Lauri Myllyvirta, lead analyst at the Centre for Research on Energy and Clean Air, who collaborated on IQAir's annual World Air Quality Report. **But the 2020 historic wildfire season more than made up the difference. Overall, the U.S. average for the deadliest type of air pollution rose nearly 7 percent over 2019 because of smoke from fall fires, primarily those in California, Oregon and Washington."** [emphasis added] Would you like to amend your original statement, in light of the most recent data on the 2020 wildfire season?

Response:

The question is on a different topic from my testimony. I was invited to discuss forest carbon and biodiversity conservation for climate resilience and the effects of fire and management on carbon. In brief, the 2020 fires produced large pulses of smoke. Much of that particulate matter moved into the upper atmosphere and dispersed over large areas. The 2020 fires were not a chronic source of pollution.

Just as people in Oregon prepare for earthquakes, rain and wind events, they and the rest of the West can prepare themselves for smoke. It is not possible to contain or prevent all fires and related smoke, so we can individually and collectively prepare for smoke.

Regarding the science that I was invited to present, we compared fire emissions with fossil fuel emissions using carbon accounting. A life cycle assessment analysis (Hudiburg et al. 2019) computed fire emissions for California based on measurements to produce combustion factors for various biomass components under different severities in the region and satellite data on burn area and severity. California's forest fire emissions averaged 10 MMT CO_2e yr^{-1} from 2013-2016. The average fossil fuel emissions for California from 2013-2016 was ~362 MMT CO_2e yr^{-1}. Thus, forest fire emissions averaged 2.8% over this timeframe. Official satellite data produced by USGS EROS data center and the USDA FS on burn area and severity within each fire area are not available yet for 2020 to do the calculations of forest wildfire CO_2 emissions (https://www.mtbs.gov/).

7. According to a report from the EPA: "*Though harvesting forests removes much of the [carbon] C in aboveground biomass (and possibly changes C density in other pools), on average, the estimated volume of annual net growth in aboveground tree biomass in the conterminous United States is about double the volume of annual removals on timberlands (Oswalt et al. 2019).*"

Given that net growth in aboveground biomass is double the volume of annual harvesting removals, would you agree that timber harvesting is not having an overall net negative effect on aboveground biomass and associated forest carbon stock?

Response: Careful scientific study and analysis has demonstrated that timber harvest is not increasing removal of carbon from the atmosphere by terrestrial systems nor is it reducing emissions. In Oregon, for example, private industrial timberland is storing less than half the total carbon potential of the sites. This is because, in many cases, the trees are harvested on a 35-40 year rotation, and very little downed or dead wood is left on site. The soil profile and the amount of carbon it stores is also impacted by intensive, short rotation forestry.

8. Your testimony cites your own paper, Law, et al. 2018, on several occasions. This paper specifically ignored the 2002 Biscuit Fire impact on Western Oregon carbon stocks. In 2020, over 1 million acres burned in Oregon during yet another historic wildfire season.

a. How would the inclusion of the Biscuit Fire modified the results of your research?

Response: Incorrect, the Biscuit Fire was included in the analysis in the publication. See Table 1. About 180 USFS FIA inventory plots are within the burn area and were used in the analysis along with FIA plots across the state to estimate the forest variables in the table along with our intensive post-fire plots that were used to estimate fire emissions in the table (Campbell et al. 2012 cited in the testimony).

b. How would the inclusion of data from recent fire seasons, including the 2020 wildfire season, modify the results you previously found in your report?

Response: As noted above, the 2020 multi-agency satellite data are not available yet, so a robust analysis cannot be conducted until the data are available.

9. According to Forest Service data, "*By maintaining current harvesting practices and regeneration activities on these forested lands, along with continued input of harvested products into the HWP pool, C stocks in forests are likely to continue to increase in the near term, though possibly at a lower rate. Because most of the timber harvested from U.S. forest land is used in wood products and many discarded wood products are disposed of in SWDS rather than by incineration, significant quantities of C in harvested wood are transferred to these long-term storage pools rather than being released rapidly to the atmosphere (Skog 2008).*"

a. Do you agree with the Forest Service?

See response 9b.

b. Please explain any discrepancies between the Forest Service's data and your own research on the cycle of harvest, regeneration, and utilization.

Response:
We accounted for these factors and our estimates are more recent than 2008, we use a more process-oriented approach to estimate net forest carbon from observations as recommended for IPCC Tier 1 (NAP 2008), track more product pools (7), and account for combustion emissions from logging and mill residues. Buildings are separated into different components each with different life spans and loss mechanisms (e.g., decay versus replacement or demolition). We did the calculations for three forested western states, OR, CA and WA over 115 years, and we found that annual wood product and landfill decomposition for the three states was 71 MMT CO_2e yr^{-1}, whereas harvest residue combustion was 12.9 MMT CO_2e averaged over 2001 to 2016 (Table 1, Hudiburg et al. 2019). These western states are net sinks because there is a positive net balance of forest carbon uptake exceeding losses due to harvest, wood product use and combustion by wildfire. However, wood product use is reducing the potential annual sink by ~21%, suggesting forest carbon storage can become more effective in climate mitigation through reduced harvest, longer rotations and more efficient wood product use, as stated in Hudiburg et al.

10. In your testimony you stated: "*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).*"

A recent Forest Service report stated, in regards to Pacific Northwest forests: "*Of all disturbance factors, wildfires occurring from 1990 to 2011 have had the most significant effect on C storage, causing the loss of about 1.4 percent of nonsoil C stocks by 2011 (fig. 1). Timber harvests reduced nonsoil C storage by approximately 0.9 percent since 1990, while insect outbreaks have also resulted in tree mortality and C losses in parts of the region. Although there has been significant interannual variability in both temperature and precipitation, between the 1950s and 2011 the climate has on average become much warmer and somewhat drier, but has had little effect on C stocks in recent years.*"
The report further stated, in regards to California's forests: "*Fires were particularly large in 2000 and 2008, when they affected more than 1 percent of the region's forest land. Fires from 1990 to 2011 resulted in the loss of about 2.1 percent of nonsoil forest C stocks by 2011 (fig. 1). The C impact of harvest within the region was relatively stable from 1990 through 2011, causing the removal of about 0.7 percent of nonsoil C stocks.*"
Please explain the discrepancy between your testimony and data from the Forest Service.

Response: In our studies on wildfires (summarized in Campbell et al. 2012), we measured litter, duff, soil organic layer, trees of different sizes, and shrubs for different fire severities, and the combustion factors were used in the estimates of fire emissions. Fire emissions are small relative to harvest emissions (Harris et al. 2016, Hudiburg et al. 2019). The USFS study you cite did not compute fire emissions, and did not compare fire emissions with those from harvest, insects, windthrow and land conversion, which Harris et al. did do more recently. As noted earlier, the Harris et al. (2016) paper includes US Forest Service staff who do the forest carbon accounting for the EPA GHG report. The Harris et al. analysis is for the lower 48 US states, and the results in Hudiburg et al. compare well with Harris et. al. even though ours were for OR, CA and WA. Across the lower 48 states, direct harvest-related emissions are 7.6 times higher than all-natural disturbances combined (Harris et al. 2016). In the West Coast states (OR, CA, WA), harvest-related emissions average 5 times fire emissions for the three states combined (Hudiburg et al. 2019).

11. The Forest Service currently estimates that the harvested wood products pool sequesters 98.8 million metric tons of CO2, the largest source of forest carbon sequestration behind aboveground biomass.

a. Is the methodology used to evaluate the carbon sequestration potential of harvested wood products cited in your testimony the same methodology used by the Forest Service?

Response: See (11b) below.

b. If your methodology differs from the Forest Service, how does your research account for carbon sequestration in long-lived harvested wood products and the use of wood products as building materials?

Response: Our Life Cycle Analysis (LCA) is very robust and has seven product pools (single- and multi-family homes, non-residential construction, mobile homes, furniture and manufacturing, shipping, other wood). Buildings are separated into components with different life spans with lag times before significant loss occurs, recognizing the difference between building life span and the residence time of carbon in buildings. The LCA employs temporally dynamic recycling and landfill rates in our analysis for OR, CA and WA, using published USFS coefficients for calculating harvested carbon and emissions from different product pools, e.g. from decomposition in landfills (Smith et al. 2006; Hudiburg et al. 2019). The Hudiburg et al. paper stresses the need for full carbon accounting, and the FS accounting used in the EPA GHG report does not account for combustion emissions from logging and mill residues. Of the cumulative wood harvested in the past 115 years, 65% is in the atmosphere, 16% is in landfills, and 19% is in long-lived products (Hudiburg et al. 2019). A more recent thinning study that also tracked harvested carbon using the LCA showed 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).

The FS study methods in the provided link above appear to focus on different parts of the budget. They only report the net flux resulting from emissions and removals. The Harris et al. 2016 paper shows the total emissions from harvest and disturbances. Again, our findings are similar to theirs for relative emissions from harvest and fire.

c. If your methodology differed in the evaluation of the harvested wood products pool, did your methodology also differ from the Forest Service in your analysis of carbon pools in the forest ecosystem?

Response: See (11b) above.

12. In your testimony you stated: *"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."*

a. What is your source for the claim that forests with large existing carbon stocks will have a rate of accumulation "far more" than the rate of carbon accumulation in young trees?

Response: Numerous studies plainly show that this statement is true. Stocks plus accumulation is carbon that is not in the atmosphere. Studies show the increasing carbon stocks with age from inventory plots on public lands (Hudiburg et al. 2009), and the effectiveness of allowing forests to grow and accumulate more carbon (higher stock plus accumulation) out of the atmosphere while benefiting species diversity (Buotte et al. 2020). A global study shows that old-growth forests are usually carbon sinks and because they can continue to accumulate carbon for centuries, they contain vast quantities of carbon (Luyssaert et al. 2007). After stand-replacing disturbance, young forests are a net source to the atmosphere for an average of 10 to 20 years, after which they gradually become a larger net carbon sink (Amiro et al. 2010).

It is not the rate of carbon uptake that matters the most, it is the total mass balance of carbon over time. Think of it this way, would you rather have a bank account with $100 making a 5% return or would you rather have a bank account with $10,000 making a 4% return. The $100 account is a young tree, and the $10,000 account is an older forest. This statement holds true for burned forests, if not logged, as well. If the burned forests is not logged, the vast majority of the carbon is still on site in the burned boles and stems. In many cases the vast majority of the biomass is still in the forest. These boles and stems may decay over time, but the decay is slow and in this way fire contributes to long-term carbon storage.

b. Are carbon accumulation rates of old forests with large carbon stocks generally increasing or decreasing on federal lands? Please cite any answer you provide to this question, and note whether the data was derived from the Forest Service or another source.

Response: Hudiburg et al. (2009) analysis of USFS FIA data showed that "biomass is still increasing in stands over 300 years old in the Coast Range, Sierra Nevada and the West Cascades" (3 of the 6 ecoregions of the study area that included the PNW and N California). The analysis is more thorough than the Forest Service standard product because the study used species- and ecoregion-specific equations and wood density cores for estimating biomass.

c. How does your statement above account for overstocked forests and the increasing risk of wildfire on our federal lands?

Response: I would need to know what forests you assert are overstocked, and by what standard you are asserting that a forest is overstocked. On the one hand, a dense forest may be natural and provide habitat for wildlife. On the other, a plantation forest (tree farm) may be very densely planted and at high risk of rapidly spreading fire.

13. In your testimony you stated: "*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.*"

a. Which public forests are you specifically referring to that have a "low vulnerability to drought and fire"? What percentage of these forests are located in the West?

Response: Just over half of the forested area of the western US is expected to have low vulnerability to drought or fire (Buotte et al. 2019). High carbon density forests in the Pacific coast and western Cascades regions were projected to be the least vulnerable to drought or fire. Forests in the Tongass also have a low vulnerability to fire. Higher elevation moist mixed conifer forests of the Interior Columbia Basin and in the Sierra Nevada also can make valuable contributions.

b. Have any of the public forests studied in the comparison of strategies you cited experienced a wildfire since the study was published?

Response: We have not mapped wildfires and looked at strategies more recently than the publication dates, and those papers include data on droughts and fires, some of which were years with large fires.

c. Do you believe that the current drought conditions in the West will increase the likelihood and severity of catastrophic wildfire this year?

Response: As noted by Parks & Abatzoglou (2020), "the relationships identified between the annual fire severity metrics and climate, as well as the observed and projected trend toward warmer and drier fire seasons, suggest that climate change will contribute to increased fire severity in future decades where fuels remain abundant." Such wildfires are likely becoming more common due to climate change causing warming and drying of vegetation and air (NASA 2021). Extreme weather events are influenced by many factors in addition to global warming (National Academies of Science). Daily and seasonal weather patterns and natural climate patterns such as El Niño or La Niña affect when and where extreme weather events take place. For example, many studies have linked an increase in wildfire activity to global warming. In addition, the risk of a fire can depend on past forest management, natural climate variability, human activities, and other factors, in addition to human-caused climate change. Determining how much climate change contributes to extreme weather events such as wildfires continues to be studied.

14. Please provide the Committee with data on the total carbon emissions in millions of metric tons associated with thinning and catastrophic wildfires on National Forest System lands for the past 10 years that you believe supports the claim that "*broad-scale thinning to reduce severity results in more carbon emissions than would be released by fire*."

Response: This specific requesting would require an analysis that isn't possible in this timeframe.

15. In your testimony you stated: *"Wildfire is mainly a function of dryness, heat and wind."*

What differences would be seen in the severity, likelihood, and intensity of catastrophic wildfires in a managed forest versus an unmanaged forest in similar climates?

Response: After a wildfire burned over the matrix of public and private forestlands in southeastern Oregon, a study found that daily fire weather was the most important predictor of fire severity, followed by stand age and ownership. It suggested that intensive plantation forestry characterized by young forests and spatially homogenized fuels rather than pre-fire biomass were significant drivers of wildfire severity (Zald & Dunn 2018).

16. Regarding the 2020 wildfire season: a. What were the total carbon emissions from wildfires in 2020?

Response: The USGS/USFS satellite data on burn area and severity have only recently become available for 2019 (release date April 2021), and the 2020 data are not yet available.

b. What were the total carbon emissions from thinning activities in 2020?

Response: The 2020 data are not available to do the analysis, and even if they were, this would take some time to produce quality estimates.

c. In your opinion, would forest management activities like hazardous fuels reductions in areas that experienced catastrophic wildfires in 2020 have helped prevent those wildfires from occurring?

Response: The 2020 wildfires in Oregon were ignited by lighting, campfires and powerlines. The primary driver of those fires was drought and wind. There is evidence that the 2020 wildfires burned rapidly through heavily managed plantations in the McKenzie River watershed. There is also evidence that wildfires burned rapidly through areas that were thinned around Mt. Thielsen and that these efforts to reduce fire severity had little to no positive effect. Studies have also shown that thinning can dry out the forest floor, increase wind speeds and contribute to increased ember cast. Furthermore, the probability that fire will burn an area that has been cut to reduce fuels is very low (around 1%) during the period of treatment effectiveness, which is around 10-20 years (Schoennagel et al. 2017). While reducing the amount of vegetation will not prevent wildfires from occurring or from spreading, they may reduce severity, intensity, and rate of spread (Schoennagel et al. 2017), and result in lower pyrogenic emissions (Campbell et al. 2012). The takeaway is that thinning forests is a very small lever and does not provide for increases in community safety.

17. Your previous research cited in your testimony primarily focused on forest carbon and timber harvesting in the State of Oregon. According to Forest Service data on forest carbon stocks in Oregon, the total amount of annual net carbon flux from timber harvesting was -1,557 thousand metric tons of CO2 while fires accounted for -1,922 thousand metric tons of CO2.

In light of this data, do you believe that timber harvesting on federal lands in Oregon has more of an effect on emissions than wildfires?

Response: Full carbon accounting is required to answer this question (see #10). Oregon's annual forest harvest-related emissions averaged 53.8 MMT CO_2e (2001-2016), while fire emissions averaged 5.3 MMT CO_2e. Combining Oregon, California, and Washington, the annual averages were 107 MMT CO_2e for harvest-related emissions and 20.7 MMT CO_2e for fire emissions. Thus, harvest-related emissions were about 5 times that of fire emissions (Hudiburg et al. 2019) and had a greater impact on forest carbon (the net ecosystem carbon balance, NECB) than fire emissions. Harris et al. (2016), which included authors who are involved in emissions estimates for the EPA GHG report, indicated that harvest-related emissions were 7.6 times that from all natural sources (fire, insects, windthrow) for the lower 48 states.

18. Many discussions of wildfire prevention have focused exclusively on catastrophic wildfire in the wildland-urban interface.

a. What are the consequences of catastrophic wildfire outside the wildland-urban interface on water quality, air quality, outdoor recreation, wildlife habitat, and local economies?

Response: Extreme conditions that lead to large wildfires can impact air quality, as we saw in 2020 according to the air quality index that remained high for a few days, and subsequently impact other areas of concern, but the level of impact depends on the severity, size and duration. A mixed-severity regime is common in the western US, where there are patches of high, moderate and low severity within a fire. In the PNW and N California including the Sierra Nevada, the proportion of total burn area that was high severity averaged 12-14% from 1984 to 2011 (Law & Waring 2014). Contrary to common belief, high severity patches have not been increasing in size during the period of the satellite record (MTBS 1985+). In the northern and middle Rockies, high elevation cold/wet forest fire activity increased and characteristically burns at high severity (Schoennagel et al. 2017). In general, the frequency of large fires in the western US has increased since 1970.

Numerous studies have found high native plant and animal species richness after wildfires that are in the mixed-severity regime, and successful natural tree regeneration in the severe patches as we found on the Biscuit Fire which included areas of short-interval repeat burning (Donato et al. 2009, Fontaine et al. 2009). Native vegetation is well-adapted to periodic wildfire, but people living in or near wildlands are not. More frequent and larger wildfires, combined with increasing development at the wildland–urban interface will likely increasing risks to property and human life unless the adaptive measures are taken (e.g. home hardening, defensible space, limiting or preventing further development in high fire risk areas).

b. What are the benefits of forest management activities for reducing fire risk and severity within the wildland-urban interface?

Response: It is highly unlikely that attempt to manage the flammability of vast landscapes by cutting will be effective or achievable over time. See responses to (#5a, 16c). State and federal agencies need to support individuals and communities to be fire wise, create and maintain defensible space and protect critical infrastructure. Home hardening works. Emergency planning and early warning systems are the most effective ways to save lives and livelihoods in extreme fire weather.

c. What are the benefits of forest management activities for reducing fire risk and severity outside of the wildland-urban interface?

Response: The Wildland Urban Interface (WUI) is not consistently defined across the nation. Oregon just passed legislation requiring further refinement to the definition, and legislators here are focusing on the lands around census designated places and the community protection zone. As discussed above, given the vastness of the landscape, the cost, the speed at which vegetation grows back and the fact that grasslands and shrublands burn too - it is highly unlikely that attempts to reduce vegetation/fuels across the landscape will work over time. They will reduce fire risk to homes and communities, if the weather is not severe it may reduce fire severity in certain forest types. See responses to (#5a, 16c).