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Comments: Dear Regional Foresters Buchanan and Eberlien,

Please accept the following comments on the Northwest Forest Plan (NWFP) Amendment Draft Environmental Impact Statement (DEIS) from Eastern Oregon Legacy Lands.

Sincerely,

David Mildrexler, PhD

Systems Ecologist

Eastern Oregon Legacy Lands

Joseph, Oregon

Climate Change Comments on the U.S. Forest Service[rsquo]s Draft Environmental Impact Statement for the Proposed Northwest Forest Plan Amendment

David Mildrexler, PhD Systems Ecologist

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March 17, 2025

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Submitted online via https://cara.fs2c.usda.gov/Public//CommentInput?Project=64745

Re: Northwest Forest Plan Amendment Draft Environmental Impact Statement

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1. The Urgency of the Climate Crisis

The Northwest Forest Plan (NWFP) Amendment Draft Environmental Impact Statement[rsquo]s (DEIS) climate analysis generally does not recognize the disproportionate importance of this decade and the next for meeting critical climate goals and avoiding the worst consequences of climate change (Friedlingstein et al., 2023). Nor does it recognize that forests within the NWFP area are among the most important in the United States for climate mitigation. These are critical shortcomings given that climate science has shown that we are in a pivotal period when future outcomes of massive consequence to society and future generations will be determined (IPCC, 2023; Ripple et al., 2023). There is growing urgency for taking integrated climate action and for recognizing the importance of mature and old forests as an irreplaceable natural climate solution (Birdsey et al., 2023; Griscom et al., 2017; Fargione et al., 2018; Lutz et al., 2018).

The DEIS looks to symptoms of climate change to rationalize a proposed action that increases direction to log in both mature and old-growth forests across the NWFP area in dry and moist forest types, under the guise of stewardship. But reducing emissions to the atmosphere that cause climate change requires protecting accumulated carbon stocks in mature and old forests, allowing these forests to grow and uptake more carbon which they do most effectively, and limited intervention in them, focused on plantations and cutting small, young trees in frequent- fire forests and reintroducing prescribed fire to restore a low-severity fire regime. As it stands, the proposed alternatives threaten greater carbon emissions during the rapidly closing window of time for meeting climate goals by reducing emissions. This is a critical shortcoming of the DEIS because it is through the lens of climate science that the long-term implications of these proposed policy changes should be considered.

The urgency of the climate crisis and the importance of protecting intact natural ecosystems is made clear in the 2023 IPCC Report:

There is a rapidly closing window of opportunity to secure a livable and sustainable future for all.

The choices and actions implemented in this decade will have impacts now and for thousands of years.

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[rsquo]s land, freshwater and ocean areas, including currently near natural ecosystems.

2. The Global Carbon Budget

The remaining carbon budget for a 50% likelihood to limit global warming to 1.5, 1.7, and 2[deg]C has reduced to 75 Gt C (275 Gt CO2), 175 Gt C (625 Gt CO2), and 315 Gt C (1150 Gt CO2), respectively, from the beginning of 2024, equivalent to around 7, 15, and 28 years, assuming 2023 emission levels (Friedlingstein et al., 2023). In other words, we are perilously close to running out of time before we overshoot the 1.5[deg]C threshold (Bevacqua et al., 2025).

Our ability to limit the overshoot time period and keep global warming below the 1.5[deg]C threshold (in the long run) is no longer possible only by phasing out fossil fuels. As the 2023 IPCC Report recognizes, we need to keep 50% of Earth[rsquo]s land and waters intact to support natural processes needed to mitigate the climate crisis. The IPCC Report specifies that [ldquo]Protection of existing natural forest ecosystems is the highest priority for reducing greenhouse gas emissions (Moomaw et al., 2019; IPCC, 2022).[rdquo]

3. Climate-Related Research Strongly Supports Retaining Mature and Old-Growth Forests in the NWFP Area

a. Forests Are an Essential Carbon Sink

The accumulation of carbon in forest ecosystems is essential for keeping carbon dioxide out of the atmosphere and mitigating ongoing climate change (IPCC, 2018; 2023). Forests account for 92% of all terrestrial biomass globally (Pan et al., 2013) and their removal of about 30% of fossil fuel emissions annually from the atmosphere has been fairly constant for about the last 60 years, with a significant portion taken up by temperate forests (Friedlingstein et al., 2023).

The world[rsquo]s forests have consistently accumulated carbon over the past three decades, despite changes in the buffering capacity of different biomes (Friedlingstein et al., 2023; Pan et al., 2024). On the topic of forest carbon status and dynamics, the DEIS (3-86) refers to [ldquo]major climate vulnerabilities facing ecosystems in the NWFP area,[rdquo] such as intensification of the hydrologic cycle driving productivity responses to climate change (Hogan et al., 2024), increasing drought and heat stress induced declines in some tree species of the western US (Stanke et al., 2021), and climatically-driven changes in disturbance regimes and concurrent shifts in vegetation distribution in forests of the USA (McDowell et al., 2020). However, the global forest carbon sink has endured despite these variations in regional and continental scales (Pan et al., 2024). And most importantly, the carbon sink in temperate forests increased significantly, by around 30 percent. US temperate forests are the largest category of land sinks in the country, offsetting about 14% of the Nation[rsquo]s CO2 emissions (EPA, 2020). In the continental United States, from 1990 to 2020 temperate forests continued to accumulate carbon as middle- aged forests grew older and despite increasing emissions from disturbances, especially insects and fire (Pan et al., 2024). Pan et al. (2024) states:

Our results indicate that the single most important action for sustaining and increasing the forest carbon sink is to stop emissions from deforestation and degradation, along with protecting the large carbon stocks that have accumulated over centuries.

In this context, mature and old-growth forests play an outsized role. As discussed more below, these forests and trees have large, accumulated carbon stocks and associated co-benefits to biodiversity, water, and buffering climatic extremes (Kauppi et al., 2015; Law et al., 2022; Mildrexler et al., 2023; Moomaw et al., 2019).

b. National Importance of NWFP Forests in Climate Mitigation

The DEIS fails to recognize the national importance of national forests within the range of the NWFP for their carbon and climate mitigation values. The NWFP area includes some of the highest biomass and carbon dense forests in the world (Smithwick et al., 2002; Keith et al., 2009), exceptional in their ability to store and accumulate carbon from the atmosphere over decades to centuries (Law and Waring, 2015). Much of the Pacific Northwest (PNW) region is within the maritime influence of the coast providing an enhanced degree of buffering against the influence of climate change (Waring et al., 2011). NWFP forests play an important role in our nation[rsquo]s fight against climate change. Full recognition of the climate values of these forests is a key lens through which policy changes should be considered.

Law et al. (2023) examined mean tree carbon density across all national forests (NFs) in the United States, finding that [ldquo]The top 5 NFs with the highest mean tree carbon density (141[ndash]170 Mg C ha[minus]1) are the Siuslaw, Olympic, Gifford Pinchot, Mt. Baker, and Willamette, which all occur in either the Coast Range or Cascade Range of western Oregon and Washington.[rdquo] Figure 1a shows the mean tree carbon density and total tree carbon stock for all national forests. Forests within the range of the NWFP (red colored dots) dominate the highest mean tree carbon density values (and are also among the highest for total tree carbon stock notwithstanding the Tongass). In fact, the top ten National Forests in the nation for mean tree carbon density are all within the NWFP area (Appendix Table 1). Among high integrity national forests, NWFP forests command the highest mean tree carbon density values (Figure 1b).

[Figure 1b: Mean tree carbon density and total tree carbon stock for all forests (a) and high integrity forests (b) - SEE PDF]

Figure 1. Mean tree carbon density (Mg C ha[minus]1) for each national forest in the National Forest System (NFS). Summaries are provided for (a) all forests and (b) high integrity forests within each national forest. Tree carbon includes live aboveground and belowground biomass. The plotting character for each national forest is scaled by its overall contribution to total tree carbon stocks across (a) all forests and (b) high integrity forests in the NFS. Forests were considered high integrity if the forest landscape integrity index was [ge]9.6 out of 10 (Grantham et al., 2020). NWFP forests are plotted as red points. Note the exceptionally high mean tree carbon density values of NWFP forests. Adapted from Law et al. (2023).

Drier forests within the range of the NWFP also support important carbon values. Compared against national averages, rather than against the exceptional carbon density values of coastal and westside forests described above, drier forests such as the Rogue River, Trinity, Klamath, Mendocino, Wenatchee and Shasta are all within the top 35 national forests in the nation for mean tree carbon density (Appendix Table 1). Appendix Table 2 shows the sum of AGC stores by national forest ranked from high to low. This accounts for the fact that forests with lower carbon density values may cover a large area, resulting in large cumulative carbon stores. All forests within the range of the NWFP are within the top 50% of the highest ranked forests for total carbon stores, and most are much higher, including numbers 2 and 3 in the nation. National forests like the Klamath, Deschutes, and Okanagan have relatively low mean tree carbon density values for NWFP forests, but have high ranks for total carbon stores because of their large areas.

The exceptional carbon and climate mitigation value of NWFP forests is well-documented in the literature. Buotte et al. (2019, 2020) identified forests in the western U.S. with high potential carbon accumulation and relatively low vulnerability to future drought and fire using the Community Land Model and two climate models with high CO2 emissions (RCP8.5), and species-specific traits capturing sensitivity to drought and fire. High-carbon-priority forests were concentrated along the Pacific coast and the Cascade Mountains, and interior forests such as within the Eastern Cascades also contain substantial high and mid-carbon priority opportunities to increase forest carbon accumulation (Buotte et al., 2019; Buotte et al., 2020; Law et al., 2018).

It is important to note that despite the outstanding capacity of NWFP forests to accumulate and store carbon from the atmosphere, implementation of the NWFP in 1993 switched these northwest forests from a carbon source (negative net ecosystem carbon balance) to a carbon sink (Healey et al., 2008; Turner et al., 2011). This switch occurred because the NWFP dramatically reduced clearing of older forests and overall harvest rates. The underlying principle for this change is the negative relationship between harvest intensity and forest carbon stocks whereby as harvest intensity increases, forest carbon stocks decrease and emissions increase (Harmon and Marks, 2002; Hudiburg et al., 2009; Mitchell et al., 2009; Simard et al., 2020). Law and Waring (2015) state:

The combined carbon stored in ecosystems and products from the ecosystems is always lower when rotation intervals are shorter and harvest intensity is higher (Mitchell et al., 2012). That is, harvesting with greater frequency and intensity lowers carbon storage in forests and prolongs the time needed to recoup the carbon debt.

This is a fundamental principle of forest carbon dynamics. Because of a century of intensive logging, for Oregon and Northern California, it would take centuries to make up for carbon that was lost through previous harvests (Birdsey et al. 2006; Hudiburg et al., 2009; Harmon and Marks, 2002). It has only been a few decades since the NWFP was implemented, and these forests remain well below their potential carbon stocks due to past and current land management practices (Hudiburg et al., 2009).

The DEIS action alternatives all propose to increase logging rates on our national forests. The DEIS describes at 3-88: [ldquo]While effects from harvest remain relatively steady from year to year, the quantities of carbon removal due to fire and insect vary greatly, depending on the actual wildland fire events.[rdquo] This steady and predictable effect from harvest is why increasing harvest rates will reduce carbon stores commensurately. We have much more control over harvest rates than losses of carbon from episodic natural disturbances.

In forests of the conterminous U.S., harvesting is the largest contributor of carbon emissions by forests being some seven times greater than all other sources combined including fire, insects, land conversion, wind and disease (Harris et al., 2016). In Oregon and Washington (Region 6) about 80% of tree mortality is attributed to harvest (Berner et al., 2017). These forests could be much more effective in the fight against climate change if we protect accumulated carbon stocks in mature and older forests and reduce harvest levels (Pan et al., 2024; Law et al., 2022).

This is why Pan et al. (2024) states that going forward, [ldquo]the single most important action for sustaining and increasing the forest carbon sink is to stop emissions from deforestation and degradation, along with protecting the large carbon stocks that have accumulated over centuries.[rdquo]

c. Mature and Old-Growth Trees Provide Carbon Benefits Essential to Fight Climate Change

Climate change provides no justification for logging mature and old-growth trees[mdash]quite the opposite. Large-diameter trees are a defining structural attribute of mature and old-growth forests and are key to the ability of forests to accumulate and store substantial amounts of carbon from the atmosphere (Luyssaert et al., 2008; Lutz et al., 2012; Lutz et al., 2018; Leverett et al., 2021; Stephenson et al., 2014). Globally, studies have found that about half the aboveground carbon (AGC) is concentrated in a small proportion of large trees (1-5% of total stems) (Lutz et al., 2018; McNicol et al., 2018; Mildrexler et al., 2020). Large-diameter trees enhance carbon stability because they are the safest long-term storage vault for AGC in the forest (Mildrexler et al., 2023). The carbon in old and mature forests is [ldquo]irrecoverable,[rdquo] meaning that the carbon stocks accumulated in these forests cannot be regained during the critical time period to meet climate goals (Noon et al., 2022).

In addition to carbon storage, large-diameter trees are crucial for their ability to accumulate carbon from the atmosphere (Luyssaert et al., 2008; Stephenson et al., 2014; Lutz et al., 2021). This is important because mature and old forests not only store much more carbon than younger forests, they continue to accumulate large quantities of carbon dioxide from the atmosphere and store it in long-lived tissues and forest soils (Luyssaert et al., 2008).

Global evaluations have shown that the rate of tree carbon accumulation increases with tree size (Stephenson et al., 2014). Stephenson et al. (2014) report:

Here we present a global analysis of 403 tropical and temperate tree species, showing that for most species mass growth rate increases continuously with tree size. Thus, large, old trees do not act simply as senescent carbon reservoirs but actively fix large amounts of carbon compared to smaller trees; at the extreme, a single big tree can add the same amount of carbon to the forest within a year as is contained in an entire mid-sized tree.

Recognition of the importance of large-diameter trees in the global carbon cycle has led to management recommendations to conserve existing large-diameter trees and those that will soon reach large diameters (Lutz et al., 2018; Lindenmayer et al., 2014).

Mature forests will be the next old forests, and along with old forests, they will do the most to mitigate climate change. Allowing mature forests to age into old-growth forests is a major opportunity to increase carbon stocks, especially on Federal Lands (Moomaw et al., 2019). Yet, the DEIS avoids recognizing the importance of retaining mature and old forests for their climate mitigation values. Changing the age-criteria in moist forests from 80 to 120 years would open up over 824,000 acres of mature moist forests to logging in LSR[rsquo]s. In dry forests, eliminating stand- level protections and only protecting a tiny fraction of trees that are >150 years of age would leave these forests vulnerable to overly aggressive logging. These proposed changes run counter to climate mitigation values of these forests and will result in large reductions in carbon stores along with substantial and rapid emissions to the atmosphere (Zhou et al., 2013; Harris et al., 2016; Hudiburg et al., 2019). This is the decisive decade for climate action to avert catastrophic consequences to society (IPCC, 2022), and mature and old forests offer major solutions, but only if they are kept alive and growing.1

Referring to a recent timber sale (Flat Country) on the Willamette National Forest that would have cut mature trees ~100, ~120 years, within the same age range now proposed for logging across hundreds of thousands of acres in the NWFP area, Dr. Jerry Franklin and Dr. Norm Johnson made the following comments:2

Both Johnson and Franklin say if the sale goes through, it would set a dangerous precedent for future logging projects in mature forests. [ldquo]These old-growth forests are relatively rare in western Oregon,[rdquo] Johnson says. [ldquo]They[rsquo]re important for a variety of species and for people, too.[rdquo]

Forests like those found in the Willamette National Forest are optimal for snow capture and retention in the spring, Franklin says. They help produce high quality water and they are effective at regulating water to minimize floods. The USFS is proposing to replace some mature trees with a plantation, he says, which doesn[rsquo]t provide any of those benefits and actually consumes a lot of water.

The Willamette National Forest near McKenzie River is one of the last reservoirs of trees, he says, adding that they can[rsquo]t be replaced. [ldquo]This is the motherlode of carbon storage,[rdquo] Johnson says. [ldquo]It just stands out on a global map. If we[rsquo]re serious about combating climate change, you[rsquo]d start with these forests and keeping them.[rdquo] For mature and old-growth forests, the decisive issue is carbon stocks. Carbon stock is carbon that is not in the atmosphere, and it takes many decades to centuries for large trees to accumulate these carbon stocks from the atmosphere. Because of the urgency of reducing greenhouse gases, incurring greater emissions now by cutting large trees so that future younger forests may accumulate carbon lost to the atmosphere from the cutting is counter-productive for reaching net zero emissions in the next few decades (Law et al., 2022; Moomaw et al., 2019; IPCC, 2022).

Young forests store very little AGC compared to mature and old forests and are often conspicuous sources of carbon to the atmosphere. Luyssaert et al. (2008) states:

In fact, young forests rather than old-growth forests are very often conspicuous sources of CO2 because the creation of new forests (whether naturally or by humans) frequently follows disturbance to soil and the previous vegetation, resulting in a decomposition rate of coarse woody debris, litter and soil organic matter (measured as heterotrophic respiration) that exceeds the NPP [Net Primary Productivity] of the regrowth.

And looking beyond AGC, large trees are keystone components of old-growth forest ecosystems, in which very substantial amounts of carbon are stored in coarse woody debris and soils which

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1https://theconversation.com/keeping-trees-in-the-ground-where-they-are-already-growing-is-an-effective-low-tech- way-to-slow-climate-change-154618

2https://eugeneweekly.com/202 1/05/13/flattening-a-forest/

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are vulnerable to loss from logging operations. Harvesting large trees and converting mature and old forests to younger ones causes emissions that go well beyond those from loss of AGC.

These conclusions are buttressed by findings in the carbon accounting literature. Law et al. (2018) evaluated strategies to mitigate climate change in the Pacific Northwest Region. The study found that forests can store more carbon if the harvest interval is lengthened on private lands and harvest is reduced on public lands (see Figure 2 based on data from Law et al., 2018). Far less effective are reforestation[mdash]just one-third as much carbon accumulation[mdash]and lastly, afforestation[mdash]just one-tenth as much carbon accumulation[mdash]that can compete with land usage for agriculture and urban development. This finding is supported by a recent National Academy report on [ldquo]Negative Emissions[rdquo] or atmospheric CO2 removal options that finds the potential for afforestation and reforestation in limiting atmospheric CO2 to be modest.

[Figure 2 - SEE PDF]

Figure 2. Land-use strategies to mitigate climate change across Oregon. Values on y-axis are cumulative change in net ecosystem carbon balance (NECB) from 2015 to 2100. The Reduce Harvest scenario illustrates the importance of letting mature and old forests grow for climate mitigation because it maintains the carbon stores in the trees and accumulates more carbon out of the atmosphere in the near future. Data are from observation-based modeling (Law et al., 2018). Adapted from Law et al. (2022).

While desirable, planting trees will contribute relatively little to carbon accumulation out of the atmosphere by 2100 compared to protecting natural ecosystems and reducing harvest, especially in the carbon-rich forest ecosystems within the NWFP area (Figure 1).

d. The DEIS Minimizes Actions that Degrade Mature and Old Forests and Exacerbate Climate Change

Unfortunately, rather than protecting mature and old-growth forests to help fight climate change, the DEIS minimizes actions that degrade forests by emphasizing the threat of climate change and downplaying the magnitude of logging. It is understood that the effects of climate change are going to worsen in the coming decades because we have loaded the atmosphere with so much carbon dioxide, and some of these future changes will continue to affect forests (Domke et al., 2023). But the DEIS argues without justification at 3-91:92 that Alternatives B and D, which would log the most forest acreages including in carbon-rich mature and old-growth forests, would contribute the most to increased capacity of the landscape to adapt to climate change. As described in section 3c, widespread logging of mature and old forests runs counter to climate change goals, and is also inconsistent with restoration needs of these forests (sections 5 - 7).

Mature and old forests are among the most resilient terrestrial ecosystems on Earth. Old trees can live for many hundreds to thousands of years, functioning as anchors of resilience and biodiversity for the entire community (Piovesan et al., 2022; Gilhen-Baker et al., 2022). Coarse- grained model projections do not consider the physiology and biophysical properties of mature and old growth forests that underlie their capacity to resist and buffer the effects of climate change. For example, physiological-based studies have found that small trees are most vulnerable during drought, not the mature trees that have reached full root, bark and canopy development and respond to climate variability better than smaller trees (Vickers et al., 2012; Irvine et al., 2004; Domec et al., 2004). Old-growth forests buffer against rising temperatures and provide cool microclimates (Frey et al., 2016) that confer advantages to some animal populations in the face of climate change (Kim et al., 2022). And old trees are particularly notable for their genetic and epigenetic life history adaptations, having survived long periods of environmental change (Piovesan et al., 2022; Cannon et al., 2022). Considering this body of research, the agency should take great care not to overemphasize risks to mature and old-growth forests that lead to management recommendations that degrade these forests and contribute to worsening climate change. The important point is not to respond to climate change with more actions that degrade forests and contribute to increased emissions from forests that mitigate climate change most effectively without any intervention.

4. Mature and Old-Growth Forest Extent Projected to Increase over the Next Five Decades Despite Increasing

Disturbances

Projections from the 2020 Resources Planning Act (RPA) Assessment of mature and old-growth forests do not support arguments that the agency needs increased discretion to log in mature and old-growth forests in the NWFP area. This analysis was summarized for mature and old-growth forests on National Forest System lands across the contiguous U.S. on pages 68-70 of the National Old Growth Amendment (NOGA) DEIS (USDA, 2024).

The NOGA DEIS states at 68:

As Figure 7 shows, RPA projections show little net change in mature and old-growth forest area on Forest Service lands across the contiguous U.S. Losses from mature and old-growth due to disturbance are offset by growth and succession that transform younger forests into mature and old growth. Younger, mature, and old-growth trends from these projections were consistent with the overall forest succession and aging trends projected for all forests in the contiguous U.S. in the 2020 RPA Assessment (Coulston et al., 2023).

The NOGA DEIS[rsquo]s section on Drivers and Stressors highlights resilience of old-growth forest in the face of climate change. For example, from 2000 to 2020, 6.8% of old-growth forest on National Forest Lands experienced fire, and 50% was either low or moderate severity, with another 18% moderate-high severity. High-severity fire also plays a natural and ecologically beneficial role in forest ecosystems including creation of habitat that many plant and animal species require (Bond et al., 2012; Hutto et al., 2008; Swanson et al., 2011). For insects and disease, 22% of old-growth forest on Forest Service land was disturbed by insects and disease between 2000 and 2020. Of this area, 72% was low severity and these areas showed a net gain in old growth with overall little net loss (DEIS at 34).

These projections and trends indicate that mature and old-growth forests will continue to expand in the face of disturbances and climate change. This calls into question arguments for increasing logging in mature and old-growth forests. Yet, the NWFP Amendment DEIS infers that changing disturbance regimes and potential future climate impacts to forests justify increased logging in mature and old-growth forests to bolster timber production. But proactive stewardship to help reduce vulnerabilities and promote beneficial disturbance dynamics does not support this approach.

Eisenberg et al. (2024) argues for proactive stewardship of forests emphasizing Tribal sovereignty and Indigenous Knowledge such as Indigenous fire stewardship (Hoffman et al., 2021). And there is growing support for a multi-disciplinary approach that is respectful and inclusive of all Knowledge Systems to help inform application of science so that we can mitigate and survive the climate and biodiversity crisis that we are currently in (Clark et al., 2024; Ogar et al., 2020). However, this should not be conflated with a call for broad discretion for logging large and old trees from mature and old-growth forests. Eisenberg et al. (2024) defines thinning as a form of proactive stewardship to [ldquo]Reduce density of small diameter trees and shift to more fire and climate resilient species composition.[rdquo]

The proposed action would dramatically increase logging in mature and old-growth forests. However, our management of these systems must minimize reductions of carbon stocks in the short-term while promoting resilience in the mid to long-term. From a climate perspective, we simply cannot afford the costs of logging large trees and unwarranted mechanical intervention in mature and old-growth forests.

5. Restoration Needs in Moist and Dry Old-Growth Forests Are Distinct and Limited

In context of the broader forest landscape, old-growth forests are highly intact systems with limited restoration needs. These diverse and complex systems are also vulnerable to management interventions that degrade and destabilize the forest community. Climate change is compounding decades of degradation caused by ill-considered management of the Nation[rsquo]s forests. But research indicates that costly mechanical treatments in old-growth forests will only exacerbate the problems. The literature points to a targeted role for intervention in frequent-fire old-growth forests with emphasis on restoring the process of periodic surface fire. There is no support for logging large and old-growth trees (as noted above).

a. Moist Old-Growth Forests

Moist forests with long fire-return intervals[mdash]such as Pacific Northwest old-growth forests, do not need restoration (Franklin and Johnson, 2012; Schoennagel et al., 2004). Franklin and Johnson (2012) state:

Management activities in these existing old-growth [moist forests], such as thinning, are not needed to sustain conditions in these forests and can actually cause old-growth MFs to diverge widely from natural forests in structure and function or become destabilized.

All remaining moist old-growth forests should be protected from logging. Proposed changes for defining old-growth based on stand initiation dates are ill-advised. Forests are not static systems. Relying on stand-initiation dates to define old-growth is problematic because as forests grow and develop old-growth qualities over time, they would not be recognized as old- growth simply because of a stand-initiation date. Definitions should be based on the characteristics of a natural forest and its environment, defined structural and functional attributes of old-growth forests. Utilize the decades of research on PNW forests to define old-growth conditions based on the best-available science.

b. Dry Old-Growth Forests

In forests with short fire-return intervals, targeted intervention can be efficacious, if carefully calibrated. Old-growth forests in mixed-severity fire regimes will vary, but prescribed fire with a range of severities, alongside Indigenous cultural burning priorities (Long et al., 2023), will help reduce future wildfire threats and increase ecological benefits in many systems without mechanical intervention (Schoennagel et al., 2017). Even in the low-severity fire regimes of ponderosa pine forests, old-growth forests have distinct restoration needs compared to heavily logged sites, a fact that is often conflated in management plans.

In dry ponderosa pine forests, historical logging that removed large-dominant trees decades ago followed by fire suppression caused widespread changes in vegetation conditions. Naficy et al. (2010) sought to specifically understand how historical logging impacted stand structure and thus restoration needs between paired logged and unlogged fire-excluded sites in ponderosa pine forest of the northern Rockies (Naficy et al., 2010). The study found that restoration needs in old-growth ponderosa pine forests are distinct from their historically logged counterparts, and at risk of degradation from management approaches derived from previously logged forests.

Naficy et al. (2010) state:

We document that fire-excluded ponderosa pine forests of the northern Rocky Mountains logged prior to 1960 have much higher average stand density, greater homogeneity of stand structure, more standing dead trees and increased abundance of fire-intolerant trees than paired fire-excluded, unlogged counterparts. Notably, the magnitude of the interactive effect of fire exclusion and historical logging substantially exceeds the effects of fire exclusion alone. These differences suggest that historically logged sites are more prone to severe wildfires and insect outbreaks than unlogged, fire-excluded forests and should be considered a high priority for fuels reduction treatments. Furthermore, we propose that ponderosa pine forests with these distinct management histories likely require distinct restoration approaches. We also highlight potential long-term risks of mechanical stand manipulation in unlogged forests and emphasize the need for a long- term view of fuels management.

In reviewing the literature cited in the DEIS and beyond, there is no support for logging large or old-growth trees for dry forest restoration. Prescribed fire, cultural burning, and removal of small trees where needed to safely reintroduce fire can support resilience in forests with frequent-fire regimes and minimize carbon losses from these systems. Research into ecological restoration in frequent-fire forests recommends retaining large and old trees, while carefully reducing surface and ladder fuels, and reintroduction of low-intensity fire at appropriate intervals (Allen et al., 2002; Brown et al., 2004; Agee and Skinner, 2005; Noss et al., 2006).

Reinforcing this point, studies that consider carbon stocks and climate change argue the need to limit removals to small trees, because even thinning smaller trees involves substantial carbon tradeoffs in the short term, a 30-40% reduction in live tree carbon stores in some forests (James, et al. 2018; Krofcheck et al., 2017; North et al., 2009). For example, thinning in a young ponderosa pine plantation showed that removal of 40% of the tree biomass would release about 60% of the carbon over the next 30 years (Stenzel et al., 2021).

Here are excerpts from numerous studies that consider carbon stocks in context of dry forest restoration.

Compared with large overstory trees, small trees accumulate carbon at a much slower rate and have higher rates of mortality, yet they compete for resources with large trees. In seasonally dry forests, fire reduces small tree density, spurring growth in large, long-lived trees that store more carbon.

* Hurteau et al., 2019

Management to reduce stand-replacing fire risk typically involves thinning small trees and prescribed burning, both of which reduce the amount of carbon stored in the forest.

* Krofcheck et al., 2019

Previous studies have demonstrated that restoration treatments that focus on removing smaller trees and restoring surface fire can substantially increase canopy base height while at the same time minimizing reductions in live tree C and increasing C stability.

* Liang et al., 2018

Currently, a large body of work supports tactics to resist conversion, although these pertain primarily to frequent-fire forest types. Well-established fuel reduction techniques emphasize the retention of larger-diameter trees with thick bark and other adaptations to fire, the removal of understory and ladder fuels that promote the transition from surface to crown fire, and maintenance burning.

* Coop et al., 2020

The goals of restoring ecosystem processes and/or reducing risk in fire-prone regions can be met by removing small trees and underburning to reduce surface fuels, not by removal of larger trees, which is sometimes done to offset the cost of the thinning. With continued warming and the need to adapt to wildfire, thinning may restore more frequent low- severity fire in some dry forests, but could jeopardize regeneration and trigger a regime change to non-forest ecosystems.

* Law et al., 2022

In dry forests historically maintained by a frequent, low-severity fire regime, the priority ought to be restoring the process of periodic surface fire. Prescribed fires create landscape heterogeneity, reduce surface and ladder fuels, lower stand density, and confer drought resistance to surviving trees.

* Mildrexler et al., 2023

The DEIS makes spurious claims at 3-90 about the impacts of fuels reduction on carbon storage in dry forests. It is incorrect that there are mixed results on long-term carbon storage benefits of fuel reduction treatments depending on how well treated stands reduced fire-severity (see Campbell et al., 2007; Campbell et al., 2011; Mitchell et al., 2009). Most critically, fuels reduction treatments only encounter wildfire on ~1% of treated acres (Figure 3; Schoennagel et al., 2017). Carbon losses from the ~99% of fuels reduction treatments that do not encounter fire must also be considered alongside the small fraction of forest that actually experiences a fire during the time period over which the treatment is effective.

[Figure 3 - SEE PDF]

Figure 3. Fuels reduction treatments reduce carbon storage in forests, and yet only 1% of the area treated actually encounters a wildfire each year (see sources listed in figure).

In dry old-growth forests the key is to restore the process of surface fire while protecting the integrity of the forest ecosystem. This approach would minimize carbon losses and damage to these complex interconnected systems from costly mechanical interventions. Naficy et al (2010) concluded:

[ldquo]The current forest structure and composition that we have documented in logged forests suggests that, where fuel reduction goals are primary, these forests should constitute a clear priority.[hellip].This is consistent with growing evidence that labor intensive and costly mechanical treatments in many unlogged, fire-excluded forests may not be necessary to restore wildfire despite structural departures from historical conditions. [emphasis added]

However, the DEIS[rsquo]s proposed alternative would eliminate stand-level protections for frequent- fire old-growth forests and manage for individual trees >150 years old. Managing for individual trees in frequent-fire old growth is a poor choice because it essentially breaks the ecosystem into parts rather than managing forests as a holistic system. This approach puts at risk many of the defining qualities of old-growth forests such as snags, downed logs, clean water, intact soils, microclimates, rare and sensitive species, future old growth trees [ndash] the complex interconnected system that defines old-growth forest communities. Large and old trees are focal centers of interaction and connectivity across the forest community, which in turn supports the large and old trees.

The individual tree approach leaves many of the defining attributes of old-growth forests, including the old trees, vulnerable to isolation and degradation. In the long run, managing for individual trees fails to consider the effects of practices that will degrade and simplify stand structure and composition and thereby reduce biodiversity in frequent-fire old-growth systems. Old-growth forest management should be guided by a holistic ecosystem approach that restores ecological process while protecting the integrity of frequent-fire old growth ecosystems.

6. The DEIS Provides No Compelling Evidence for Restoration Needs in Moist Mature Forests Between 80 and 120 Years Old

Moist forests of the Pacific Northwest are a unique forest type[mdash] among the world[rsquo]s most effective for climate mitigation and located within the maritime influence of the coast providing enhanced buffering against the effects of climate change, as discussed above.

The DEIS does not provide any compelling restoration needs for mature forests despite proposing to change the threshold for forest management in these forests from 80 to 120 years. At the time the guidelines were debated, the issue was whether the upper age limit of stands should be 50 or 80 years.3 Since then, the importance of protecting these mature carbon-rich forests that are doing the job of pulling carbon from the atmosphere and locking it away in long- lived tissues and soils is greatly amplified.

At 3-36 the DEIS explains that the criteria is proposed for change because these trees [ldquo]have aged out of thinning under the 1994 NWFP[hellip].[rdquo] Similarly In Table 2-1 on page 2-16 the DEIS states that these changes [ldquo]account for 30 years of time passage since the 1994 NWFP decision.[rdquo] This is no ecological justification to open these forests to logging and experimental treatments. These mature forests are next in line to become old growth. The rapid increase in carbon storage with increasing tree diameter emphasizes the importance of preserving mature forests, letting the trees grow, and keeping this carbon stored in the forest ecosystem where it remains for centuries (Law et al., 2018; Lutz et al., 2018).

In an opinion piece entitled [ldquo]Protect older natural forests in the western Cascades,[rdquo] Douglas-fir is described as a [ldquo]long-distance runner rather than a sprinter, and at 100 years its growth has just

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3 Managing Young Stands to Meet LSR and Riparian Objectives Keynote Comments by Jerry R. Franklin https://www.fs.usda.gov/r6/reo/landuse/ama/franklin2001.htm

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begun to hit its stride. High rates of growth continue throughout the second century of theseforests resulting in massive additional accumulations of wood and captured atmospheric carbon. Stocks of dead wood (snags and logs) are rebuilt and add significantly to carbon storage because of their slow rate of decay, helping to combat climate change and providing critical wildlife habitat.[rdquo]4 The opinion piece states that mature natural forests fulfill many of the same ecological roles as fully developed old-growth forests, and states that there is no ecological justification for logging these forests.

At 3-27 the DEIS provides the following description: [ldquo]Mature forest stands in moist Matrix are described as having significant complexity and large amounts of carbon to support the recruitment of future old-growth forests. Moist forest stands on Matrix LUA[rsquo]s under all alternatives also provide function as connectivity between LSRs and LSOG-dependent species as well as organisms associated with younger forests.[rdquo] This is a description of resilient forests that do not need restoration.

Supporting this assertion is the fact that forests within the NWFP area are among the highest integrity forests in the nation, and mature forests are a major component of this landscape (Figure 1b.) Areas ranked with high integrity by this index are associated with more intact forest landscapes that have ecosystem functions (e.g., carbon storage, biodiversity, watershed protection) closer to natural levels (Law et al., 2023). Some of these mature areas are previously unlogged. These areas will tend to be highly diverse in tree size, age, and composition, providing diverse forest habitats. Mature forests, along with old growth, are among the richest in biodiversity, and provide habitat for thousands of species (Franklin and Johnson, 2012). Species that require large home ranges need these undisturbed areas that provide connectivity.

Alternatives B and D would open 824,000 additional acres of mature moist forest to management activities [ldquo]to improve and maintain late successional and old-growth forest conditions within moist forest LSRs.[rdquo] But logging these forests is degradation from a carbon perspective, and many other values of these forests will likely be degraded including water quality and quantity, damage to soils, fragmentation due to skid trails and haul routes, loss of interior habitat conditions and microclimates, and spread of invasive weeds.

The DEIS claim at 3-26 that opening these mature moist forest stands to logging under Alternatives B and D provides opportunity [ldquo]to apply improved scientific understanding of the development of late-successional and old-growth forest conditions[rdquo] is controversial at best.

Moist forests have inherently broad ranges of natural variation, and have long, variable fire return intervals that can exceed the period of effective fire suppression and are therefore not outside of their historical range of variability based on the effects of fire suppression alone (Franklin and Johnson, 2012). Mature forest, typically in the age range of 80 to 200 years in the Douglas-fir region, is a very important successional stage that is gradually growing into additional and replacement old growth (Thomas et al., 2006). Opening these forests to logging and fragmentation from road building and haul routes can push development away from old-growth conditions. Historical logging of these intact forests has been a key factor in putting aquatic values at significant risk of degradation and native fishes at widespread risk of extinction (Nehlsen et al., 1991; Frissell et al., 1993; Rieman et al., 2003). In moist forest types globally,

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4https://www.registerguard.com/story/opinion/columns/2021/04/27/guest-view-protect-older-natural-forests-western-cascades-jerry-franklin-norm-johnson/7385736002/

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logging (including postfire logging) has resulted in loss of resiliency and biodiversity, homogenization of forest structure, reduced canopy cover and increased fire risk, increased risk of insects and disease epidemics, degraded wildlife habitat, and degraded soil and watershed quality (Beschta et al., 2004; Cyr et al. 2009; Rhodes, 2007; Lindenmayer et al., 2009; Zald and Dunn, 2018; Wales, et al., 2007).

Moreover, logging in these mature stands will undoubtedly focus on large trees, otherwise projects will not be economically viable. The DEIS clearly states in Table 2-1 at 2-17 that this change aims to bolster timber production. These proposed actions run counter to stopping emissions from deforestation and degradation and protecting the large carbon stocks that have accumulated over centuries[mdash] the single most important action for sustaining and increasing the forest carbon sink (Pan et al., 2024).

A piece entitled New Trees Are No Substitute for Old Trees,5by Norm Christenson and Jerry Franklin, describes the importance of the mature stage in forest development.

The forest continues to thin as it approaches maturity. The surviving trees will get bigger, accumulating additional carbon and storing some of it within the debris of the forest floor. In a mature stage, the shady understory of the forest keeps things moist, and much of the debris consists of larger logs that are not easily ignited, so the [ldquo]dead stuff[rdquo] is less likely to serve as fuel for a fire. This mature forest has many fewer but much larger trees and its ecosystem becomes more complex [mdash] translating into an increasing number of plant and animal species.

In all cases, nature knows what it is doing, and human intervention tends to make matters worse, not better. If we can let our forests be, we will reap many benefits including increased biological diversity, water conservation and recreation. And fewer wildfires.

There is ample forest on private land to meet our needs for timber and wood fiber. It is our public lands in both the U.S. and Canada that represent our best opportunity to manage forests to both mitigate and adapt to climate change.

While most remaining old-growth forests in national forests are protected, they represent less than 13 percent of the overall forest landscape. However, nearly 50 percent of public lands now support mature forests that are on their way to becoming old growth.

So we need to both protect as much of our remaining forests as we can, but [mdash] importantly [mdash] we also must let them get old. New trees are no substitute for old trees and the ecosystems they nurture. Letting our current mature forests age further is our best opportunity to diminish carbon emissions and mitigate catastrophic wildfires that threaten the health of humans and of our planet.

5https://www.politico.com/news/magazine/2023/06/11/to-fight-wildfire-our-forests-need-to-grow-old-00101360

The NWFP should retain and adopt the 80-year-old threshold across all moist forest types in both LSR and matrix as a minimum to maintaining key forest elements needed to mitigate climate change.

7. Protect Large Trees, Restore Fire, and Minimize the Carbon Cost of Thinning in Mature Dry Forests

In mature dry forests, the priority should be developing old-growth conditions by restoring the process of periodic surface fire and making stands more resilient to future wildfires. Prescribed fires help create landscape heterogeneity, reduce surface and ladder fuels, lower stand density, and confer drought resistance to surviving trees (Knapp et al., 2006; van Mantgem et al., 2016). Prescribed fire can modulate future fire activity (Schoennagel et al., 2017) and favor early-seral species such as ponderosa pine, western larch and Douglas-fir. Large trees of these species and grand fir are resilient to prescribed fire because they have attained the thick bark that provides resistance to low- and moderate-severity fire (Howard and Aleksoff, 2000; Pellegrini et al., 2017). Surface fires help reduce small tree density, spurring growth of large trees that store more carbon (Hurteau et al., 2019).

In dry, frequent-fire forests, stand density reductions coupled with reintroduction of fire can alleviate the effects of fire suppression and support the vigor and resilience of residual trees including large-tree populations (Krofcheck et al., 2017; Stephens et al., 2020; Tepley et al., 2020). In some areas, reduction of midstory and understory vegetation through thinning and prescribed fire can reduce fire intensity, severity, and rate (Davis et al., 2024; Schoennagel et al., 2017), as well as reduce competition and increase the availability of light, water, and nutrients to the remaining trees with concurrent impacts on tree photosynthesis and growth (Tepley et al., 2020; Stenzel et al., 2021).

Thinning also has an inherent carbon cost that increases as larger trees are harvested, thereby putting thinning of larger trees in conflict with carbon goals because it takes so long to replace the harvested biomass (Law and Harmon, 2011; James et al., 2018). As discussed earlier, as harvest intensity increases, forest carbon stocks decrease and emissions increase (Hudiburg et al., 2009; Mitchell et al., 2009; Simard et al., 2020). Claims that carbon stores will be [ldquo]stabilized[rdquo] by increasing harvest of large-diameter trees that store and accumulate the most carbon are inconsistent with basic science on thinning (Zhou et al., 2013) and the carbon cycle (Law et al., 2018; Campbell et al., 2011; Mildrexler et al., 2024). These claims ignore the large amounts of CO_2 rapidly released to the atmosphere following harvest (Hudiburg et al., 2019), and that large trees cannot be replaced in short timeframes. It can take centuries to reaccumulate forest carbon stocks reduced by harvest of large trees (Birdsey et al., 2006).

As dry forests recover from a century of intensive logging, it is important to distinguish between the shift of AGC stocks into small-diameter, fire-sensitive trees and the retention of a small fraction of the largest more fire-resistant trees that store disproportionately massive amounts of carbon (Mildrexler et al., 2023). Small tree carbon stores are relatively unstable and at risk of loss to fire and drought, whereas large tree carbon stores are relatively stable and resistant (Hurteau et al., 2019). See the excerpts from studies that consider carbon stocks in context of dry forest restoration on pages 11-12 which are relevant for mature dry forests.

Mildrexler et al. (2020) evaluated carbon storage in large-diameter trees across the six national forests located east of the Cascade Crest in Oregon and Washington ([ldquo]eastside forests[rdquo]). The study quantified the relative contribution of large trees ([ge]21 inches DBH) to aboveground carbon (AGC) storage based on analysis of 636,520 trees on 3,335 USFS Forest Inventory & Analysis (FIA) plots. In these forests, large trees compose a small fraction of total stems (2.0 to 3.7% of all stems among five dominant tree species) yet hold 33 to 46% of total AGC stored by each species. The very largest trees, >30 inches DBH, held an even greater proportion of carbon (16.6%) relative to their small numbers (0.6%) demonstrating the importance of letting large trees grow larger and accumulate more carbon.

Logging even a small fraction of large trees contributes disproportionately to lost carbon stores, and releases large amounts of carbon to the atmosphere. The amount of carbon that remains stored in wood products is insufficient to offset the loss of carbon stored in the forest. Life cycle assessment shows that 65% of carbon in wood harvested in Oregon over the past 115 years has been emitted to the atmosphere, 16% is in landfills and only 18% remains in wood products (Hudiburg et al., 2019). Replacing large-diameter trees with seedlings will create a major carbon loss to the atmosphere during harvest (Harris et al., 2016) and not achieve storage of comparable atmospheric carbon for the indefinite future. It could also increase, not decrease fire-risk by making stands hotter, drier and windier and replacing large trees, which are generally more fire resistant, with flammable shrubs and small trees. Protecting large trees in dry forests provides the greatest benefit for water, resilience, carbon, habitat, and biodiversity (see section 8).

The important point for achieving forest restoration and climate change goals is to find synergies among these important priorities. Mildrexler et al. (2023) outlined several key synergies in eastside forests. These findings are also relevant to dry forests within the NWFP area. Note in this context large-diameter trees refers to those [ge]21 inches DBH.

Synergy: Enhancing forest resilience does not necessitate widespread cutting of any large- diameter tree species. Favoring early-seral species can be achieved with a focus on smaller trees and restoring surface fire, while retaining the existing large tree population.

Synergy: Small trees are more relevant to drought and fire vulnerability and store less carbon, whereas large trees are more resilient to fire and drought and are the highest priority for keeping carbon in the forest.

Synergy: Mature and old mesic forests are a high priority for protection, provide crucial biophysical benefits on climate, including a large cooling effect on maximum temperatures regulating climate extremes and protecting biodiversity. Large grand fir is essential to this ecology.

The importance of forest carbon storage is now greatly amplified by a warming climate that must urgently be addressed with reductions in greenhouse gases and natural climate solutions (IPCC, 2018; Ripple et al., 2020). Rather than holding ecosystems to an idealized conception of the past using historical conditions as management targets (Millar et al., 2007), a good understanding of the environmental co-benefits associated with large tree protection is needed to inform management strategies that contribute toward solving humanity[rsquo]s most pressing Earth system challenges (Moomaw et al., 2019; Mildrexler et al., 2023).

Notwithstanding the clear direction of the literature, Alternative B would eliminate foundational plan components for closed-canopy and multi-canopy stands in dry LSR[rsquo]s (DEIS at 2-19). These habitats support important species including marten, goshawk, northern spotted owl, and flying squirrels. These species and others are critical to the overall prey-base and functionality of these forests. The DEIS states at 3-29 that [ldquo]dry forests would be anticipated to become more open and reflective of historic range of variation, with fewer dense, multi-canopy stands.[rdquo] The Alternative B approach leads to bad outcomes for climate, habitat, water and species. Using historical conditions as management targets has been warned about for decades (Millar et al., 1997).

The joint IPCC/IPBES report clarifies that limiting global warming to ensure a habitable climate and protecting biodiversity are mutually supporting goals, and we need to be mindful to avoid actions that help one, but harm the other (P[ouml]rtner et al., 2021). This is why the report 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. Alternatives B and D propose actions that degrade climate and biodiversity.

8. Mature and Old Forest Protection Confers Significant Co-benefits

Mature and old-growth forests both help mitigate the future impacts of climate change and help us contend with the impacts we are already experiencing. Protecting mature and old-growth forests is a powerful solution for confronting the twin crises of climate change and biodiversity loss. In any forest, the largest trees relative to the rest of the stand contribute disproportionately to ecological function such as increasing drought-tolerance, reducing flooding from intense precipitation events, altering fire behavior, redistributing soil water, and acting as focal centers of mycorrhizal communication and resource sharing networks (Bull et al., 1997; Brooks et al., 2002; Brown et al., 2004; Luyssaert et al., 2008; Beiler et al., 2015; Lindenmayer and Laurance, 2017; Teich et al. 2022). In the U.S. Pacific Northwest, carbon-dense old growth forests buffer against increasing temperatures by creating microclimates that shelter understory species from rising temperatures (Frey et al., 2016; Davis et al., 2019). Forests with large-diameter trees tend to have high tree species richness, and a high proportion of critical habitat for endangered vertebrate species, indicating a strong potential to support biodiversity into the future and promote ecosystem resilience to climate change (Lindenmayer et al., 2014; Buotte et al., 2020). Additional co-benefits include (but are not limited to):

a. Water

Mature and old growth forests are associated with increased water availability (McKinley et al., 2011; Perry and Jones, 2016; Law et al., 2018; Buotte et al., 2020). Large trees in mature and old forests act like sponges, retaining water and releasing it slowly during the summer. A Forest Service report showed that more than 136 million people nationwide rely on surface water from Forest Service lands for some of their drinking water (Liu et al., 2022). A study that prioritized the most carbon and species-rich forests in the Western U.S. for protections found that besides safeguarding climate and biodiversity, preserving high-priority forests would help protect clean water, providing a crucial ecosystem service given mounting concerns over water security in the western U.S. (Law et al., 2021).

A study focused on Oregon[rsquo]s forests found that forestlands account for 78% (4.14 Mha) of the 5.3 Mha of surface drinking water source areas across Oregon, yet only 9% (0.37 Mha) of these forestlands are currently protected at GAP 1 or 2 levels (Law et al., 2022). This could increase to 27% by 2030 and 48% by 2050 if high-priority areas for carbon, biodiversity and resilience are protected (GAP 1 or 2). Most of the currently protected surface water source areas and the areas suitable for potential increases in protection are in the West Cascades, though protection of surface water sources areas would also increase notably in the Klamath Mountains and Coast Range (Law et al., 2022). Strong protections for mature and old-growth forests in the NWFP would contribute to increased water security for the PNW region.

b. Habitat

Large-diameter snags and large, downed logs provide critically important wildlife habitat and account for a relatively high proportion of total snag biomass in temperate forests (Rose et al., 2001; Lutz et al., 2021). There is currently a significant deficit of large snags (dead trees) in western US forests relative to the minimum habitat needs of many native cavity-nesting wildlife species (Bell et al., 2021). Large hollow trees, both alive and dead, are the most valuable for denning, shelter, roosting, and hunting by a wide range of animals (Rose et al., 2001). In the Interior Columbia River Basin, grand fir and western larch form the best hollow trees for wildlife uses (Rose et al., 2001). Downed hollow logs serve as important hiding, denning, and foraging habitat on the forest floor (Bull et al., 1997; Bull et al., 2005). Large decaying wood influences basic ecosystem processes such as soil development and productivity, nutrient immobilization and mineralization, and nitrogen fixation (Harmon et al., 1986).

As mature forests age into older classes, snags are a natural outcome. However, logging often removes these snags for worker-safety concerns and because logging preferentially targets large- diameter trees that would otherwise become ecologically valuable snags and downed logs.

Forests subjected to logging tend to stay impoverished of snags. Protecting mature and old forests would ensure future snags that contribute to overall ecosystem health.

c. Warming and Climate Extremes

In mesic forest environments, microclimatic buffering and transpirational cooling are amplified because sites with higher moisture availability are better able to shift energy to latent as opposed to sensible heat fluxes (Mildrexler et al., 2011). Microclimates in moist forests are strongly linked to their closed-canopy structure (Aussenac, 2000; Chen et al., 1999). Removal of the overstory creates canopy openings that increase solar radiation penetration resulting in increased drying of the understory vegetation and the forest floor, and a thermal response of rising land surface temperatures (Chen et al., 1993; Chen et al., 1999). This alteration in the subcanopy thermal regime changes atmospheric mixing between the ground, subcanopy and canopy, which in turn modifies the microclimate condition of the affected stand.

Projections suggest that proportionally, the largest changes in microclimatic buffering capacity will occur in lower elevation or dry forests, which currently have more limited buffering capacity (Davis et al., 2019). In these drier regions, microclimatic buffering by forest canopies may create important microsites and refugia in a moisture-limited system (Davis et al, 2019; Meigs and

Krawchuk, 2018). In an old-growth ponderosa pine stand in eastern Oregon, ~35% of the total daily water used from the upper 2 m was replaced by hydraulic redistribution from deep soil by deep-rooted larger trees in summer (Brooks et al., 2002). The bigger trees rarely reach 80% loss of hydraulic conductivity, and both mature pine and mesic Douglas-fir were better buffered from the effects of drought on photosynthesis compared with young pine (~20-yr old) due to full root development and larger stem capacitance in older trees (Kwon et al., 2018). Redistribution of deep soil water can increase seedling survival during summer drought when young trees lack the root development to reach deep soil water (Brooks et al., 2002). Large trees perform important functional attributes related to water and climate such as carbon storage, hydraulic redistribution, shielding the understory from direct solar radiation, and providing wildlife habitat.

Forest modulation of summer maximum temperature is especially powerful (Mildrexler et al., 2018) and can partly offset the projected increases in temperature due to anthropogenic climate change (De Frenne et al., 2019). Mildrexler et al. (2023) examined climatic regimes of major forest types across eastside forests with summer maximum land surface temperatures and found that the relatively wet fir/spruce/hemlock type was 12[deg]F cooler than the dry ponderosa pine type. Thinning to open the canopy of these closed-canopy forests dramatically increases solar radiation penetration to the forest floor, resulting in increased drying of the understory vegetation and the forest floor, and a thermal response of rising land surface temperatures. With heatwave frequency, intensity, and duration projected to increase (Still et al., 2023), the capacity of forests to buffer against temperature extremes and provide refugia is increasingly recognized as important to sustaining biodiversity in a warming world (De Frenne et al., 2019; Davis et al., 2019).

9. Protecting Old and Mature Forests Is Powerful Near-Term Integrated Climate Action

The climate crisis will continue to accelerate in the coming decades. We are already witnessing an alarming and unprecedented succession of climate extremes and widespread impacts to humanity and all life on Earth (Ripple et al., 2023). The actions we take now will have long-term impacts on future generations. A reduction in fossil fuel emissions is the single most important measure for mitigating climate change; however, logging is the second largest emitter of greenhouse gases to the atmosphere globally (IPCC, 2018).

Protecting mature and old-growth forests is one of the most effective and strategic options we can take for managing atmospheric carbon dioxide and meeting urgent climate goals. But to be effective, protections must safeguard these forests from degradation, chiefly by protecting mature and old-growth forests from logging. And such protections must recognize the targeted nature of restoration needs in frequent-fire forests. The sooner these forests are protected, the more climate protection they can provide.

The NWFP contains some of the most important forests in the world for climate mitigation. The Forest Service could become a global leader in safeguarding Earth[rsquo]s climate and biodiversity by strengthening climate mitigation measures in its proposed amendments.

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Appendix

Table 1. Mean tree carbon density (Mg C ha[minus]1) for each national forest in the National Forest System. Tree carbon includes live aboveground and belowground biomass. Forests within the range of the NWFP are highlighted in yellow.

[Table 1. SEE PDF]

Table 2. Total tree carbon stock (Tg C) for each national forest in the National Forest System (NFS). Tree carbon includes live aboveground and belowground biomass. Forests within the range of the NWFP are highlighted in yellow.

[Table 2. SEE PDF]

ATTACHMENT: Final NWFP Climate Change Comments EOLL 031725.pdf; This is the same content that is coded in text box; it was originally included as an attachment.