Data Submitted (UTC 11): 8/23/2021 7:00:00 AM
First name: Doug
Last name: Heiken
Organization: Oregon Wild
Title: Conservation and Restoration Coordinator
Comments: see attached.

Submitted on behalf of Oregon Wild & Cascadia Wildlands & Many Rivers Group of the Sierra Club

23 August 2021

TO: Willamette National Forest

VIA: https://cara.ecosystem-management.org/Public//CommentInput?Project=55868

Subject: Youngs Rock Rigdon DEIS [mdash] comments

Please accept the following comments from Oregon Wild, Cascadia Wildlands, and the Sierra Club, Many Rivers Group concerning the Youngs Rock Rigdon DEIS, https://www.fs.usda.gov/project/?project=55868.

* Oregon Wild represents 20,000 members and supporters who share our mission to protect and restore Oregon[rsquo]s wildlands, wildlife, and water as an enduring legacy. Our contact information is: PO Box 11648, Eugene OR 97440 | 541-344-0675 | dh@oregonwild.org.
* Cascadia Wildlands is part of a movement to protect and restore wild ecosystems of the Cascadia Bioregion, including vast old-growth forests, rivers full of wild salmon, wolves howling in the backcountry, and vibrant communities sustained by the unique landscapes. Cascadia Wildlands[rsquo] contact information is: P.O. Box 10455, Eugene, OR 97440 | Eugene, OR 97401 | 541-434-1463 | rebecca@cascwild.org.
* The Sierra Club is the nation[rsquo]s oldest and largest grassroots environmental organization, representing over 1,400,000 members nationally. Their mission is to explore, enjoy and protect the planet. The Many Rivers Group of the Sierra Club represents over 3,000 members in Oregon[rsquo]s Lane, Coos and Douglas Counties. Many Rivers Group Sierra Club contact information is: PO Box 11211, Eugene, Oregon 97440, willamettedams@q.com (Conservation Chair, Fergus McLean).

The proposed action alternative 2 involves:

* 2,608 total acres of commercial logging and fuel reduction
*

* 1,419 acres of thinning in mature natural stands
* 736 acres of thinning in managed stands with [frac12] ac gaps (including 273 acres in riparian reserves)
* 531 acres of regeneration harvest in managed stands (shelterwood with reserves)
* 63 mmbf (~12,600 log truck loads)
* Logging in: Special Interest Areas, riparian reserves, spotted owl critical habitat
* No harvest in riparian reserves in natural stands.
* 273 acres of thinning in riparian reserves in managed stands.

* 47 miles of roads put in storage
* 12 miles of road decommissioning
* 10 miles temporary road construction (not mapped? rough estimate, because they intend to be very flexible with purchaser on logging systems)
* 127 miles haul road maintenance
* Wet weather log hauling allowed near critical habitat for Chinook salmon and bull trout
* Logging systems: 940 acres helicopter, 1,251 acres skyline, 925 acres ground-based (rough estimate, because they intend to be very flexible with purchaser on logging systems)
* Plan amendment to allow logging in 2 Special Interest Areas

* 2,799 acres of suitable spotted owl nesting, roosting, foraging habitat would be removed by regen and early seral creation (not maintained; not degraded; removed)
* 467 total acres of spotted owl dispersal habitat would be removed
* 997 total acres of spotted owl dispersal habitat would be modified but [ldquo]maintained[rdquo]
* Within Spotted Owl critical habitat: 1,561 acres of suitable and 82 acres of dispersal habitat would be removed. Another 377 acres of dispersal habitat would be modified but maintained.
* 2,799 acres (21%) of forest suitable for red tree voles would be affected by early seral forest creation and regeneration harvest treatments

* 152 acres of (non-commercial?) gaps for pine/oak release in natural stands
* 104 acres of non-commercial roadside pine release
* 1,687 acres of fuel reduction outside of commercial logging units
* 276 acres meadow restoration (non-commercial)
* 695 acres floodplain restoration (non-commercial)
* 200 acres of drop and leave thinning in riparian reserves (non-commercial)
* 489 acres strategic fuel reduction (non-commercial)
* 739 roadside understory fuel reduction (non-commercial)
* Various recreation projects

Alt 3 would decommission more roads and harvest less in northern spotted owl critical habitat, and do less regen harvest in managed stands.

Key Recommendations

We commend the Forest Service (FS) for some aspects of this project such as floodplain restoration, road decommissioning, recreation enhancements, variably thinning dense young plantations that were previously clearcut, non-commercial thinning of the understory along roads, full protection of riparian reserves in natural stands, and meadow restoration. Unfortunately all this good work is overshadowed by unnecessarily aggressive logging of 1400 acres of natural forests, clearcutting of 500 acres of plantations, and 10 miles of new road construction.

Our main recommendations to improve this project and help achieve a more harmonious mix of goals for public lands are:

* Consider a new alternative that better harmonizes pine/oak persistence on the one hand, spotted owl habitat maintenance, avoiding GHG emissions by keeping carbon stored in forests, maintaining canopy cover that helps suppress ladder fuels and maintain fire resilience while reducing long-term maintenance costs, mitigating blow-down risks, and conserving recreation/scenic values,
* Conduct careful legacy tree culturing of pine, oak, and other legacy trees by thinning small/young trees around the dripline of those trees;
* Drop logging of natural stands that have few if any pine trees;
* Amend the definition of [ldquo]legacy trees[rdquo] to be protected in harvest units to include all trees over 24[rdquo] dbh, as well as smaller trees that exhibit old growth characteristics, such as thick/textured/colored bark, large branches, distinctive canopy architecture, tall height, etc.;
* Retain more trees in natural stands (except around pine and oak as described above) to maintain spotted owl habitat, carbon storage, and long-term low-maintenance fire resiliency;
* Avoid stand-scale regen except for structure-rich gaps in managed stands. Wildfire will decide where stands will be regenerated;
* Minimize road construction and expand non-commercial small tree thinning (which does not require roads) to areas with abundant pine and oak that are not accessible from existing roads;
* Avoid wet season logging and log hauling to protect soil, water quality, and fish;
* Make sure all design features get carried through to marking crews, contractors, etc.
* Conduct thorough monitoring of project implementation and effectiveness.

Meaningfully Address Scoping Comments

Oregon Wild submitted detailed and thoughtful scoping comments dated July 17, 2019. We incorporate those comments by reference. The FEIS should address the issues and alternatives raised in our scoping comments. We should not have to repeat ourselves, but alas [hellip].

We are also attaching a compilation of supporting materials that explain the numerous flaws in the FS NEPA analysis, especially with regard to the analysis of climate change and GHG emissions caused by logging.

Purpose and need

Old growth forests are valuable for many things, including recreation and fish & wildlife habitat, and now carbon storage is rapidly moving to the top of the list. We are disappointed that the Forest Service is not making carbon storage and climate mitigation a central goal for this project. We are facing a global crisis, and the FS is making excuses for continuing business-as-usual, using commercial logging as blunt tool for land management, even if it means emitting thousands of tons of carbon to the atmosphere. The FS can meet its goals related to pine enhancement, while still keeping much more carbon in the forest and out of the atmosphere.

The purpose and need for this project should be adjusted to include the following:

* retaining carbon in the forest to help mitigate the global climate crisis;
* retaining features of dense late successional habitat, especially in moist/mixed forests. These forests remain under-represented across the landscape, and may be difficult to retain and recreate in the face of climate change;

* retaining snag recruitment over time. Logging has a long-term adverse effect on snag recruitment that must be mitigated. The FS snag standards are outdated and need to be updated;
* meeting forest plan requirements, including the ACS and survey and manage. These are meant to be a constraint on management activities for good reason and should be followed carefully;
* moderate hydrologic effects of logging and roads (by minimizing canopy removal and roads);
* moderate fire behavior by retaining mature canopy cover that moderates fire effects. Lesmeister, D. B., S. G. Sovern, R. J. Davis, D. M. Bell, M. J. Gregory, and J. C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4):e02696. 10.1002/ecs2.2696. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2696)

The DEIS says the purpose and need includes [ldquo]Provide a sustainable supply of forest products.

.. a reliable supply of timber products [hellip] contributes to the stability of local, regional, and national economies[rdquo]

The agency should reconsider timber targets in light of the fact that the public needs carbon storage to reduce global climate change much more than they need wood products. The NEPA analysis also needs to account for the fact that managing forests for water quality, water quantity, quality of life, and carbon storage for a stable climate will contribute far more to community stability than propping up the timber boom-bust industry with subsidized logging.

The agency must recognize that wood products are already under-priced and over-supplied due to [ldquo]externalities[rdquo] (costs that are not included in the price of wood, so those costs are shifted from wood product producers and consumers to the general public who suffer the consequences of climate change without compensation from those who profit from logging related externalities). Ecosystem carbon storage on the other hand is under-supplied because there is not a functioning market for carbon storage and climate services. The agency is in a position to address these market imperfections by focusing on unmet demand for carbon storage instead of offering wood products that are already oversupplied.

Land protection, both public and private, provides substantial ecological benefits by avoiding conversion of natural systems to intensive, developed uses. These benefits include carbon sequestration, watershed functioning, soil conservation, and the preservation of diverse habitat types (e.g., Daily 1997, Brauman et al. 2007, Kumar 2012, Watson et al. 2014). Land protection also solves a key market failure: private markets tend to underprovide socially beneficial land uses such as natural forests, agricultural lands, or managed timberlands. The reason for this failure is that many of the benefits of these lands go to the public in general, not individual landowners. When private values and market transactions determine land uses, less land will be devoted to socially beneficial uses than if citizens could collectively determine use on the basis of social values (e.g., Angelsen 2010, Tietenberg and Lewis 2016).

Katharine R.E. Sims, Jonathan R. Thompson, Spencer R. Meyer, Christoph Nolte, Joshua S. Plisinski. 2019. Assessing the local economic impacts of land protection. Conservation Biology. 26 March 2019 https://doi.org/10.1111/cobi.13318, https://harvardforest.fas.harvard.edu/sites/default/files/Sims_et_al-2019-Conservation_Biology.pdf.

See further discussion below regarding new information that undermines key assumptions the FS relies upon and requires reconsideration of Matrix goals. Including the destabilizing effect of the timber industry and the stabilizing effect of forest conservation.

Recent fires also highlight important points made by former Forest Service Chief Jack Ward Thomas on Instability of Stability:

The vision that I was taught in school of the "regulated forest" and the resultant predictable outputs of commodities has turned out to have been a dream. [hellip] By now it is becoming obvious that this dream was built on the pillars of the seemingly boundless virgin forest and an ethic of manifest destiny coupled with hubris of being able to predict the response of nature and humans. This was coupled with an inflated sense of understanding of forested ecosystems and of human control. Perhaps it is time to recognize that such stability is not attainable in any western region except for relatively short periods of years or decades. [hellip] It is increasingly apparent that ecological processes are not as well understood nor as predictable as had been assumed by natural resource managers steeped in Clementsian ecological theory of orderly and predictable succession of plant communities from bare ground to a mature, steady state. [hellip] In summary, the timber supply from federal lands is one drought, one insect and disease outbreak, one severe fire season, one election, one budget, one successful appeal, one loss in court, one listing of a threatened or endangered species, one new piece of pertinent scientific information, one change in technology, one shift in public opinion, one new law, one loss of a currently available technological tool, one change in market, one shift in interest rates, et al, away from "stability" at all times. And, these changes do not come one at a time, they come in bunches like banannas [sic] and the bunches are always changing. So, stability in timber supply from the public lands is simply a myth, a dream that was never founded in reality. It is time to stop pretending.

Jack Ward Thomas 1997. The Instability of Stability,
http://web.archive.org/web/20001201174000/http://coopext.cahe.wsu.edu/~pnrec97/thomas2.htm

Whether or not the Forest Service adopts carbon storage as part of the purpose and need, the agency should appoint to the Interdisciplinary Team a legit expert in climate change and ecosystem carbon cycling. Whoever wrote the deeply flawed boilerplate from the regional office is not qualified to provide legally compliant hard look at these issues. The ongoing climate crisis demands this much.

Conserve Mixed Conifer Without Pines
Natural stands of mixed-conifer with few if any pines or oak should be deprioritized for treatment. The lack of pines is evidence that these stands had a different fire regime. Dry forest restoration is not needed in these stands. These stands can and should be managed for late successional conditions to help recover spotted owls; stabilize the climate, communities, and watersheds; and moderate fire hazard.

For instance, during a recent field visit, we noticed that the top of unit 2357 is not a dry forest. Few if any pines or oaks are present. These areas do not need treatment, and may be RA32.

[ldquo]Fuel reduction is not warranted in old-growth forests whose large trees and shaded microclimates make them resistant to fire.[rdquo] Tom Spies, emeritus scientist with the USDA Forest Service[rsquo]s Pacific Northwest Research Station. Look to wildfires history to better prepare for next one. Sept 20, 2020 op-ed in The Oregonian. https://www.oregonlive.com/opinion/2020/09/opinion-look-to-wildfires-history-to-better-prepare-for-next-one.html.

The 2012 draft rule for NSO critical habitat says:

Silvicultural treatments are generally not needed to maintain existing old-growth forests on moist sites (Wimberly et al. 2004, p. 155; Johnson and Franklin 2009, pp. 3, 39). In contrast to dry and mesic forests, short-term fire risk is generally lower in the moist forests that dominate on the west side of the Cascade Range, and occur east of the Cascades as a higher-elevation band or as peninsulas or inclusions in mesic forests. Disturbance-based management for forests and northern spotted owls in moist forest areas should be different from that applied in dry or mesic forests. Efforts to alter either fuel loading or potential fire behavior in these sites could have undesirable ecological consequences as well (Johnson and Franklin 2009, p. 39; Mitchell et al. 2009, pp. 653[ndash]654; USFWS 2011, p. III-17).

http://www.fws.gov/home/feature/2012/pdfs/NSO-small.pdf.

Disclose and Harmonize Trade-offs
The YRR project should seek and find alternatives that harmonize trade-offs. This project involves significant trade-offs. Logging to restore fire adapted dry and moist forests will unavoidably cause significant adverse effects on:

* endangered and at-risk species such as spotted owls and red tree voles. Logging will degrade spotted owl habitat.
* large trees and dense late successional forest habitat that is still under-represented on the landscape;
* carbon storage and climate stability;
* the risk of blow down;
* the spread of weeds;
* long-term maintenance costs (The frequent fire regime that created and maintained these forests no longer exists and the Forest Service is unlikely to allow it to return naturally. Activities to mimic those natural processes are imperfect surrogates, expensive, and inadequately funded. If the FS does not follow through on those activities, there is a significant risk that surface and ladder fuels will flourish and pose a greater fire hazard than retaining the existing dense mature forests.)

The EIS should develop a full range of alternatives that resolve trade-offs in different ways. Trade-offs such as open forest vs closed canopy habitat, roads and logging volume vs snag habitat, carbon storage, etc.

Consider an Alternative That Better Harmonizes Competing Objectives
The Forest Service needs to explore options and find a better balance between pine/oak enhancement on the one hand, and old growth conservation, spotted owl recovery, watershed projection, and carbon storage on the other. These goals are somewhat in conflict, because oak pine restoration requires reducing tree density, while

conservation of old growth, spotted owls, and carbon requires retaining more trees. The Forest Service has chosen to aggressively emphasize one set of values while sacrificing the others.

The FS can do better if they fully develop and adopt an alternative that eliminates commercial logging in mature forests where pines are absent or rare, and focuses on reducing stand density right around old-growth pine and oak trees, while retaining enough trees to maintain suitable spotted owl habitat, except where pine and oak are abundant. This will require retaining far more than the 30 trees per acre as currently proposed for this project.

In addition to conserving spotted owls and other old-growth-associated wildlife, retaining extra trees serves many important purposes: reducing carbon emissions, mitigating the risk of blowdown, helping to suppress the growth of hazardous fuels, mitigating recreation and scenic impacts, etc. The conservation alternative should also avoid road construction and its adverse impacts on salmon and bull trout by focusing commercial logging near existing roads. If necessary, the non-commercial understory fuel treatments can be expanded to reach high priority patches of pine/oak that are inaccessible from existing roads. Alternative 3 in the Environmental Impact Statement moves incrementally in the right direction, but does not go far enough to harmonize the diverse goals we have for our public forests.

We urge the FS to develop an alternative (Modified Alternative 3?) that we feel best harmonizes the competing values involved in this project:

* Focus on thinning the plantations and the dryer forests. Defer the moist mature forests that lack pine and oak because they are more valuable as carbon stores and late successional habitat;
* Scale back the logging to treat only what can be maintained over time with prescribed fire. This will reduce the cost of maintenance and avoid the risk that hazardous ladder fuels will develop.
* Retain all trees >24[rdquo] dbh, including Douglas-fir trees. These trees are valuable habitat and carbon stores and should be retained.
* Retain all trees with old growth characteristics, regardless of size. Characteristics such as thick/textured/colored bark; thick branches, distinctive canopy architecture, tall height, etc.;
* Protect high quality owl habitat, defined inclusively. Field-verify stands that may be RA32 and may have been missed by LiDAR;
* Conduct red tree vole surveys in suitable habitat, not just RA32 and develop a conservation strategy based on the information from those surveys, recognizing the fragmented nature of habitat and existing dispersal bottlenecks, such as private lands and recent logging and recent fires;
* Retain significantly more trees per acre and higher basal area in all mature forests to reduce the risk of blowdown, retain carbon, mitigate impacts on late successional wildlife. We urge the FS to retain significantly more trees than in the Jim[rsquo]s Creek Project. See suggested idea for a modified prescription below. This will help mitigate several significant adverse impacts of logging, including blow down risk, late successional habitat quality used by spotted owls and red tree voles, long-term snag habitat recruitment, carbon emissions, soil and hydrologic effects, help suppress ladder fuels, weed spread, scenic and recreation impacts.

This alternative will move things toward the open forest conditions in forests that where pine and oak are actually present, and especially where pine and oak are abundant, while better mitigating adverse effects by retaining more carbon and more features of late successional forest, where pine and oak are less prevalent.

Thinning to 30 tpa is too heavy. The FS should consider an alternative for situations where there are fewer than 30 legacy pines, as follows: for where numbers of legacy pine and oak fall short of 30, double the proposed retention of trees in the stand other than pines, favoring those that are largest. For instance, if there are 30 or more legacy pines, retain all legacy pines (plus some skips and recruitment trees); when there are only 20 legacy pines per acre, retain all pines, and thin the remainder of the stand to retain an additional 20 large non-pines (30-20=10 x2=20 additional trees); when there are 10 legacy pines per acre, retain all pines, plus 40 of the largest non-pines (30-10=20 x2=40), etc. This would achieve density reduction to benefit pines in all cases, with the greatest benefit where pines are most abundant, while at the same time mitigating trade-offs and harmonizing values related to spotted owl habitat, carbon storage, and snag habitat recruitment in stands where pines are less common.

Northern spotted owl

It is imperative that the FS do more to conserve suitable habitat for spotted owls and their prey, such as red tree voles, as part of the Youngs Rock Rigdon project. A large part of this project area is designated as critical habitat for the spotted owl. The spotted owl is warranted for increased Endangered Species Act protections due to the combined effects of habitat loss and competition from the invading barred owl. These two threats are linked. Habitat conservation is an essential tool to increase the chances that spotted owls can co-exist with barred owls, instead of circling the drain toward extinction. Top owl scientists say we need to retain as much suitable owl habitat as possible, not just a subset of the highest quality owl habitat.

This project will have significant adverse impacts on the northern spotted owl which is at greater risk due to barred owls and climate change that was recognized when this area was designated as [ldquo]Matrix[rdquo] 25 year ago. An important part of the strategy to help spotted owls coexist with barred owls is to maximize the availability of suitable habitat. This project conflicts with that goal.

We are concerned about logging that will remove high-quality (RA32) and other suitable nesting, roosting, and foraging habitat for northern spotted owls. The method used to identify RA32 habitat was not inclusive, and not designed to avoid false negative findings that stands were NOT RA32. Logging and other activities that impact habitat and other life requirements for this species must be carefully balanced with the other goals of this project (like restoring more open, dry forest structure). Suitable NFR habitat should not be degraded, and thinning or other activities surrounding them should be carefully considered to ensure connectivity is maintained or enhanced for both spotted owls and red tree voles.

The FS needs to do a better job of inclusively identifying high quality spotted owl habitat as required by the Revised Recovery Plan for the Spotted Owl. Excessive reliance on modeling and remote sensing is unacceptable. The Forest Service needs to send biologists out to carefully field check the presence or absence of high quality owl habitat in order to avoid accidentally logging owl habitat in violation of the recovery plan.

A 2010 Draft report [ldquo]Population Demography of Northern Spotted Owls[rdquo] corroborates the need to protect more than just the highest quality spotted owl habitat as contemplated in the draft Recovery Action 32.

We also found a negative relationship between recruitment rates and the presence of Barred Owls and a positive relationship between recruitment and the amount of suitable owl habitat in the study areas. Recruitment was higher on federal lands where the amount of suitable owl habitat was generally highest. [p 96] [hellip]

While our observational results do not demonstrate cause-effect relationships, they provide support for the hypothesis that the invasion of the range of the Spotted Owl by Barred Owls is at least partly the cause for the continued decline of Spotted Owls on federal lands. Our results also suggest that Barred Owl encroachment into western forests may make it difficult to insure the continued persistence of Northern Spotted Owls (see also Olson et al. 2004). The fact that Barred Owls are increasing and becoming an escalating threat to the persistence of Spotted Owls does not diminish the importance of habitat conservation for Spotted Owls and their prey. In fact, the existence of a new and potential competitor like the Barred Owl makes the protection of habitat even more important, since any loss of habitat will likely increase competitive pressure and result in further reductions in Spotted Owl populations (Horn and MacArthur 1972, Olson et al. 2004, Carrete et al. 2005). [pp 97-98] [hellip]

Our results and those of others referenced above consistently identify loss of habitat and Barred Owls as important stressors on populations of Northern spotted Owls. In view of the continued decline of Spotted Owls in most study areas, it would be wise to preserve as much high quality habitat in late-successional forests for Spotted Owls as possible, distributed over as large an area as possible. This recommendation is comparable to one of the recovery goals in the final recovery plan for the Northern Spotted Owl (USDI Fish and Wildlife Service 2008), but we believe that a more inclusive definition of high quality habitat is needed than the rather vague definition provided in the 2008 recovery plan. Much of the habitat occupied by Northern Spotted Owls and their prey does not fit the classical definition of [ldquo]old-growth[rdquo] as defined by Franklin and Spies (1991), and a narrow definition of habitat based on the Franklin and Spies criteria would exclude many areas currently occupied by Northern Spotted Owls. [p 99]...

Eric D. Forsman, Robert G. Anthony, Katie M. Dugger, et al. [ldquo]Population Demography of Northern Spotted Owls.[rdquo] DRAFT COPY 17 December 2010. This draft manuscript is in press at the University of California Press with a projected publication date of July 2011. It will be No. 40 in Studies In Avian Biology, which is published by the Cooper Ornithological Society. http://www.reo.gov/monitoring/reports/nso/FORSMANetal_draft_17_Dec_2010.pdf. Based on these recommendations, the Forest Service should be prioritizing conservation of suitable spotted owls habitat, rather than converting such habitat into savannas. The FEIS needs to clearly disclose the adverse consequences of ignoring the advice of scientists, i.e. increasing the adverse competitive interactions between spotted owls and barred owls.

Wiens (2012) has recommended retaining conifer forests older than 120 years of age as a method to reduce interspecific competition between the owl species. Where barred owls occur, he has found that spotted owl survival greatly declines as the percent of forests >120 years of age in the general home range drops below 35%.

USFS 2019. Calapooia EA, Sweet Home Ranger District, Willamette National Forest. https://www.fs.usda.gov/nfs/11558/www/nepa/108782_FSPLT3_4527425.pdf

Yackulic et al (2019) show that continued emphasis on habitat restoration can help mitigate uncertainty about barred owl removal efforts which remain untested. Yackulic, Charles, et al. 2019. The past and future roles of competition and habitat in the range-wide occupancy dynamics of Northern Spotted Owls. Ecological Applications, 2019 DOI: 10.1002/eap.1861. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/eap.1861. ([ldquo] ... maintaining or improving habitat condition could be an important factor in promoting persistence of NSO populations over longer time spans and could allow managers to be less reliant on BO removals in the future ... habitat recovery could eventually lessen the need for intensive management actions such as Barred Owl removal. If, on the other hand, managers allow habitat conditions to decline they may have to rely more on BO removal ...[rdquo]) Stated another way, the agencies can reduce uncertainty about the long-term funding and long-term effectiveness of barred owl removal by emphasizing recovery of high quality suitable nesting, roosting, foraging habitat for northern spotted owls.

Red tree vole

Red tree voles are an important prey for the spotted owl and other predators. The rationale for amending the requirements for red tree vole surveys are not convincing. Focus treatments on areas that do not have red tree voles.

We recommend the Forest Service follow the commitments in the Northwest Forest Plan to survey for rare and uncommon species such as the red tree vole, and develop a conservation strategy that reflects on-the-ground data on the presence and absence of red tree vole and the connectivity of RTV habitat given barriers to movement such as private lands, young forest, and recently burned areas.

The Red tree vole is a Category C species which includes uncommon species for which pre-disturbance surveys are practical. And sites discovered during surveys will be protected according to a high-priority sites (HPS) strategy developed under the management recommendations (MR).

We have some significant concerns with the proposed plan amendment and red tree vole strategy:

* The DEIS says "YRR IDT made some refinements to the design of some HPS to better align with proposed management actions" This sounds like some high priority sites are going to be logged. This is not appropriate as it will compromise the effectiveness of the HPS strategy, and it violates the letter and spirit of the 2001 Survey and Manage ROD.
* Page 20 of the standards & guidelines for the 2001 survey and manage ROD state that surveys will be conducted and sites will be managed under the HPS strategy. The glossary defines HPS as a subset of known sites. So the FS should be developing a HPS Strategy based on the results of surveys that identify actual known sites of RTV;
* The 2001 standards & guidelines also state that management recommendations may identify [ldquo]areas[rdquo] where surveys are no longer necessary, but in the case of the RTV, the management recommendations do not identify [ldquo]areas[rdquo] where surveys are not required. The approach being utilized here is not allowed by the 2001 ROD unless the FS uses [ldquo]in lieu direction subject to further NEPA analysis.[rdquo] This involves a significant forest plan amendment;
* The proposed strategy does not provide for [ldquo]well-distributed[rdquo] habitat. The proposed strategy is designed to leave large [ldquo]gaps[rdquo] (>1 km across) within the YRR project area where red tree vole will be unprotected so that logging can proceed;
* All riparian reserves over 80 years old should be retained as part of the red tree vole strategy. Riparian reserves objectives include conservation of red tree vole. Logging for pine habitat is not part of the ACS;
* The YRR Project will create an east-west barrier to RTV connectivity. The project is located in a pinch point between private land and Tumblebug fire area and the river. Federal lands need to mitigate for poor habitat conditions on non-federal lands;
* Conserving the red tree vole requires conserving the older denser forests that they rely on. Fire exclusion and resulting succession over the last century in the YRR project area is not all bad. It helps mitigate for the high

rates of logging and loss of late successional habitat across the landscape.
* There is no assurance that high priority sites identified in the absence of surveys are in fact occupied;
* The RTV strategy should connect and protect and larger subset of suitable habitat, not just RA32.
* 10-25 acre patches don[rsquo]t support viable colonies of red tree vole;
* The FS cannot assume that existing reserves are currently suitable for red tree voles. They may not be due to past logging and fire;
* The [ldquo]ensemble of models[rdquo] approach may leave important areas out. If the ensemble must agree before an area received protection, then one incorrect model can veto the correct models. Site-specific information should be used to determine red tree vole habitat;
* There is a low probability that relatively long narrow connectivity corridors will be effective;
* Linear models to identify high priority sites are not ideal.
* The YRR High Priority Site Strategy appeared to rely on RA32 (DEIS p 404). This is not appropriate because RA32is just a small subset of the suitable habitat for red tree vole.

Survey and Manage
It appears that S&M fungi surveys were only conducted in a small subset of suitable old growth habitat (i.e., RA32). (p 206 "The Willamette National Forest chose to use modelled [ldquo]RA32[rdquo] habitat (habitat modeled as suitable for meeting requirements under the Northern Spotted Owl

Recovery Action 32 (USDI 2011) as a proxy for old-growth forest, to determine high priority areas for fungi surveys. Equivalent effort fungi surveys were conducted").

We think it is appropriate to survey all natural stands over 80 years old for rare and uncommon fungi that may be impacted by logging.

Wind Throw
We continue to be very concerned about the increased risk of blow down caused by removing too many trees from these stands. Increasing the risk of blow down is reducing resilience, not increasing it. Thinning to 30 trees per acre will expose ecologically trees to wind forces that they have not been exposed to for many decades.

Far too many valuable old growth pine trees blew down after the Jim[rsquo]s Creek Project. Trees that survived for decades even with increased competition from ingrown trees, but then died after the FS tried to [ldquo]save[rdquo] them by logging. The risk of blow down can be mitigated by retaining significantly more trees in the natural stands.

Riparian Reserves / Watershed Health / Water Quality
We are concerned about widespread impacts to soil and water from heavy equipment, road construction, and wet season log hauling. Best Management Practices (BMPs) do not go far enough to avoid impacts from these activities. The DEIS did not fully and accurately disclose these impacts, which is very concerning given the fact that this watershed is home to threatened chinook and bull trout.

Thinning dense young planted stands in riparian reserves should leave generous buffers to ensure ongoing recruitment of abundant dead wood both instream and throughout the width of the riparian reserves.

We applaud the decision not to log riparian reserves in the natural stands. There is no compelling rationale for logging riparian reserves older than 80 years old. Any restoration treatments in older riparian stands should be non-commercial (fall and leave small trees, prescribed fire, road removal, etc).

Be sure the NEPA analysis clearly shows that logging does not benefit dead wood recruitment. Rather, commercial wood removal from riparian reserves is a tax on wood recruitment and should be mitigated, not encouraged. This analysis must account for the fact(s) that: (i) trees continue to grow even if they are not thinned, (ii) logging dramatically reduces the population of green trees available for recruitment, (iii) small wood is functional, especially in small streams that are typical in most units, (iv) abundant wood is needed to meet ACS objectives not just instream, but throughout the full width of the riparian reserves.

Fire Hazard / Fuel Reduction
Fuel reduction activities should be focused on small trees if in native stands. These stands are naturally more resilient to fire, and if one of the larger goals of the project is to restore a natural fire regime, these stands should be prepared for natural and prescribed fire by retaining all large trees. Fuels reduction along private land boundaries should be a shared endeavor with private owners - encourage adjacent timber land owners to establish fuel breaks or more fire-resilient mature forests along their border with USFS as well.

We support the non-commercial logging of small fuels (<7[rdquo] dbh) along roads. In order to avoid the adverse effects of road construction, these non-commercial treatments should be used to restore dry mixed conifer forests in places that are not accessible from existing roads.

Logging has complex effects on fire and fuels with some effects tending to reduce hazard, and other effects tending to increase hazard. The FEIS needs to recognize that:

* Significant reduction of canopy cover can increase fire hazard by making the stand hotter/dryer/windier, generating more hazardous slash, stimulating the growth of future surface and ladder fuels, and additional roads increase human ignition risks;
* There is a very low likelihood that fuel treatments will interact with fire, so the benefits are unlikely, while the trade-offs on habitat and carbon are virtually certain to occur;
* [ldquo]High overstory density can be resilient[rdquo] when ladder fuel are sparse and there is a gap between surface and canopy fuels. Terrie Jain (2009) Logic Paths for Approaching Restoration: A Scientist's Perspective, from Workshop: Restoring Westside Dry Forests - Planning and Analysis for Restoring Westside Cascade Dry Forest Ecosystems: A focus on Systems Dominated by Douglas-fir, Ponderosa Pine, Incense Cedar, and so on. May 28, 2009. http://ecoshare.info/projects/central-cascade-adaptive-management-partnership/workshops/restoring-westside-dry-forests/

Snags
Large snags are critically important habitat elements that benefit a wide range of species and other ecosystem

services. Logging large areas of natural forests down to 30 trees per acre will result in a significant loss of snag habitat recruitment, the effects of which will be felt for more than 100 years. This is a significant problem given the fact that the FS is operating under outdated and discredited snag habitat standards, and the DEIS shows that this landscape is already suffering from a significant deficit of snag habitat. "For snags with a minimum diameter of 20 inches, the portion of the landscape lacking snags is more than twice that estimated for reference conditions, while the portion of the landscape with 0 to 6 snags per acre is more than 1.5 times reference conditions. The portions of the landscape with large snags are less than half reference conditions." DEIS p 177.

DEIS Figure 43 (p 189) shows that large snags adversely affected by logging.

The DEIS (e.g., page 194) failed to take a hard look at the long-term adverse consequences of losing so much snag habitat on the wide range of snag-associated species. In the DEIS, DecAID only used to ID "reference" conditions, not wildlife impacts.

The FEIS analysis of snag habitat consequences needs to compare predicted loss of snags from logging to DecAID thresholds for specific wildlife species that are most sensitive to snag abundance.

Dynamic ecosystems historically included large-scale mortality events both pulsed and continuous. Mortality and biomass accumulation are natural and desirable ecological processes that forest management has been working for decades to capture, suppress, and avoid. Large snags are severely under-represented in our forests and logging will capture, reduce and delay recruitment of future large snags. Korol et al (2002) estimated that even if we apply enlightened forest management on federal lands in the Interior Columbia Basin for the next 100 years, we will still reach only 75% of the historic large snag abundance, and most of the increase in large snags will occur in roadless and wilderness areas. Jerome J. Korol, Miles A. Hemstrom, Wendel J. Hann, and Rebecca A. Gravenmier. 2002. Snags and Down Wood in the Interior Columbia Basin Ecosystem Management Project. PNW-GTR-181. http://www.fs.fed.us/psw/publications/documents/gtr-181/049_Korol.pdf. Wisdom et al (2008) found that snag abundance in the Pacific northwest forests is inversely related to past harvest and proximity to roads. Wisdom, M.J., and Bate, L.J. 2008. Snag density varies with intensity of timber harvest and human access. For. Ecol. Manage. 255: 2085[ndash]2093. doi:10.1016/j.foreco.2007.12.027.http://www.fs.fed.us/pnw/pubs/journals/pnw_2008_wisdom001.pdf ([ldquo]Our highest snag density [hellip] occurred in unharvested stands that had no adjacent roads. [hellip] Stands with no history of timber harvest had 3 times the density of snags as stands selectively harvested, and 19 times the density as stands having undergone complete harvest. Stands not adjacent to roads had almost 3 times the density of snags as stands adjacent to roads.[rdquo])

Most managers under-estimate how many snags a healthy forest is supposed to have. The old-growth Douglas-fir/western hemlock forest at the site of the Wind River Canopy Crane has 59.5 snags/hectare larger than 51 cm dbh. Shaw, David C.; Franklin, Jerry F.; Bible, Ken; Klopatek, Jeffrey; Freeman, Elizabeth; Greene, Sarah; Parker, Geoffrey G. 2004. Ecological setting of the Wind River old-growth forest. Ecosystems. 7: 427-439. http://www.fs.fed.us/pnw/pubs/journals/pnw_2004_shaw001.pdf. Where are we intentionally managing for this outcome?

Snags have been severely depleted across the eastside and westside forests. On industrial forest lands [ldquo]The density of large snags [under an industrial forest regime] was projected to be less than 1% that found in unmanaged stands.[rdquo] Wilhere, G.F. 2003. Simulations of snag dynamics in an industrial Douglas-fir forest. Forest Ecology and Management. Volume 174, Issues 1-3, 17 February 2003, Pages 521-539. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T6X-47P120B-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=54598041b1147ba33dab125d9058d7b2.

The federal agencies need to compensate for the severe lack of snags on intensively managed forest lands, but unfortunately snags are lacking on federal lands as well. For snag depletion in westside forests, see Nonaka, E, Spies, TA, Wimberly, MC, and Ohmann, JL. 2007. Historical range of variability (HRV) in live and deadwood biomass: a simulation study in the Coast Range of Oregon, USA. Can. J. For. Res. 37:2349-2364. http://ddr.nal.usda.gov/bitstream/10113/9953/1/IND44013619.pdf , and Jerome J. Korol, Miles A. Hemstrom, Wendel J. Hann, and Rebecca A. Gravenmier. 2002. Snags and Down Wood in the Interior Columbia Basin Ecosystem Management Project. PNW-GTR-181. http://www.fs.fed.us/psw/publications/documents/gtr-181/049_Korol.pdf.

The 9th Circuit recently reiterated that [ldquo]species viability may be met by estimating and preserving habitat [lsquo]only where both the Forest Service[rsquo]s knowledge of what quality and quantity of habitat is necessary to support the species and the Forest Service[rsquo]s method for measuring the existing amount of that habitat are reasonably reliable and accurate.[rsquo] Earth Island Inst. v. U.S. Forest Serv., 442 F.3d 1147, 1175-76 (9th Cir. 2006) (quoting Native Ecosystems Council v. U.S. Forest Serv., 428 F.3d 1233, 1250 (9th Cir. 2005))[rdquo] ONRC v. Goodman (Mt Ashland case, 9th Circuit Sept 24, 2007) (emphasis added).

http://caselaw.findlaw.com/us-9th-circuit/1151013.html

and http://caselaw.findlaw.com/us-9th-circuit/1094367.html.

The Forest Service cannot provide any assurance that its plans and projects will assure viable populations of native wildlife that depend on dead trees. The Forest Service does not know how many snags are necessary to support viable populations of cavity associated species. The Forest Service has provided no credible link between DecAID tolerance levels, potential population levels, and/or viable populations. The Forest Service has also failed to reliably quantify existing and projected habitat for snag associated species.

An unavoidable impact of all commercial logging is to [ldquo]capture mortality[rdquo] which reduces valuable snag habitat in the short-term (via hazard tree felling) and in the long-term (via delayed recruitment and reduced overall recruitment). For example, in a thinning project on the Siuslaw National Forest [ldquo]modeling stand #502073 over a 100-year cycle [using ORGANON] predicts a total stand mortality of 202 trees (>10 inches dbh) for the unthinned stand, while mortality for the thinned stand was two trees. Therefore, thinning will reduce density-dependent mortality within the stand by 99%.[rdquo] NOAA April 4, 2006 Magnuson Act consultation on Essential Fish Habitat and Response to Siuslaw NF Lobster Project BA. There is no reason to think that thinning in densely stocked forests elsewhere would be any different.

Dead wood in forests is thought to follow a U-shaped pattern over time [ldquo]from the combined and lagged effects of legacy wood decay and the recruitment of new dead wood,[rdquo] (Harmon 1986, Hudiburg 2009) resulting in abundant dead wood legacies from the previous stand in young forests, less dead wood in middle-aged stands as the legacies decay, and more again in older stands as natural mortality processes manifest. If the goal is to restore high quality old forest habitat, the agencies must respect this dynamic by recognizing that dead wood recruitment requires (1) [ldquo]surplus[rdquo] biomass and (2) it[rsquo]s a process that takes time, so managers should ensure that middle-aged stands accumulate biomass and begin to recruit and accumulate snags and dead wood. The low of dead wood in middle aged stands is not universal or necessarily desirable, and since many young stands were deprived of the legacies they normally enjoy, it would be advisable to start accumulating snags and dead wood as soon as possible, not wait for mature stages.

The federal forest agencies now recognize that current methods and assumptions used to develop snag habitat standards are outdated, and the old snag standards do not ensure enough snags to meet the intent of the standard, yet the agencies have not adjusted their management plans to account for this new information nor have they developed new standards that are consistent with the latest scientific information.

The agencies need to prepare a EIS to consider a replacement methodology for maintaining species and other values associated with dead wood. This is especially critical because adequate dead wood is recognized as an essential feature of healthy forests and the Forest Service has identified lots of [ldquo]management indicator species[rdquo] associated with dead wood habitat.

Back in the early 1990s the Forest Service recognized the their forest plans were not adequate to maintain populations of spotted owls and they tried to develop plans to conserve spotted owl without following NEPA and NFMA procedures. The courts said they had to stop cutting owl habitat until they had complied with environmental laws. This is the same situation we find ourselves in today with dead-wood associated species. The agencies should stop harming dead wood habitat until they have a legal plan to conserve associated species over the long-term. Seattle Audubon Society v. Epsy, 998 F.2d 699, 704 (9th Cir. 1998) (an agency must re-examine its decision when the EIS "rests on stale scientific evidence and false assumptions").

As explained on the DecAID website:

Why is DecAID needed?

National Forest LRMP standards and guidelines for management of snags and down wood in the Pacific Northwest were based on wildlife species models and tools that were developed in the 1970s and 1980s (Thomas et al. 1979, Neitro et al. 1985, Marcot 1992, Raphael 1983). New information about the ecology, dynamics, and management of decayed wood has been published since then, and the state of the knowledge continues to change. Rose et al. (2001) report that results of monitoring indicate that the biological potential models are a flawed technique (page 602). There has been an evolution from thinking of large woody material as habitat structures, to thinking of decaying wood as an integral part of complex ecosystems and ecological processes.

This paradigm shift has made the management of dead wood a much more complex task. We can no longer expect to go to our LRMPs or the biological potential model to get one number for the amount or size of snags and down wood that we can apply to all projects and to all acres. We are directed to use the best available science to manage ecosystems, and the best available science simply will not support business as usual for managing dead wood.

Region 6 - USDA Forest Service. A Guide to the Interpretation and Use of the DecAID Advisor. June, 2006. http://www.fs.fed.us/r6/nr/wildlife/decaid-guide/

A few of the problems with the old standards are:

* They failed to account for the fact that the number of snags needed for roosting, escape, and foraging can exceed the number of snags needed for nesting;
* They failed to recognize that the number of snags needed to support viable populations of secondary cavity users may exceed the needs of primary cavity excavators;
* The old standard failed to account for the size height of snags favored by some species;
* In applying the old standards the agencies often fail to account for rates of snag fall and recruitment;
* The old standards fail to recognize non-equilibrium conditions in our forests, i.e. some species rely on the natural large pulses of snags associated with large disturbances;
* The old standards fail to account for the differential use of space and population density of different species;
*
The old standards ignore other important habitat features of dead wood, e.g. loose bark, hollow trees, broken tops, etc.

The Forest Service recognizes that

Forest Plan standards were based on a model that did not account for snags required for foraging (EA p. 68 and Appendix K p. 45). There is general consensus in the scientific and professional community that using the biological potential model (which was used in developing the Forest Plan standard) is flawed and does not provide adequate nesting, roosting, or foraging structure for cavity excavating birds [hellip]

North Fork John Day RD, Umatilla NF. 2011. Mirage Vegetation Management Project DN. http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/53012_FSPLT2_055455.pdf.

The authors of DecAID describe some of the limitations of the old methods of managing snag habitat.

Limitations of Existing Approaches for Assessing Wildlife-Dead Wood Relations.

Models of relationships between wildlife species and snags in the Pacific Northwest typically are based on calculating potential densities of bird species and expected number of snags used per pair. This approach was first used by Thomas et al. (1979). Marcot expanded this approach in Neitro et al. (1985) and in the Snag Recruitment Simulator (Marcot 1992) by using published estimates of bird population densities instead of calculating population densities from pair home range sizes. This approach has been criticized because the numbers of snags suggested by the models seem far lower than are now being observed in field studies (Lundquist and Mariani 1991, Bull et al. 1997). In addition, the models provided only deterministic point values of snag sizes or densities and of population response ("population potential") instead of probabilistic estimates that are more amenable to a risk analysis and risk management framework.

In addition, existing models have focused on terrestrial vertebrate species that are primary cavity excavators. Thomas et al. (1979) and Marcot (1992) assumed that secondary snag-using species would be fully provided for if needs of primary snag-excavating species were met. However, McComb et al. (1992) and Schreiber (1987) suggested that secondary cavity nesting birds may be even more sensitive to snag density than are primary cavity excavators.

Furthermore, existing models do not address relationships between wildlife and down wood, nor do they account for species that use different types of snags and partially dead trees, such as hollow live and dead trees used by bats (Ormsbee and McComb 1998, Vonhof and Gwilliam 2007), Vaux's swift (Chaetura vauxi) (Bull and Hohmann 1993), American marten (Martes americana) (Bull et al. 2005), and fisher (Martes pennanti) (Zielinski et al. 2004).

Bruce G. Marcot , Janet L. Ohmann, Kim L. Mellen-McLean, and Karen L. Waddell. Synthesis of Regional Wildlife and Vegetation Field Studies to Guide Management of Standing and Down Dead Trees. Forest Science 56(4) 2010. http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_marcot002.pdf

Lessons Learned During the Last Fifteen Years

[hellip]

Several major lessons have been learned in the period 1979-1999 that have tested critical assumptions of these earlier management advisory models:

* Calculations of numbers of snags required by woodpeckers based on assessing their [lsquo]biological potential[rsquo] (that is, summing numbers of snags used per pair, accounting for unused snags, and extrapolating snag numbers based on population density) is a flawed technique. Empirical studies are suggesting that snag numbers in areas used and selected by some wildlife species are far higher than those calculated by this technique.226
* Setting a goal of 40% of habitat capability for primary excavators, mainly woodpeckers,369 is likely to be insufficient for maintaining viable populations.
* Numbers and sizes (dbh) of snags used and selected by secondary cavity-nesters often exceed those of primary cavity excavators.
* Clumping of snags and down wood may be a natural pattern, and clumps may be selected by some species, so that providing only even distributions may be insufficient to meet all species needs.
* Other forms of decaying wood, including hollow trees, natural tree cavities, peeling bark, and dead parts of live trees, as well as fungi and mistletoe associated with wood decay, all provide resources for wildlife, and should be considered along with snags and down wood in management guidelines.
*
The ecological roles played by wildlife associated with decaying wood extend well beyond those structures per

se, and can be significant factors influencing community diversity and ecosystem processes.

Rose, C.L., Marcot, B.G., Mellen, T.K., Ohmann, J.L., Waddell, K.L., Lindely, D.L., and B. Schrieber. 2001. Decaying Wood in Pacific Northwest Forests: Concepts and Tools for Habitat Management, Chapter 24 inWildlife-Habitat Relationships in Oregon and Washington (Johnson, D. H. and T. A. O'Neil. OSU Press. 2001) http://web.archive.org/web/20060708035905/http://www.nwhi.org/inc/data/GISdata/docs/chapter24.pdf

The FEIS should address evidence that retaining more than the minimum number of snags has significant benefits for cavity dependent species. Comparing two sites in Northern California, Blacks Mountain Experimental Forest (BMEF) with little past logging and lots of snags, and Goosenest Adaptive Management Area (GAMA) with lots of logging and fewer snags, the author[rsquo]s found [ldquo][hellip] three times as many snags (6.38/acre vs. 2.04/acre, respectively) [hellip] The use of snags by cavity-nesting bird species was dramatically different between the sites. Thirty-one cavity-nesting pairs from 10 species were detected at BMEF, while only one pair each of two species were detected at GAMA[hellip]. This fifteenfold difference is much greater than any measure of snags or cavities reported. [hellip][rdquo]

We feel that forest managers may well be asking a misleading question. [ldquo]Snags per acre[rdquo] requirements implicitly assume an equilibrium condition and reflect only one ecological requirement for a given cavity-nesting species. [hellip] [C]onsideration of foraging habitat and other ecological requirements must be part of the [ldquo]snags per acre[rdquo] management considerations. This is an important, but somewhat daunting proposition, as potential cavity-nesting species are diverse, and each species likely has very different foraging ecologies, as well as other differences in habitat requirements. [hellip] [C]avity nesters at BMEF used larger snags on average [hellip] [T]he loss of large trees due to logging in eastside pine and other forests, over the past century has major implications for cavity-nesting birds. [hellip] [F]orest managers must have a sense of snag recruitment in relationship to snag fall, and the patterns and processes that underlie them, when addressing wildlife needs. [hellip] We view the understanding of these complexities to be of primary importance in forest management for wildlife.

Steve Zack, T. Luke George, and William F. Laudenslayer, Jr. 2002. Are There Snags in the System? Comparing Cavity Use among Nesting Birds in [ldquo]Snag-rich[rdquo] and [ldquo]Snag-poor[rdquo] Eastside Pine Forests. USDA Forest Service Gen. Tech. Rep. PSW-GTR-181. http://www.fs.fed.us/psw/publications/documents/gtr-181/017_Zack.pdf.

The bottom line is that current management at both the plan and project level does not reflect all this new information about the value of abundant snags and down wood. The agency must avoid any reduction of existing or future large snags and logs (including as part of this project) until the applicable management plans are rewritten to update the snag retention standards. See also PNW Research Station, [ldquo]Dead and Dying Trees: Essential for Life in the Forest,[rdquo] Science Findings, Nov. 1999 (http://www.fs.fed.us/pnw/sciencef/scifi20.pdf) ([ldquo]Management implications: Current direction for providing wildlife habitat on public forest lands does not reflect findings from research since 1979; more snags and dead wood structures are required for foraging, denning, nesting, and roosting than previously thought.[rdquo]) and Jennifer M. Weikel and John P. Hayes, HABITAT USE BY SNAG-ASSOCIATED SPECIES: A BIBLIOGRAPHY FOR SPECIES OCCURRING IN OREGON AND WASHINGTON, Research Contribution 33 April 2001, http://www.fsl.orst.edu/cfer/snags/bibliography.pdf.

Site Specific Analysis
This is a large project with a diversity of conditions. The NEPA analysis must be site-specific and account for differences between young vs older forests, and moist vs dryer forests. Please provide detailed information about each logging unit and each road segment, including species composition before and after logging and a histogram of the size classes and age classes of trees before and after logging. The maps in the DEIS are difficult to use in the field. Unit maps are necessary to see what part of each unit will be in [ldquo]skips[rdquo] and which part will actually be logged.

Unit-specific maps and disclosure would help us understand what we saw during a recent field visit. For instance, Unit 9150, near Middle Fork trailhead appears to be RA32; Unit 2656, north of Simpson Creek, near boundary with private land, has unique geologic features and small streams but we do not know if those stream are recognized and mapped as riparian reserves.

Road Construction
The DEIS analysis of effects of road construction (p 280) is only one paragraph and does not provide any site specific information so fails it to take the required [ldquo]hard look.[rdquo] The location of proposed roads needs to be mapped in the FEIS, as well as key information such as length, acres accessed, soil type, slope, number large trees that would need to be removed, proximity to water and other sensitive resources, and the criteria used by managers and specialists to locate and design proposed roads. How can the Forest Service disclose the site-specific impacts of those roads (on legacy trees, presence of sensitive species, soil, water quality, slope stability, weeds, fish, cultural resources, etc) if they don[rsquo]t know where the roads will be built? How can the public comment on the wisdom and effects of proposed road construction if we don[rsquo]t know where it is?

The DEIS says that resource specialists will use site-specific information to locate roads. This is post hoc analysis that does not conform to NEPA. Procedures implementing the National Environmental Policy Act ([ldquo]NEPA[rdquo]) [ldquo]must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.[rdquo] 40 C.F.R. [sect] 1500.1(b).

The DEIS says that temporary roads will be obliterated. This is misleading. It implies that the effects of temporary roads are temporary, when in fact the effects of constructing and using roads is significant and long-lasting.

Some very short spurs to facilitate variable thinning in managed stands might be justified, but building roads to commercially log natural stands makes no sense, because it will not only cause significant harm to soil and water, but also lead to significant emissions of greenhouse gases and remove suitable nesting, roosting, foraging habitat for the threatened northern spotted owl.

Temporary roads still cause serious adverse impacts to soil, water and wildlife, and spread weeds. Decommissioning such roads is not entirely successful and the soil compaction effects can last for decades. The agency should consider avoiding building spurs by treating some areas non-commercially (e.g. thin lightly, create lots of snags, and leave the material on site).

We urge the agency to avoid road construction, including temporary road construction. The ecological costs of road construction almost always outweigh any benefits of the associated commercial logging activity. Since an optimal landscape restoration plan includes a mix of treated and untreated areas, the agency can easily avoid road construction by co-locating untreated areas and inaccessible areas.

Temporary roads have many of the same impacts as permanent roads, including complete vegetation removal, severe soil disturbance and compaction, severe modification of the flow of water and air through the soil, impairment of soil biological activity, wildlife habitat fragmentation (especially for microfauna), and wildlife cover loss. In spite of the fact that some roads may only be used by heavy equipment on a temporary basis, the biophysical effects of temporary roads can be long-lasting. The FS may even come back and use these temporary roads for future vegetation management or fire management. The temporal effects of temp roads can also be extended by legal or illegal use by off highway vehicles, woodcutters, hunters, mushroom collectors, etc.

The November 2000 National Forest Roadless Area Conservation FEIS p 3-30 says that temporary roads are not designed and constructed to the same standard as classified roads and therefore result in a [ldquo]higher risk of environmental impacts.[rdquo] The NEPA analysis must account for this increased risk of temporary roads compared to permanent roads.

The Roadless FEIS also says:

Temporary roads present most of the same risks posed by permanent roads, although some may be of shorter duration. Many of these roads are designed to lower standards than permanent roads, are typically not maintained to the same standards, and are associated with additional ground disturbance during their removal. Also, use of temporary roads in a watershed to support timber harvest or other activities often involves construction of multiple roads over time, providing a more continuous disturbance to the watershed than a single, well-designed, maintained, and use-regulated road. While temporary roads may be used temporarily, for periods ranging up to 10 years before decommissioning, their short- and long-term effects on aquatic species and habitats can be extensive. [The FEIS has similar disclosures citing extensive impacts to terrestrial species and habitats, and rare plant populations.]

Roadless Area Conservation FEIS [mdash] Specialist Report for Terrestrial and Aquatic Habitats and Species prepared by Seona Brown and Ron Archuleta, EIS Team Biologists http://web.archive.org/web/20040515020554/http://roadless.fs.fed.us/documents/feis/specrep/xbio_spec_rpt.pdf.

"Temporary roads are constructed with no engineering specifications since they are targeted to be used for a short time (ideally a single season), and then obliterated. This lack of construction design makes it particularly important to follow Project Design Criteria for avoiding potentially unstable slopes, even with potentially short time frame of use. That is because even temporary roads which are constructed with road cuts in steep, unstable terrain can trigger debris avalanches and slope failures by removing downslope support and interfering with surface and subsurface water flows that can weaken slopes."

USDA 2020. Stella Landscape Restoration Project Draft Environmental Impact Statement. Page III-30. Rogue River Siskiyou National Forest. https://www.fs.usda.gov/project/?project=53241.

The agency typically assumes that temporary roads will have no effect because they are temporary. The agency has shown no scientific evidence to support this assumption. In fact, scientific research has shown exactly the opposite. Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads. Charles H. Luce, USDA Forest Service Intermountain Research Station, 1221 S. Main, Moscow, ID 83843. September 1996. Restoration Ecology, Vol. 5, No. 3. page 268.

Please consider George Wuerthner[rsquo]s summary of the many problems with so-called temporary roads. George Wuerthner 2009. Temporary Roads Are Like Low Fat Ice Cream, NewWest. 3-17-09. http://www.newwest.net/topic/article/temporary_roads_are_like_low_fat_ice_cream/C564/L564/ ([ldquo]The problem is that temporary roads have most of the same environmental impacts as regular roads.[rdquo]). See also, Wuerthner[rsquo]s April 2020 blog post showing the persistent impacts of temporary roads. http://www.thewildlifenews.com/2020/04/22/are-temporarily-roads-ecologically-invisible/.

Research results, published in Restoration Ecology, shows there is nothing temporary about temporary roads, and that ripping out a road is NOT equal to never building a road to begin with. The saturated hydraulic conductivity of a ripped road following three rainfall events was significantly greater than that of the road surface before ripping... most saturated hydraulic conductivities after the third rainfall event on a ripped road were in the range of 22 to 35 mm/hr for the belt series and 7 to 25 mm/hr for the granitics. These conductivities are modest compared to the saturated hydraulic conductivity of a lightly disturbed forest soil of 60 to 80 mm/hr.[rdquo] id. Even this poor showing of restoring pre-road hydrologic effects worsened with repeated rainfall. [ldquo]Hydraulic conductivity values for the ripped treatment on the granitic soil decreased about 50% with added rainfall (p(K1=K2)=0.0015). This corresponded to field observations of soil settlement and large clods of soil created by the fracture of the road surface dissolving under the rainfall... The saturated hydraulic conductivity of the ripped belt series soils also dropped from its initial value. Initially, and for much of the first event, the ripped plots on the belt series soil showed no runoff. During these periods, run-off from higher areas flowed to low areas and into macropores.... Erosion of fine sediment and small gravel eventually clogged these macropores... Anecdotal observations of roads ripped in earlier years revealed that after one winter, the surfaces were nearly as solid and dense as the original road surfaces.[rdquo] Id. Even though ripped roads increase water infiltration over un-ripped roads, it does not restore the forest to a pre-road condition. [ldquo]These increases do not represent [lsquo]hydrologic recovery[rsquo] for the treated areas, however, and a risk of erosion and concentration of water into unstable areas still exists.[rdquo] Luce, C.H., 1997. Effectiveness of Road Ripping in Restoring Infiltration Capacity of Forest Roads, Restoration Ecology; 5(3):265-270. http://library.eri.nau.edu/gsdl/collect/erilibra/import/Luce.1997.EffectivenessOfRoadRippingIn.pdf.The Rogue River-Siskiyou National Forest[rsquo]s Rustler EA (2010) says:Temporary roads are also expected to have an irretrievable reduction in soil productivity since they are bladed (soil is mixed and displaced) and compacted. Even once rehabilitated, the soil profile is modified to a degree that may take many years to return to the productive state of the undisturbed forest soils adjacent to it.Connect Prescriptions to Desired Outcomes Provide clear and detailed rationale that connects proposed actions to desired conditions. Test the rationale for actions and effects analysis against the scientific evidence, including the full range of evidence, reasonable opposing viewpoints, and the evidence presented in these comments. For each treatment unit, provide clear descriptions of silvicultural prescriptions and marking guides in the NEPA document.

Pacific Yew and Other Minor Species
We urge the FS to retain uncommon and unique species such as Pacific Yew, cedar, and bigleaf maple trees in this project, including in the non-commercial fuel reduction treatments. The DEIS says that minor tree species will be favored, but that falls short of a binding commitment to protect those species.

Economic Analysis / social cost of carbon dioxide emissions
The DEIS (pp 283-288) cites the economic values associated with timber extraction and sawlog production without disclosing that those economic benefits are likely dwarfed by the economic costs associated with the GHG emissions caused by logging. The FEIS economic analysis should disclose social cost of carbon dioxide emissions associated with logging.

The social, economic, and environmental costs of unmitigated climate change are astronomical. With a recognition that nature-based carbon storage can help mitigate those costs, it is becoming clear that conservation of nature, especially forests, creates far more value than natural resource extraction. Bradbury, R.B., Butchart, S.H.M., Fisher, B. et al. The economic consequences of conserving or restoring sites for nature. Nat Sustain (2021). https://doi.org/10.1038/s41893-021-00692-9. https://rdcu.be/cgpdK ([ldquo]At $31/tonne [of carbon] the nature-focused state NPV was greater than the alternative state NPV at 100% of forest sites. [hellip] [W]hile these patterns hold for all goods combined and for non-excludable goods, the alternative state was often more valuable when only excludable goods were considered. Our findings thus provide a strong economic justification for incentives to encourage private landowners towards decisions that favour nature-focused land management to enhance overall social value.[rdquo]).

It is important to quantify the total carbon emissions from logging then use proxies such as the social cost of carbon dioxide emissions to help explain the effects of those emissions. Another powerful proxy is provided by Bressler (2021) which shows that 4,434 tonnes of CO2e emissions is estimated to result in 1 premature human death. Bressler, R.D. The mortality cost of carbon. Nat Commun 12, 4467 (2021). https://doi.org/10.1038/s41467-021-24487-w.https://www.nature.com/articles/s41467-021-24487-w.pdf. The agency should calculate and disclose how many people they are killing with their logging plans.

The Biden Administration says it is essential that federal decision-making consider the full cost of agency actions that may harm the climate:

Sec. 5. Accounting for the Benefits of Reducing Climate Pollution. (a) It is essential that agencies capture the full costs of greenhouse gas emissions as accurately as possible, including by taking global damages into account. Doing so facilitates sound decision-making, recognizes the breadth of climate impacts, and supports the international leadership of the United States on climate issues. The [ldquo]social cost of carbon[rdquo] (SCC), [ldquo]social cost of nitrous oxide[rdquo] (SCN), and [ldquo]social cost of methane[rdquo] (SCM) are estimates of the monetized damages associated with incremental increases in greenhouse gas emissions. They are intended to include changes in net agricultural productivity, human health, property damage from increased flood risk, and the value of ecosystem services. An accurate social cost is essential for agencies to accurately determine the social benefits of reducing greenhouse gas emissions when conducting cost-benefit analyses of regulatory and other actions. [hellip]

(b) There is hereby established an Interagency Working Group on the Social Cost of Greenhouse Gases [hellip]

(ii)   Mission and Work. The Working Group shall, as appropriate and consistent with applicable law:

(A) publish an interim SCC, SCN, and SCM within 30 days of the date of this order, which agencies shall use when monetizing the value of changes in greenhouse gas emissions resulting from regulations and other relevant agency actions until final values are published;

(B) publish a final SCC, SCN, and SCM by no later than January 2022;

Biden Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis; JANUARY 20, 2021. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis/. Experts offered 8 steps to restating the social cost of carbon dioxide emissions. Gernot Wagner, David Anthoff, Maureen Cropper, Simon Dietz, Kenneth T. Gillingham, Ben Groom, J. Paul Kelleher, Frances C. Moore & James H. Stock. 2021. Eight priorities for calculating the social cost of carbon. Nature | Vol 590 | pp 548-550 | 25 February 2021. https://media.nature.com/original/magazine-assets/d41586-021-00441-0/d41586-021-00441-0.pdf. (1. Reverse Trump[rsquo]s changes. 2. Seek broad input. 3. Update damage functions. 4. Reappraise climate risks. 5. Address equity. 6. Review discount rates. 7. Update socio-economic pathways. 8. Clarify limitations.).

Gifford Pinchot said "Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run." The social cost of carbon dioxide emissions is a useful yardstick for measuring [ldquo]the greatest good to the greatest number[rdquo] because it allows the agency to compare the centralized economic value of timber to the decentralized economic costs of greenhouse gases emissions from logging.

GHG emissions from fossil fuels, logging, and other land management activities impose significant costs on society, such as the cost of damage caused by climate change and the costs of adapting to climate change and the cost of sequestering carbon to mitigate emissions. The Social Cost of Carbon Dioxide could be referred to as the [ldquo]climate misery index[rdquo] related to the human impacts of greenhouse gas emissions. CEQ[rsquo]s draft guidance on NEPA and Climate Change recognizes that the Social Cost of Carbon Dioxide (SCC) is a [ldquo]harmonized, interagency metric that can provide decision-makers and the public with some context for meaningful NEPA review.[rdquo] 79 Fed. Reg. 77802, 77827. [ldquo]The SCC estimates the benefit to be achieved, expressed in monetary value, by avoiding the damage caused by each additional metric ton (tonne) of carbon dioxide (CO2) put into the atmosphere.[rdquo] Ruth Greenspan and Dianne Callan 2011. More than Meets the Eye: The Social Cost of Carbon in U.S Climate Policy, in Plain English (World Resources Institute, July 2011) at 1, http://pdf.wri.org/more_than_meets_the_eye_social_cost_of_carbon.pdf; Wentz, J. 2016. EPA[rsquo]s Use of the Social Cost of Carbon is Not Arbitrary or Capricious http://blogs.law.columbia.edu/climatechange/2016/03/07/epas-use-of-the-social-cost-of-carbon-is-not-arbitrary-or-capricious/. The NEPA analysis should carefully disclose these social costs. The express purpose of SCC analysis is to provide an apples-to-apples basis for comparing a project[rsquo]s economic benefits with GHG pollution impacts (costs). Where SCC is not analyzed and disclosed, these impacts (costs) are hidden from the public and, in fact, often [ldquo]paid for[rdquo] by the broader environment and public in the form of degraded ecological resiliency, public health impacts, and more.

For an example of how the social cost of carbon can be incorporated into NEPA analysis see Niemi (2015):

Summary

Actions that reduce the amount of carbon stored in federal forests contribute to disruption of the global climate by increasing atmospheric concentrations of carbon dioxide. The climate disruption raises the risk of economic harm[mdash]locally, nationally, and globally[mdash]from extreme weather events, higher temperatures, changes in precipitation, rising sea levels, acidification of oceans, and changes in ecosystems. Laws and executive orders require managers of federal forests to account for these risks. This paper describes the recent failure of the Bureau of Land Management (BLM), to satisfy the requirements. It also describes the steps the BLM must take to meet its obligations, and illustrates the method the BLM and other federal forest management agencies should use to account for carbon-related risks in the future.

The BLM failed to account for climate-related risks when it selected its Preferred Alternative for managing federal forests in western Oregon. If implemented, this alternative would yield more timber but less forest carbon than another alternative. Using old data and a conservative view of risk, the BLM provided information that indicates the additional climate-related costs may:

[bull] Outweigh the additional timber-related benefits by 2-to-1.

[bull] Equal $91,000 per additional timber-related job.

[bull] Equal $4 for every $1 of additional timber-related payments to local counties.

Current data, plus a widely accepted view of risk indicates the additional climate-related costs may:

[bull] Outweigh the additional timber-related benefits by more than 30-to-1.

[bull] Equal $1.6 million per additional timber-related job.

[bull] Equal $68 for every $1 of additional timber-related payments to local counties.

The BLM disregarded this information when choosing its Preferred Alternative. To satisfy its legal and administrative requirements, the BLM should fully and clearly describe the climate related risks that accompany the Preferred Alternative, and explain its justification for imposing these risks on the individuals, households, businesses, and communities that would bear them. This justification should address both the reduction in overall economic wellbeing that would result from implementing the Preferred Alternative and the moral issues that arise from imposing climate-related risk on those that would not enjoy the timber benefits.

Niemi, E. 2015. Accounting for Climate-Related Risks In Federal Forest-Management Decision, 10 May 2015 [draft]. Federal Forest Carbon Coalition Background Paper 2015[ndash]2. http://static1.1.sqspcdn.com/static/f/551504/26259333/1432605642583/SocialCostsOfCarbonOClandsNiemiMay2015.pdf?token=wDqoa5RkP8EoBLlsRWIPPRuahzg%3D. Niemi (2015) explained that [ldquo]Moore and Diaz (2015) found that accounting for the impacts of climate on economic growth increases the Interagency Working Group[rsquo]s estimates of the social cost of carbon by a factor of six.[rdquo] citing Moore, F.C., and D.B. Diaz. 2015. [ldquo]Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy.[rdquo] Nature Climate Change. 12 January. http://www.eenews.net/assets/2015/01/13/document_cw_01.pdf ([ldquo]Optimal climate policy in this model stabilizes global temperature change below 2 ?C by eliminating emissions in the near future and implies a social cost of carbon several times larger than previous estimates. A sensitivity analysis shows that the magnitude of climate change impacts on economic growth, the rate of adaptation, and the dynamic interaction between damages and GDP are three critical uncertainties requiring further research. In particular, optimal mitigation rates are much lower if countries become less sensitive to climate change impacts as they develop, making this a major source of uncertainty and an important subject for future research.[rdquo])

Do not rely on the flawed boilerplate climate analyses

The climate change analysis in the DEIS (p 281) is just the usual boilerplate. As explained below, the Forest Service[rsquo]s standardized NEPA language regarding carbon and climate change fails to take a hard look that NEPA requires. The analysis makes several highly misleading statements about forest carbon and climate change. The analysis inappropriately mischaracterizes the role of individual logging projects in the cumulative problem of global GHG emissions. The analysis misstates the effects of logging related carbon emissions that are not related to [ldquo]deforestation.[rdquo] The analysis grossly misstates the climate effects of logging intended to reduce disturbance. The analysis misleadingly implies that logging benefits the climate by increasing forest productivity.

The NEPA analysis should consider the adverse climate consequences of GHG emissions caused directly and indirectly by logging. The Forest Service should not rely on the boilerplate NEPA language from the regional office which is flawed in many ways. Instead the Forest Service:

* Must recognize the cumulative nature of the GHG emissions and climate problems. It does not matter that this project is small in the global scheme because all emissions matter when the causation is global and cumulative;
* Cannot credibly assert that this project is harmless because it[rsquo]s not causing deforestation. This is immaterial. All GHG emissions, regardless of the source or how it is labelled, are part of the problem and cause the same climate impacts.
* Cannot credibly assert that thinning for forest health justifies or mitigates emissions from logging. Logging does not increase the capacity for growing trees. To the contrary, logging harms soil and reduces site productivity. Storing carbon in wood products is not preferable to storing carbon in forests. Evidence shows that forests are a more secure way of storing carbon. If this forest is not logged, or if more green tree are retained in situ, the agency cannot conclude that natural mortality will be greater than logging mortality. In fact, it is quite easy to predict that logging causes significantly more mortality than natural processes.
* Must not compare carbon before and after logging. That is an improper framework for NEPA analysis. The proper NEPA framework is to compare the effects of different alternatives (over time), so the agency must describe the carbon emissions and carbon storage in the forest over time with logging and without logging.
* Logging to reduce fire effects does not result in a net increase in forest carbon storage. The agency cannot predict the location, timing, or severity of future wildfires, so most fuel treatments will cause carbon emissions without any offsetting benefits from modified fire behavior. Studies clearly show that the total carbon emissions from logging (plus unavoidable wildfire) are greater than carbon emissions from wildfire alone.
* Cannot credibly assert that carbon storage in wood products is a useful climate strategy. Logging kills trees, stops photosynthesis, and initiates decay and combustion, with the end result being a significant transfer of carbon from the forest to the atmosphere. In stark contrast, an unlogged forest continues to grow and transfer more carbon from the atmosphere to the forest. Carbon emissions caused by logging far exceed the small fraction of carbon transferred to wood products. Carbon accounting methods that attempt to account for substitution of wood for other high-carbon building materials are fraught with uncertainty and too often represent maximum potential substitution effects rather than lower realistic estimates.

New Information Requires Modification of Matrix Objectives.

The Forest Service should not justify this project based on out-dated timber targets and land allocations that encourage logging. In 1994, when the Northwest Forest Plan was adopted, the agencies under-estimated the impact of the barred owl and global climate change, and over-estimated the benefits of the timber industry. We now know that we are in a climate emergency that requires bold action by everyone. We now know that spotted owls need more than the reserves in order to co-exist with barred owls. We now know that the timber industry is a destabilizing force that booms and busts to the detriment of local communities, and maintaining quality of life is a stabilizing force that encourages diverse economic development. The Forest Service can and should do the right thing and harmonize high priority restoration actions without unnecessarily sacrificing other important goals.

This project is based on part on the need to produce timber to meet RMP objectives. There is a trade-off between ecological objectives and timber objectives, and new information indicates that these trade-offs are becoming more acute. Before sacrificing older forests in order to produce timber, the agency needs to carefully consider new information developed since the Northwest Forest Plan was adopted in 1994. Several significant new developments indicate a need to increase emphasis on conservation and restoration of more mature & old-growth forests, and reduced emphasis on Matrix objectives such as timber production from logging of mature & old-growth forests. Unfortunately, the agencies have not taken steps to account for new information and has failed to adjust Matrix objectives accordingly.

A few of the most important new issues include:

Barred owls [mdash] The threatened spotted owl faces a significant new threat in the form of the barred owl which has recently invaded the range of the spotted owl, uses and similar habitat, and uses many of the same food sources. Hundreds of thousands of acres of suitable owl habitat that were assumed in the NW Forest Plan to be available for spotted owl nesting, roosting, and foraging are now occupied and defended by territorial barred owls to the exclusion of spotted owls. There is an urgent need to protect additional suitable owl habitat (and reduce the loss of existing habitat) in order to increase the likelihood that threatened spotted owls can coexist with newly invading barred owls instead of facing competitive exclusion. More habitat increases the chances that the two owls can co-exist. More discretion and more logging reduce the changes for co-existence and increase the chances for competitive exclusion/extirpation.

FWS has recommended protection of a subset of high quality owl habitat, but whether this subset of habitat is enough to ensure species recovery has never been tested and validated. The habitat modeling done as part of the spotted owl recovery planning process assume that the barred owl population would remain constant, but it is more realistic to expect that the barred owl population will continue to increase for some time. We are a long way from an effective rangewide barred owl control program, and if the program ever gets fully implemented, failure to maintain the program in perpetuity will likely lead to a rapidly resurgent population of barred owls. There are too many preconditions that undercut FWS[rsquo] modeling assumptions and the effectiveness of relying on a subset of suitable habitat. Spotted owls would be safer if all suitable habitat were protected.

The FS is using Recovery Action 32 to mitigate for the barred owl, but in reality all suitable habitat should be conserved. When the agency discovers that its plans are out of date and adopts new strategies, the agency must follow NEPA and NFMA procedures to amend its forest plan. ONRC and HCPC v. Forsgren, 252 F. Supp. 2d 1088 (D. Or. 2003) March 11, 2003. http://law.justia.com/cases/federal/district-courts/FSupp2/252/1088/2424683/ Here, RA 32 is a new strategy that the FS is using as a de facto plan amendment to justify logging suitable habitat. This is not allowed without following legal requirements.

Owl dispersal habitat [ndash] The matrix was intended to support spotted owl dispersal, and it was assumed that 40% canopy closure of trees 11[rdquo] dbh would be enough, but new information indicates that spotted owl dispersal habitat should be managed for [ldquo]at least 80%[rdquo] canopy cover. Sovern et al (2015) found that

[ldquo]Roost Site Selection. In contrast to the assumption that stands with relatively open canopies provide suitable dispersal habitat for spotted owls, our results suggest that dispersing juveniles selected stands for roosting that had relatively high canopy closure (x = 66 + 2%). [hellip] Two hypotheses could explain why dispersing owls selected closed-canopy stands. First, several researchers (Barrows 1981, Forsman et al. 1984, Weathers et al. 2001) have shown that temperature and precipitation appear to influence selection for roost trees and attributes within a roost tree, such as perch height and percent overhead cover. [hellip] Second, juvenile northern spotted owls may have selected for closed-canopy forest because their preferred prey were most abundant [hellip] Landscape Scale Selection. [hellip] [O]ur mean estimate of canopy closure from plots at roosts (66%), which was likely an underestimate of canopy cover, was considerably higher than the minimum values recommended by Thomas et al. (1990) [i.e. 50-11-40]. [hellip] Management Implications. [hellip] Based on our study, we recommend that managers should pursue a strategy that exceeds the canopy cover guidelines recommended by Thomas et al. (1990) when managing dispersal habitat for spotted owls. Based on our estimate of mean canopy closure (66%), and our estimate of mean canopy cover from overlaying a dot grid on the same areas (approx. 14% larger), we recommend that the target for canopy cover in stands managed for dispersing spotted owls should be at least 80%.[rdquo]

Stan G. Sovern, Eric D. Forsman, Katie M. Dugger, Margaret Taylor. 2015. Roosting Habitat Use and Selection By Northern Spotted Owls During Natal Dispersal. The Journal of Wildlife Management 79(2):254[ndash]262; 2015; DOI: 10.1002/jwmg.834.

Carbon storage [mdash] Global climate change is a new and significant threat not only to imperiled species, but also whole forest ecosystems and human communities. To reduce the severity of global climate change requires, among other things, that the global carbon cycle be managed to store more carbon. Carbon-rich ecosystems like mature & old-growth forests of western Oregon present a tremendous opportunity to increase carbon storage and mitigate climate change.

Climate change is a new and significant reason to conserve forests and reduce logging. A science review will show that long-live d forests are a great place to store carbon, while wood products are relatively short-lived and not a good place to store carbon. Also, carbon can't be moved from the forest to durable wood products without causing significant GHG emissions. Alleged benefits of wood products substitution for steel and concrete are vastly over-estimated. All high biomass forests should be conserved, and many young forest should be allowed to grow.

Climate change [mdash] A warmer world with more seasonal extremes of wet and dry also creates uncertainty about our ability to sustain older forests, and about whether we can recreate functional old forests starting from young, planted stands. If climate change brings increasing frequency and severity of drought and natural disturbance, it may be harder to sustain existing older forests and harder to establish new forests and sustain them through long periods of forest succession required to reach habitat goals for imperiled species like spotted owls, marbled murrelet, and salmon. This highlights the old adage that [ldquo]a bird in the hand is worth two in the bush.[rdquo] We should retain all the older forests that we currently have (and carefully nurture likely recruitment forests). Climate uncertainty alone represents an increased risk for spotted owl recovery.

Undisturbed ecosystems and late successional forests are more resistant and resilient to climate change. Gy[ouml]rgy Kr[ouml]el-Dulay et al (2015). Increased sensitivity to climate change in disturbed ecosystems. Nature Communications, 2015; 6: 6682. http://web.ics.purdue.edu/~jsdukes/Kr%C3%B6el-DulayEtAl_NC_2015.pdf. Climate change is a huge new stress on ecosystems that are already stressed. We can help ecosystems better withstand climate change by reducing anthropogenic stress caused by logging, roads, grazing, etc. Climate change is expected to amplify the hydrologic cycle. This calls for increased protection of whole watersheds and especially streams buffers (and reducing road/stream interactions). There may be a need for modest reductions in tree density, but only in limited areas. For wildlife that depend on dense forest conditions (i.e., most of our threatened & endangered species), logging to reduce stress or reduce fire hazard will only make things worse. Wildlife are more threatened by the combined effects of logging plus fire, than by fire alone. See Heiken, D. 2010. Log it to save it? The search for an ecological rationale for fuel reduction logging in Spotted Owl habitat. Oregon Wild. v 1.0. May 2010.
https://www.dropbox.com/s/pi15rap4nvwxhtt/Heiken_Log_it_to_save_it_v.1.0.pdf?dl=0

Dead wood standards [mdash] Large accumulations of dead wood are essential for meeting objectives for fish & wildlife habitat, water quality, and carbon storage. Past and ongoing forest management has greatly reduced the prevalence of large snags and dead wood. Northwest Forest Plan standards for dead wood are based on an outdated [ldquo]potential population[rdquo] methodology which greatly underestimates the amount of snags and down logs needed to meet the needs of a variety of species associated with dead wood. Forests are a dynamic system where the population of all live trees represent the recruitment pool for all dead trees, so if more dead trees are needed over time, that means more live trees need to be retained for long-term recruitment. Before conducting activities like commercial logging (especially regen logging) that will result in long-term reduction in recruitment of snags and dead wood, the agencies should follow NEPA procedures to amend their management plans, consider alternatives, and adopt new standards that assure objectives are met over time and across the landscape.

Complex early seral forest - There is some concern that clearcuts on non-federal do not provide high quality habitat for wildlife that prefer complex early seral habitat with abundant legacies and diverse non-conifer vegetation. While this habitat may be under-represented, there are no listed species that depend on it because most of the species associated with ephemeral young forests tend to be mobile, generalist, and/or opportunistic. There are a wide variety of policy options for enhancing early seral that do not require that we sacrifice old forests. K. Norm Johnson, Debora L. Johnson. 2007. Policies to Encourage Diverse, Early Seral Forest in Oregon: What Might We Do? http://ecoshare.info/2010/10/04/k-norman-johnson-policies-to-encourage-diverse-early-seral-forest-in-oregon-what-might-we-do/ Climate change is expected to increase the prevalence of early seral forests. Regen logging produces lower quality early seral. We should instead stop salvage logging.

Fire Hazard [ndash] New information highlights the fact that regen logging increases fire hazard for many decades by causing the establishment of homogeneous young conifer stands with dense fuels close to the ground. See Harold S. J. Zald, Christopher J. Dunn. 2018. Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications. Online Version of Record before inclusion in an issue. 26 April 2018. https://doi.org/10.1002/eap.1710. Also, https://phys.org/news/2018-04-high-wildfire-severity-young-plantation.html. This concern is highlighted by climate change which is extending the fire season. Roads also increase roadside ladder fuels and fire ignition risk. Conversely, another study shows that mature forests are more resilient to wildfire, which brings into question the long-held assumption that time-since-fire is an indicator of fuel build-upand increased fire hazard. Lesmeister, D. B., S. G. Sovern, R. J. Davis, D. M. Bell, M. J. Gregory, and J. C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4):e02696. 10.1002/ecs2.2696.
https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2696

Hydrologic Effects [ndash] New information indicates that logging and roads have significant and long-lasting adverse effects on hydrology, including artificial peak flows in the years during storms, especially immediately after logging; as well as artificial low stream flows during summer, which lasts for several decades when dense young conifers establish after logging. Perry & Jones (2016) found [ldquo][hellip] Long-term paired-basin studies extending over six decades revealed that the conversion of mature and old-growth conifer forests to plantations of native Douglas-fir produced persistent summer streamflow deficits of 50% relative to reference basins, in plantations aged 25 to 45 years. This result challenges the widespread assumption of rapid [ldquo]hydrologic recovery[rdquo] following forest disturbance [hellip] [ldquo] Perry, T. D., and Jones, J. A. (2016) Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA. Ecohydrology, doi: 10.1002/eco.1790. http://onlinelibrary.wiley.com/doi/10.1002/eco.1790/full. Jones & Grant (1996) found [ldquo]"This study demonstrated that road construction combined with patch clear-cutting ranging from 10 to 25% of basin area produced significant, long-term increases in peak discharges in small and large basins in the western Cascades.... In the western Cascades, clear-cutting and vegetation removal influence water balances by affecting evapotranspiration and possibly snow accumulation and melt, whereas road construction influences hillslope flow paths by converting subsurface flow to surface flow.[rdquo] Jones, J.A., Grant G.E., "Peak flow response to clear-cutting and roads in small and large basins, western Cascades, Oregon," Water Resources Research, 32(4) 959-974, April 1996 https://www.wou.edu/las/physci/taylor/g473/refs/jones_grant_1996.pdf. The National Climate Assessment concludes that global climate change is expected to reduce the ability of watersheds and ecosystems to regulate water quality and water flow and buffer extreme events. http://nca2014.globalchange.gov/ Efforts toward watershed and riparian conservation should therefore be increased;

Pacific Fisher [ndash] In 2014, FWS proposed listing the Pacific fisher as "threatened" under the ESA. A final listing decision is due in Fall 2015. The imminent listing of the fisher requires the agencies to increase connectivity in the NWFP. The current network of reserves was designed more for spotted owls and is not ideal for fishers which have more difficulty in navigating between reserves. William J. Zielinski, et al., Using landscape suitability models to reconcile conservation planning for two key forest predators, Biological Conservation (2006), doi:10.1016/j.biocon.2006.07.003.http://www.sierraforestlegacy.org/Resources/Conservation/SierraNevadaWildlife/CaliforniaSpottedOwl/CASPO-Zielinski06.pdf The agencies need to increase conservation of habitats in the matrix that are suitable or potentially suitable for fisher. This includes mature & old-growth forests and riparian reserves.

The PNW economy has changed. At the NWFP tenth anniversary conference on April 13, 2004 in Portland, USFS PNW Regional Economist Richard Haynes said that the NW economy has [ldquo]fundamentally changed[rdquo] over the last ten years since the NWFP was approved. The changes include: growth and diversification of the overall economy so that the timber industry plays a much smaller role in the overall economy, structural changes in the timber industry both regionally and nationally so that few mills remain dependent upon federal old-growth log supply, and serious decline of the export market so the logs from private lands are now more available to domestic mills. This raises a significant issue about whether the NWFP should continue to log any more late-successional old-growth at all and take continued risks with population viability of late-successional old-growth dependent species. Changed economic circumstances represent significant new information and requires the agency to prepare an EIS to consider protecting all remaining mature and old-growth forests and shifting efforts toward restoration including thinning dense young plantations.

The economic and social benefits of logging are decreasing. As recently as 2001, there were 12 jobs generated per million board feet cut. In 2012, that ratio had declined to 6.5 jobs per million board feet logged. (Oregon Employment Department, July 17, 2014).

https://www.qualityinfo.org/-/jobs-per-board-feet-of-timber-harvests-in-oregon;

Since 2010, timber harvest and jobs have become decoupled. There is no reason to think that increased timber harvest will result in increased employment.

https://www.qualityinfo.org/-/jobs-per-board-feet-of-timber-harvests-in-oregon;

Producing timber from federal lands feeds an inherently volatile industry that perpetuates community instability. There is significant new information indicating that the timber industry is inherently volatile so proving timber from federal lands causes community instability rather than community stability. BLM[rsquo]s 2015 Western Oregon Plan Revision DEIS (p 472) said:

Over the long-term (1969-2007), timber-based industries nationally exhibited low or negative growth rates with high volatility compared with the United States economy as a whole, indicating that these industries tend to be inherently volatile. Increases in timber industry activity in the planning area could bring additional exposure to greater economic instability.

http://www.blm.gov/or/plans/rmpswesternoregon/deis.php BLM[rsquo]s DEIS acknowledges that the timber industry is far more volatile than other industries so boosting timber jobs does not necessarily translate to community stability. This new information requires a fundamental shift in thinking about the value of federal lands for timber production versus provision of public benefits that do contribute to community stability, such as: clean water, carbon storage and stabilizes the climate, biodiversity, diverse recreation opportunities, scenic values, etc.

Lehner, J. 2012. Historical Look at Oregon[rsquo]s Wood Product Industry. http://oregoneconomicanalysis.com/2012/01/23/historical-look-at-oregons-wood-product-industry/

Timber industry volatility would have its greatest effect in local communities that have the lowest levels of economic diversity, the greatest dependence on commodity production, and would therefore see the greatest fluctuations in jobs and income. The gain and loss of jobs caused by timber industry volatility would cause a variety of social problems related to job insecurity, depression, substance abuse, health care insecurity, domestic abuse, etc. which would in turn cause an increase in the demand for social services that are not adequately funded. If the Forest Service and BLM would emphasize development of less volatile economic sectors through provision of amenities instead of commodities, the social problems described above would be diminished and the demand for social services would be reduced.

All things being equal, a more diversified economy is a more stable economy. Oregon will always have a timber industry based on non-federal forest lands. The highest and best use of public forest lands, in terms of community stability, is to conserve the resources on those lands to provide a stable flow of ecosystem services such as clean water, carbon storage and recreation opportunities, that will help diversify the economy, and mitigate the economic instability caused by logging on non-federal lands.

[ldquo]Sustained yield[rdquo] is based on flawed science. Sustained yield logging in the matrix is premised on the concept of a [ldquo]regulated forest.[rdquo] As explained in the Days Creek [ndash] South Umpqua Harvest Plan EA [ldquo]The key to achieving sustained yield is to establish a regulated forest with the proper distribution of stand age and size classes so that over time, approximately equal periodic harvests of the desired size and quality are produced. A [lsquo]regulated forest[rsquo] consists of tree sizes in approximately equal parts and age classes that correspond to the size classes. To achieve the desired age class distribution, it is necessary that the harvest type resets the age class or seral stage, i.e. a regeneration harvest of selected stands is necessary, including regeneration harvest of intermediate-age classes. Over time, regeneration harvests can transform or convert an irregular forest structure to a regulated one (Hennes et al., 1971).[rdquo] Unfortunately, this is only possible on paper. In the real world, none of this is possible, especially if the agency wishes to meet other important objectives such as water quality, climate stability, health populations of fish & wildlife, etc. See Jack Ward Thomas 1997. The Instability of Stability, http://web.archive.org/web/20001201174000/http://coopext.cahe.wsu.edu/~pnrec97/thomas2.htm ([ldquo]The vision that I was taught in school of the "regulated forest" and the resultant predictable outputs of commodities has turned out to have been a dream. [hellip] By now it is becoming obvious that this dream was built on the pillars of the seemingly boundless virgin forest and an ethic of manifest destiny coupled with hubris of being able to predict the response of nature and humans. This was coupled with an inflated sense of understanding of forested ecosystems and of human control. Perhaps it is time to recognize that such stability is not attainable in

any western region except for relatively short periods of years or decades. [hellip] It is increasingly apparent that ecological processes are not as well understood nor as predictable as had been assumed by natural resource managers steeped in Clementsian ecological theory of orderly and predictable succession of plant communities from bare ground to a mature, steady state. [hellip] In summary, the timber supply from federal lands is one drought, one insect and disease outbreak, one severe fire season, one election, one budget, one successful appeal, one loss in court, one listing of a threatened or endangered species, one new piece of pertinent scientific information, one change in technology, one shift in public opinion, one new law, one loss of a currently available technological tool, one change in market, one shift in interest rates, et al, away from "stability" at all times. And, these changes do not come one at a time, they come in bunches like banannas [sic] and the bunches are always changing. So, stability in timber supply from the public lands is simply a myth, a dream that was never founded in reality. It is time to stop pretending.[rdquo]). See also: Donald Ludwig, Ray Hilborn, Carl Waters 1993. Uncertainty, Resource Exploitation, and Conservation: Lessons from History. Science, New Series, Vol. 260, No. 5104 (Apr. 2, 1993), pp. 17-36. http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/swrcb/swrcb_ludwig1993.pdf

When we bring all these lines of evidence together one realizes that since the NWFP and the matrix land allocation was adopted there are many more reasons to protect forests and fewer reasons to log them. This needs to be considered in a new EIS. Since these significant new issues were not properly considered in the Northwest Forest Plan FEIS, the agency needs to address them in project level NEPA analyses. Since these significant new issues were not properly considered in the Northwest Forest Plan FEIS, the agency needs to address them here.

Preparation of new NEPA documents is a non-discretionary duty of all federal agencies. The CEQ regulations state that:

(c) Agencies:

(1) Shall prepare supplements to either draft or final environmental impact statements if:

[hellip] (ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

40 CFR 1502.9(c). This duty applies to both EISs and EAs. ISC v. Alexander (9th Circ. 2000).

"A federal agency has a continuing duty to gather and evaluate new information relevant to the environmental impact of its actions.... [W]hen new information comes to light the agency must consider it, evaluate it, and make a reasoned determination whether it is of significance as to require formal NEPA procedures." Warm Springs Dam Task Force v. Gribble, 621 F.2d 1017, 1023-24 (9th Cir. 1980). "[T]he decision whether to prepare a supplemental EIS is similar to the decision whether to prepare an EIS in the first instance: If there remains 'major Federal actio[n]' to occur, and if the new information is sufficient to show that the remaining action will 'affec[t] the quality of the human environment' in a significant manner or to a significant extent not already considered, a supplemental EIS must be prepared." Marsh v. ONRC, 490 U.S. 360, 374, 109 S. Ct. 1851, 1859 (1989). While BLM is making decision to implement the regen harvest and mature forest thinning aspects of its RMP, it must first prepare a new or supplemental EIS to consider all the new information that has arisen over the last two decades. Most of the new information indicates that forest conservation is even more important than previously realized and that logging is less important than previously realized.

Similarly, under both NMFA and FLPMA, the agencies must [ldquo][hellip] prepare and maintain on a continuing basis an inventory of all public lands and their resources and other values [hellip] This inventory shall be kept current so as to reflect changes in conditions and to identify new and emerging resource and other values [hellip][rdquo] 43 USC 1711 (similar at 16 USC 1603). The resulting inventory shall be used in creating land use plans which are living documents, not a static end result. [ldquo]The Secretary shall [hellip] develop, maintain, and when appropriate, revise land use plans [hellip][rdquo] 43 USC 1712 (similar at 16 USC 1604). These provisions, combined with NEPA[rsquo]s action-driven mandate for considering [ldquo]new circumstances or information,[rdquo] and the multiple-use mandate to utilize resources in the combination that [ldquo]best meet the present and future needs of the American people[rdquo] (43 USC 1702, 16 USC 1601) create a non-discretionary duty to keep programmatic plans up to date.

The fact that LRMPs and RMPs are all 20 years old (and well beyond the expected life-span of the plans) just adds to the evidence indicating the need for reconsideration of the emphasis on timber production, when conservation is what[rsquo]s needed.

Why Mature Forests Must be Protected.
Related to the new information and changed circumstances regarding the merits of logging the Matrix, there is also lots of new and significant reasons to conserve mature forests. These concerns must be addressed in the FEIS.

Jerry Franklin & Norm Johnson recently explained that there[rsquo]s no good reason to log mature forest, even in the matrix:

[hellip] primeval older forests are now grossly underrepresented in Oregon[rsquo]s forested landscapes, and they provide important ecological services and have high social value. They should be permanently protected.

Since adoption of the NWFP, we have learned much about the ecological role of these mature natural forests. Westside Douglas fir forests undergo significant structural and functional changes during their second century of life. Much of their evolution into fully developed old growth involves natural thinning processes, including death of some larger trees. Production foresters abhor the mortality of such trees as wasted harvestable timber. Viewed ecologically, however, their death creates gaps in the forest canopy that allow development of multiple canopy layers and enriched understories, which foster significant biological diversity.

Among tree species, Douglas fir is a long-distance runner rather than a sprinter, and at 100 years its growth has just begun to hit its stride. High rates of growth continue throughout the second century of these forests 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.

Mature natural forests fulfill many of the same ecological roles as fully developed old-growth forests, such as providing habitat for endangered species like the spotted owl. They help reduce impacts of rain-on-snow storms that can lead to extensive floods in Western Oregon drainages. Ultimately, of course, mature forests become the replacements for old-growth forests that are inevitably lost to wildfire and wind, as occurred last September in wildfires in Western Oregon and Washington.

There are no ecological justifications for harvesting more than 2,000 acres of mature forest in the Flat Country Project. Such activities terminate the natural developmental processes that are at work in these stands, forcing the forest to [ldquo]start over[rdquo] on its way to becoming old growth.

One Forest Service justification for the proposed harvest is that the mature forests are [ldquo]too dense[rdquo] and [ldquo]overstocked.[rdquo] However, these judgments are based on measures of desirable tree density developed for managing wood production plantations! Such measures have no relevance to the natural developmental processes underway in primeval mature forests.

The Forest Service also argues that harvesting mature forests is necessary to provide early successional habitat [mdash] the rich community of shrubs, forbs and grasses that naturally develop along with tree seedlings after wildfire or other disturbances. As longtime advocates for such habitat, we know that the wildfires of 2020 will provide significant areas of early successional habitat if the Forest Service does not salvage logs and aggressively replant them.

Jerry Franklin and Norm Johnson 2021. Protect older natural forests in the western Cascades. Guest Viewpoint. Eugene Register Guard. 4-27-2021. https://www.registerguard.com/story/opinion/columns/2021/04/27/guest-view-protect-older-natural-forests-western-cascades-jerry-franklin-norm-johnson/7385736002/citing Franklin & Johnson 2021. ArcGIS Storymap. Protect Older Natural Forests in the Western Cascades https://dlj.maps.arcgis.com/apps/MapJournal/index.html?appid=e9eb7176553d42a0a84a9e1f56e25950

[ldquo]As recognized by FEMAT, a conservation strategy for the Pacific Northwest must consider mature forests as well as OG. Forests are considered to enter maturity when their mean annual increment culminates, following which time they begin developing the characteristics that ultimately produce OG. Mature forests serve various important ecologic functions. They serve as future replacements for old-growth, help protect existing OG by reducing the starkness of age-class boundaries, and provide landscape connectivity and transitional habitat that compensate to some degree for the low levels of OG. Moreover, they are almost certainly more resistant to crown fires than younger forests, and hence contribute to buffering the landscape.[rdquo]

Late-Successional and Old-Growth Forests in the Pacific Northwest. Statement of DAVID A. PERRY Professor Emeritus. Department of Forest Science, Oregon State University, before the Subcommittee on Public Lands and

Forests of the Committee on Energy and Natural Resources, United States Senate. March 13, 2008.

Large trees provide a wide variety of important values that are scarce due to decades of logging on public and private lands. Scientists wrote to the Forest Service explaining [ndash]

Primary forests and large, old trees, both living and dead, provide irreplaceable benefits to society that are essential to forestalling the loss of biodiversity and climate change related environmental emergencies. Those forests and trees have elevated conservation status, needing to reach maturation in order to achieve their ecological potential in supporting associated biodiversity, contributing to carbon storage and myriad ecosystem servicesii. Trees greater than 18 inches dbh (>45 cm) have been declining in forests at all latitudesiii. With that decline occurring, occurring, the following values of large trees are of utmost importance in preserving:

? Large, old trees are among the most massive terrestrial organisms on Earth. They are bio-cultural elements of a natural inheritance that is declining globallyiv

? The size of a tree increases over time accumulating keystone features that provide large internal cavities and canopy structures for wildlife not present in younger trees.

? Large, old trees, including snags and downed wood, are needed for nesting, roosting, foraging, denning, and other habitat elements that support numerous lichens, epiphytes, up to 30% of all vertebrates in some forestsv, and invertebrates, many of which are rare, endemic, or endangeredv.

? Large, old trees anchor soils through their massive root systems, stabilize slopes, and provide shading and habitat (logs) for aquatic speciesvi.

? Large, old trees provide nutrients and soil carbon, are associated with high levels of plant varieties, play critical roles in hydrological cycles, and are [ldquo]blueprints[rdquo] for restorationvii.

? Large, old trees store a disproportionate amount of carbon with greater leaf surface area for CO_2 absorption, and massive carbon-storing tree trunks and rootsviii. For instance, a recent global study found half of carbon in living above ground biomass is stored in the largest 1% diameter treesix.

? Large, old trees provide stable microclimates and mitigate soil desiccationx.

? Mycorrhiza fungal networks are more connected and carbon rich as forests age with large trees serving as central nodes in the networksxi.

? Large, old trees are especially valuable when killed individually or in large patches by natural disturbance processes such as insects, forest pathogens, wind storms, and wildfirexii that generate [ldquo]complex early seral forestsxiii.[rdquo]

DellaSala et al 2020. Open Letter to The Forest Service on the Importance of Large, Old Trees and Forests. https://drive.google.com/file/d/1oRTRDNoQSngZKXnwz04lITABz85AqS0D/viewciting -

ii Lindenmayer, D.B. et al 2012. Global decline in large trees. Science 338:1305-1306. Lindenmayer, D.B. et al. 2013. New policies for old trees: averting a global crisis in a keystone ecological structure. Conservation Letters 7:61-69. Brandt, P et al 2014. Multifunctionality and biodiversity: ecosystem services in temperate rainforests of

the Pacific Northwest. Biol Conserv. 169:362-371

iii Lindenmayer, D.B., W.F. Laurance, J.F. Franklin. 2012. Global decline in large old trees. Science 338:1305-06.

iv Lutz, J A et al 2018. Global importance of large diameter trees. Global Ecol Biogeogr:1-16

v Lindenmayer, D.B., et al. 2012. Ibid

vi Reeves, G.H. et. al. 2006. The aquatic conservation strategy of the Northwest Forest Plan. https://www.fs.usda.gov/treesearch/pubs/27229

vii Mackey, B 2014. Counting trees, carbon, and climate change. The Royal Statistical Society:19-23. Frey, S J K et al 2016. Spatial models reveal the microclimatic buffering capacity of old-growth forests. Sci Adv 2016:e1501392.

viii Mackey, B 2014. Counting trees, carbon, and climate change. The Royal Statistical Society:19-23. Frey, S J K et al 2016. Spatial models reveal the microclimatic buffering capacity of old-growth forests. Sci Adv 2016:e1501392.

ix Lutz, J.A. et al. 2018. Ibid

x Frey, S J K et al 2016. Ibid

xi Maser, C., et al. 2008. Trees, truffles, and beasts: how forests function. Rutgers University Press, NJ. Davis, K. T., et al. 2019a. Microclimatic buffering in forests of the future: the role of local water balance. Ecography 42:1[ndash]11.

xii Franklin, J.F. et al. 2000. Threads of continuity. Conservation Biology in Practice 1:9-16.

xiii Swanson, M.E. et al. 2011. The forgotten stage of forest succession: early-successional ecosystems on forested sites. Frontiers in Ecology and Environment 9:117-125.

All logging, including thinning stands of any age, include some adverse impacts and trade-offs. Some impacts of logging are unavoidable, so there is no such thing as a logging operation that is 100% beneficial. Depending on how thinning is done thinning can have adverse impacts such as soil disturbance, habitat disturbance, carbon removal, spreading weeds, reduced recruitment of snags, road-related erosion and hydrologic impacts, moving fuels from the canopy to the ground, creating a hotter-drier-windier microclimate that is favorable to greater flame lengths and rate of fire spread, etc. Some of these negative effects are fundamentally unavoidable, therefore all thinning has negative effects that must be compensated by beneficial effects such as reducing competition between trees so that some can grow larger faster, increased resistance drought stress and insects, increasing species diversity, possible fire hazard reduction, etc. It is generally accepted that when thinning very young stands, the benefits outweigh the adverse impacts and net benefits are likely. It is also widely understood that thinning older stands tends to have greater impacts on soil, water, weeds, carbon, dead wood recruitment so the impacts very often outweigh the benefits, resulting in net negative outcome on the balance sheet. As we move from young forest to older forests, the net benefits turn into net negative impacts, but where is that line? The authors of the Northwest Forest Plan took all this into account and determined that 80 years is a useful place to draw the line between forests that are likely to benefit from silviculture and those that are likely to experience net negative consequences. There is no new science to change that conclusion. In fact, new information developed since 1994 shows that dead wood is probably more valuable than previously thought - being important for a wide variety of ecological functions, not least of which is providing complex habitat that supports prey species for spotted owl and a variety of other predators both east and west of the Cascades. As stands become mature at around 80 years of age, they begin accumulating snags and dead wood from natural mortality processes. Thinning [ldquo]captures mortality[rdquo] and removes it from the forest thus preventing those trees from ever becoming snags and dead wood and interrupting the critical process whereby mature forests accumulate dead wood. The loss of recruitment of dead wood habitat when logging older stands is a long-term impact and provides a very strong argument against logging in stands over 80 years old. For further information see 1993 SAT Report pp 146-152. AND February 1991 Questions and Answers on A Conservation Strategy for the Northern Spotted Owl (prepared in response to written questions from the Senate Energy and Natural Resources Committee to the Interagency Scientific Committee on the May 1990 ISC Report. AND Jerry Franklin, David Perry, Reed Noss, David Montgomery, Christopher Frissell. SIMPLIFIED FOREST MANAGEMENT TO ACHIEVE WATERSHED AND FOREST HEALTH: A CRITIQUE. National Wildlife Federation. https://web.archive.org/web/20061008082841/http://www.coastrange.org/documents/forestreport.pdf. Jerry Franklin says the 80-year cut-off for logging under the Northwest Forest Plan came from the discovery that after the 1902 Yacolt burn in SW Washington, forests that naturally regenerated with a legacy of abundant dead wood and vegetation complexity developed into suitable spotted owl habitat after 80 years. K. Norm Johnson says protection of stands older than 80 years [ldquo]is so pivotal to everyting that has happened to this day. There[rsquo]s no more important criteria under the Northwest Forest Plan than that one.[rdquo] Scott, Aaron 2020. Timber Wars podcast, Episode 5. https://www.opb.org/article/2020/09/22/timber-wars-episode-5-the-plan/.

The agency needs to recognize the distinction between thinning young plantations and thinning mature forests. Robert Anthony reminded the regional executives in 2013 that:

The long-term benefits of thinning in young plantations to create forests with characteristics of late-successional forests (e.g. large diameter standing and down wood) may outweigh any short-term negative effects on owls or their prey. However, as the age of forests selected for thinning increases, the short-term negative effects of such activities will likely increase and the benefits decrease. The Northwest Forest Plan specified a maximum age of 80 years for forests that are slated for thinning. The reasons for this guideline were that (1) it was unclear if thinning could actually accelerate the rate at which naturally regenerated mature forests developed old forest conditions, and (2) spotted owls forage in mature forests, and thinning of these forests will likely reduce their quality as spotted owl habitat both in the short and long term. If these young forests are not currently good foraging habitat, they are gradually developing late-successional characteristics that will provide foraging habitat in the near future. Consequently, thinning in riparian forests >80 years old or any younger forests where thinning is not likely to accelerate the development of late-successional forest structure is not recommended. If these young forests are not currently good foraging habitat, they are gradually developing late-successional characteristics that will provide foraging habitat in the near future. Consequently, thinning in riparian forests >80 years old or any younger forests where thinning is not likely to accelerate the development of late-successional forest structure is not recommended.

Anthony, R.G. 2013. [ldquo]Effects of Riparian Thinning on Marbled Murrelets and Northern Spotted Owls.[rdquo] Part III of the Science Review Team for the identification and interpretation of the best available scientific information to determine effects of riparian forest management. 28 January 2013.

The agency must carefully review and document their consideration of all the reasons not to log mature forests set forth in this paper: Doug Heiken 2009. The Case for Protecting Both Old Growth and Mature Forests. Version 1.8 April 2009.
https://www.dropbox.com/s/4s0825a7t6fq7zu/Mature%20Forests%2C%20Heiken%2C%20v%201.8.pdf?dl=0.

Skeena Watershed Council in British Columbia note that "Old growth forests are now a non-renewable resource. They will not be replaced with new growth due to climate change. While the forest will grow, we will not see trees get as large or as old as the ones we have now.[rdquo]

[ldquo][W]e must make clear that natural forests are managed for biodiversity and the full set of ecosystem services that forests provide. And, by the way, which biodiversity are we shortest of? The biodiversity that[rsquo]s associated with older forests.[rdquo] FEN MONTAIGNE 2019. Why Keeping Mature Forests Intact Is Key to the Climate Fight. Yale e360 OCTOBER 15, 2019. https://e360.yale.edu/features/why-keeping-mature-forests-intact-is-key-to-the-climate-fight.

Lutz (and 95 co-authors!) compiled detailed forest plot data from 48 sites around the world and found that large trees play critical roles in forest structure and function (especially carbon storage), yet they are vulnerable to disturbance (especially logging) and take a long time to replace, so they need to be conserved.

Main conclusions: Because large-diameter trees constitute roughly half of the mature forest biomass worldwide, their dynamics and sensitivities to environmental change represent potentially large controls on global forest carbon cycling. We recommend managing forests for conservation of existing large-diameter trees or those that can soon reach large diameters as a simple way to conserve and potentially enhance ecosystem services.

...

Concentration of resources within a few individuals in a community is a pervasive property of biotic systems (West, Brown, & Enquist, 1997), whether marine (Hixon, Johnson, & Sogard, 2014), terrestrial (Enquist, Brown, & West, 1998) or even anthropogenic (Saez & Zucman, 2016). The concentration of total forest biomass in a few large-diameter trees is no exception (Pan, Birdsley, Phillips, & Jackson, 2013). Large-diameter trees in forests take many decades or even centuries to develop, but human or natural disturbances can decrease their abundance, rapidly changing forest structure (Allen et al., 2010; Lindenmayer, Laurance, & Franklin, 2012; Lutz, van Wagtendonk, & Franklin, 2009; van Mantgem et al., 2009).

... Previous studies have showed that large-diameter trees comprise a large fraction of the biomass of many forests (Bastin et al., 2015; Brown et al., 1995; Clark & Clark, 1996; Lutz, Larson, Swanson, & Freund, 2012) and that they modulate stand-level leaf area, microclimate and water use (Martin et al., 2001; Rambo & North, 2009). Large-diameter trees contribute disproportionately to reproduction (van Wagtendonk & Moore, 2010), influence the rates and patterns of regeneration and succession (Keeton & Franklin, 2005), limit light and water available to smaller trees (Binkley, Stape, Bauerle, & Ryan, 2010), and contribute to rates and causes of mortality of smaller individuals by crushing or injuring sub-canopy trees when their bole or branches fall to the ground (Chao, Phillips, Monteagudo, Torres-Lezama, & Vasquez Mart[iacute]nez, 2009; Das, Stephenson, & Davis, 2016). Large-diameter trees (and large-diameter snags and large-diameter fallen woody debris) make the structure of primary forests and mature secondary forests unique (Spies & Franklin, 1991). Large-diameter trees occur at low stem densities, yet influence spatial patterns over long inter-tree distances (Das, Larson, & Lutz, 2018; Enquist, West, & Brown, 2009; Lutz et al., 2014). ...

... Changes in climate, disturbance regimes and logging are accelerating the decline of large-diameter trees (e.g., Bennett, McDowell, Allen, & Anderson-Teixeira, 2015; Lindenmayer & Laurence, 2016; Lindenmayer et al., 2012). The dynamics of large-diameter trees is dependent on at least two factors: (a) presence of species capable of attaining a large size, and (b) conditions, including disturbance regimes, that permit the development of large-diameter individuals. If the species richness of the large-diameter assemblage is high, a forest may be better able to respond to perturbations (Musavi et al., 2017) and maintain its structure and ecological function. However, if the largediameter species richness is low, then a forest could be susceptible to any change that affected those few species.

...

DISCUSSION

The relationship between the large-diameter threshold and overall biomass (Figure 2a) suggests that forests cannot sequester large amounts of aboveground carbon without large trees, ...

...

Temperate forests featured a higher density of trees > 60 cm DBH (Table 1), consistent with the presence of the very largest species of trees in cool, temperate forests (Sillett et al., 2015; Van Pelt et al., 2016). Temperate forests also exhibited considerably lower densities of small trees (e.g., 1 cm < DBH < 5 cm; Supporting Information Table S3.2) and lower total stem density.

...

There is still considerable uncertainty as to what will happen to large-diameter trees in the Anthropocene when so much forest is being felled for timber and farming, or is being affected by climate change. Bennett et al. (2015) suggested that the current large-diameter trees are more susceptible to drought mortality than smaller-diameter trees. Larger trees, because of their height, are susceptible to sapwood cavitation and are also exposed to high radiation loads (Allen, Breshears, & McDowell, 2015; Allen et al., 2010), but vigorous large-diameter individuals may also still be sequestering more carbon than smaller trees (Stephenson et al., 2014). Both Allen et al. (2015) and Bennett et al. (2015) suggested that larger trees will be more vulnerable to increasing drought than small trees, and Luo and Chen (2013) suggested that although the rate of mortality of larger trees will continue to increase because of global climate change, smaller trees will experience more drought-related mortality. These last two conclusions need not be in conflict as the background mortality rates for smaller trees are higher than those of larger trees within mature and old-growth forests (Larson & Franklin, 2010). What remains generally unanswered is whether the increasing mortality rates of large-diameter trees will eventually be offset by regrowth of different individuals of those same (or functionally similar) species. ...

... The conservation of large-diameter trees in tropical and temperate forests is therefore imperative to maintain full ecosystem function, as the time necessary for individual trees to develop large sizes could preclude restoration of full ecosystem function for centuries following the loss of the oldest and largest trees (Lindenmayer et al., 2012). Clearly, areas that have been recently logged lack large-diameter trees, and therefore have less structural heterogeneity than older forests. That the largest individuals belong to relatively few common species in the temperate zone means that the loss of large-diameter trees could alter forest function [ndash] if species that can attain large diameters disappear, forests will feature greatly reduced structural heterogeneity (e.g., Needham et al., 2016), biomass, and carbon storage.

Lutz et al (2018). Global importance of large-diameter trees. Global Ecology and Biogeography. 2018:1-16. DOI: 10.1111/geb.12747. http://www.columbia.edu/~mu2126/publications_files/Lutz_et_al-2018-Global_Ecology_and_Biogeography.pdf, https://www.fs.fed.us/rm/pubs_journals/2018/rmrs_2018_lutz_j001.pdf.

Conservation of mature & old-growth trees helps achieve social goals. The social importance of conserving large trees is often under-appreciated. See Blicharska et al. (2014).

Abstract: In addition to providing key ecological functions, large old trees are a part of a social realm and as such provide numerous social-cultural benefits to people. However, their social and cultural values are often neglected when designing conservation policies and management guidelines. We believe that awareness of large old trees as a part of human identity and cultural heritage is essential when addressing the issue of their decline worldwide. Large old trees provide humans with aesthetic, symbolic, religious, and historic values, as well as concrete tangible benefits, such as leaves, branches, or nuts. In many cultures particularly large trees are treated with reverence. [hellip] Although the social and cultural role of large old trees is usually not taken into account in conservation, accounting for human-related values of these trees is an important part of conservation policy because it may strengthen conservation by highlighting the potential synergies in protecting ecological and social values.

Recognition of Social and Cultural Values of Large Old Trees

Large old trees have important ecological functions (Lindenmayer et al. 2012, 2013), but they often have enormous social significance as well; therefore, protecting them for ecological reasons also supports maintenance of aesthetic, symbolic, religious, and historic values (i.e., these different kinds of values can be protected in a synergetic manner).

Many conservation policies already highlight the necessity to include people, their needs, and values in conservation decisions. [hellip] both tangible and intangible benefits provided by large old trees can be directly translated into the ecosystem services concept.

[hellip] The context in which issues are represented has the potential to affect the actual action because context induces particular ways of understanding the issue and thus may lead to new types of actions in the policy process (Hajer 1995). Therefore, framing the conservation of large old trees from a human perspective, for whom they are protected and for whom they deliver important services,

may facilitate creation and implementation of relevant policies.

[hellip] This flagship function of large old trees appears to be more universal than that for other types of flagship species. The latter are usually limited to a particular

environment and geographic area, whereas large old trees are highly valued by humans across cultural and environmental realms.

Blicharska, M.; Mikusinski, G. 2014. Incorporating social and cultural significance of large old trees in conservation policy. Conserv. Biol. 28(6):1558-1567.

http://www.researchgate.net/profile/Grzegorz_Mikusinski2/publication/264673453_Incorporating_social_and_cult ural_significance_of_large_old_trees_in_conservation_policy/links/5495bc800cf29b9448241278.pdf

The complex structure and multi-layered canopy of mature & old-growth forests provides a buffer against thermal extremes which means that older forests can serve as climate refugia as the climate warms. OPB interviewed one of the authors of the study and reported:

[hellip] the kind of forest makes a big difference on temperature.

[ldquo]The more structurally complex the forest, the more big trees, the more vertical layers [ndash] the cooler it was,[rdquo] he says.

The research showed differences as much as 4.5 degrees on warm days. Old growth forests also held in heat during cold weather. Overall, these forests have a moderating effect on temperature extremes.

One reason, researchers suspect, is that tree plantations, even mature ones, don[rsquo]t have nearly the understory material [ndash] small trees, shrubs, ground cover [ndash] as more complex stands. Nor do these single-age plantations have a lot of big trees [ndash] unlike old growth stands.

[ldquo]We think one of the mechanisms causing this is thermal inertia,[rdquo] Betts says. [ldquo]That takes these trees longer to warm up and longer to cool down. And that could be providing some of the buffering capacity of these older forests.[rdquo]

Betts says these stands of old growth could provide refuges for temperature-sensitive wildlife in the face of climate change.

Jes Burns 2016. Old-Growth Forests Provide Temperature Refuges In Face Of Climate Change: Study. OPB/EarthFix | April 22, 2016 http://www.opb.org/news/article/forest-refuges-climate-change/citing Sarah J. K. Frey, Adam S. Hadley, Sherri L. Johnson, Mark Schulze, Julia A. Jones, Matthew G. Betts. 2016. Spatial models reveal the microclimatic buffering capacity of old-growth forests. SCIENCE ADVANCES. 22 APR 2016 : E1501392. http://advances.sciencemag.org/content/advances/2/4/e1501392.full.pdf. The buffering provided by mature & old-growth forests is relatively stable even in a dynamic climate regime, so [ldquo]To maintain microrefugia in a rapidly changing climate, conservation of old-growth and other structurally complex forest habitat is critical[rdquo] Christopher Wolf, David M. Bell, Hankyu Kim, Michael Paul Nelson, Mark Schulze, Matthew G. Betts,

Temporal consistency of undercanopy thermal refugia in old-growth forest. Agricultural and Forest Meteorology, Volume 307, 15 Sept 2021, 108520, ISSN 0168-1923, https://doi.org/10.1016/j.agrformet.2021.108520.

Pre-fire nesting/roosting habitat had lower probability of burning at moderate or high severity compared to other forest types under high burning conditions. Our results indicate that northern spotted owl habitat can buffer the negative effects of climate change by enhancing biodiversity and resistance to high-severity fires, which are predicted to increase in frequency and extent with climate change. Within this region, protecting large blocks of old forests could be an integral component of management plans that successfully maintain variability of forests in this mixed-ownership and mixed-severity fire regime landscape and enhance conservation of many species.

Lesmeister, D. B., S. G. Sovern, R. J. Davis, D. M. Bell, M. J. Gregory, and J. C. Vogeler. 2019. Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4):e02696. 10.1002/ecs2.2696. https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.2696. The PNW Research Station put out a press release on this study on July 2, 2019 which said:

Old-growth forests have more vegetation than younger forests. Researchers expected that this meant more fuel would be available for wildfires, increasing the susceptibility of old-growth forests to severe fire, high tree mortality, and resulting loss of critical spotted owl nesting habitat. However, the data suggested a different effect.

Lesmeister and his colleagues classified fire severity based on the percentage of trees lost in a fire, considering forest that lost less than 20% of its trees to fire subject to low-severity fire and those with more than 90% tree loss subject to high-severity fire. They found that old-growth forest was up to three times more likely to burn at low severity[ndash]a level that avoided loss of spotted owl nesting habitat and is generally considered to be part of a healthy forest ecosystem.

[ldquo]Somewhat to our surprise, we found that, compared to other forest types within the burned area, old-growth forests burned on average much cooler than younger forests, which were more likely to experience high-severity fire. How this actually plays out during a mixed-severity wildfire makes sense when you consider the qualities of old-growth forest that can limit severe wildfire ignitions and burn temperatures, like shading from multilayer canopies, cooler temperatures, moist air and soil as well as larger, hardier trees.[rdquo]

Because old-growth forests may be refuges of low-severity fire on a landscape that experiences moderate to high-severity fires frequently, they could be integral as biodiversity refuges in an increasingly fire-prone region.

U.S. Forest Service Pacific Northwest Research Station 2019. Old-growth forest may provide valuable biodiversity refuge in areas at risk of severe fire. July 8, 2019. https://yubanet.com/california/old-growth-forest-may-provide-valuable-biodiversity-refuge-in-areas-at-risk-of-severe-fire/; https://www.fs.usda.gov/pnw/news-releases/old-growth-forests-may-provide-valuable-biodiversity-refuge-areas-risk-severe-fire.

Betts et al (2017) also found old growth to be of value to wildlife in terms of microclimate buffering:

Results

We found a significant negative effect of summer warming on only two species. However, in both of these species, this relationship between warming and population decline was not only reduced but reversed, in old-growth-dominated landscapes. Across all 13 species, evidence for a buffering effect of old-growth forest increased with the degree to which species were negatively influenced by summer warming.

Main conclusions

These findings suggest that old-growth forests may buffer the negative effects of climate change for those species that are most sensitive to temperature increases. Our study highlights a mechanism whereby management strategies to curb degradation and loss of old-growth forests[mdash]in addition to protecting habitat[mdash]could enhance biodiversity persistence in the face of climate warming.

Matthew G. Betts, Ben Phalan, Sarah J. K. Frey, Jos[eacute]e S. Rousseau, Zhiqiang Yang.

2017. Old-growth forests buffer climate-sensitive bird populations from warming.

Diversity and Distributions. Volume 24, Issue 4. April 2018. Pages 439-447, https://doi.org/10.1111/ddi.12688. See also, USDA/USDI 1994. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. Vol I, pp 3&4-29 -31. https://www.blm.gov/or/plans/nwfpnepa/ ([ldquo]Small patches of old-growth forest can provide thermal and mesic refugia for a variety of organisms. Understory habitats in old-growth forests can escape freezing conditions due to the thermal buffering of dense tree canopies. Deer and other vertebrates may rely on these thermal refuges during harsh storms or during dispersal to larger forest stands of suitable habitat. Many invertebrates migrate locally to mesic refugia during summer. During very dry periods in forests east of the Cascade Range, many invertebrates may require dense forest cover and mesic understory habitats to avoid desiccation[rdquo]).

Research in European forests have found similar climate buffering effects -

The researchers also discovered that forests have so far done a remarkable job of buffering plants against the broader climate change going on outside them.

Temperature measurements revealed that forests often have significantly different temperatures from what weather stations [ndash] always placed far from trees [ndash] record. In summer, for example, they are on average 4[deg]C cooler. This is not only because thick canopies keep out the light, but also because evapotranspiration of water through the leaves and into the atmosphere sucks heat out of the forest, and the vegetation keeps out breezes that would mix warm air into the cool.

Climate models don[rsquo]t take into account this buffering, despite the fact that two thirds of the world[rsquo]s species live in forests and forest processes such as carbon and nutrient cycling depend on temperature, says Professor Pieter de Frenne, a bioscientist also at Ghent University [hellip]

Aisling Irwin 2020. Forest darkness helps stave off effects of nitrogen pollution [ndash] but this is set to change. Horizon [ndash] EU Research and Innovation Magazone. 01 October 2020. https://horizon-magazine.eu/article/forest-darkness-helps-stave-effects-nitrogen-pollution-set-change.html. The microlcimlate buffering effects of mture forest become increasingly valuable as time passes because climate change is expected to increase rates of disturbance and make mature forests more scarce. See also, Christopher Wolf, David M. Bell, Hankyu Kim, Michael Paul Nelson, Mark Schulze, Matthew G. Betts,

Temporal consistency of undercanopy thermal refugia in old-growth forest. Agricultural and Forest Meteorology, Volume 307, 15 Sept 2021, 108520, ISSN 0168-1923, https://doi.org/10.1016/j.agrformet.2021.108520. ([ldquo]To maintain microrefugia in a rapidly changing climate, conservation of old-growth and other structurally complex forest habitat is critical, [hellip][rdquo]).

Tree height is an indicator of old growth habitat suitability. This is likely because tree height is a direct measure of

3-dimensional habitat volume below the tree tops. North, Kane, Kane, et al 2017.Cover of tall trees best predicts California spotted owl habitat. Forest Ecology and Management. 405: 166-178. https://doi.org/10.1016/j.foreco.2017.09.019, https://www.fs.fed.us/psw/pubs/55075, https://www.fs.fed.us/psw/publications/north/psw_2017_north004.pdf, https://www.fs.fed.us/psw/news/2017/20171005_spottedowl.shtml ([ldquo]Although total canopy cover was high in nest stands and PAC [protected activity center] areas, the cover in tall (>48m) trees was the canopy structure most highly selected for, while cover in lower strata (2[ndash]16m) was avoided compared to availability in the surrounding landscape. [hellip] High canopy cover ([ge]70%) mostly occurs when large tree cover is high, indicating the two variables are often confounded. ... [T]he cover of tall trees may be a better predictor of owl habitat than total canopy cover because the latter can include cover in the 2[ndash]16 m strata [ndash] conditions that owls actually avoid.[rdquo]) This study seems to indicate that California spotted owls, and maybe northern spotted owls, are OK with relatively simple stands of tall trees with high canopy cover in the overstory. They don[rsquo]t necessarily need or prefer complex stands with multiple cohorts and lower canopy layers. The agencies therefore should NOT intervene with logging to reduce canopy cover of tall trees in order to establish new cohorts to benefit spotted owls.

Conservation of mature forests is an important step toward conservation of fungal diversity. Antonio Tomao, Jos[eacute] Antonio Bonet, Carles Casta[ntilde]o, Sergiode-Miguel, 2020. How does forest management affect fungal diversity and community composition? Current knowledge and future perspectives for the conservation of forest fungi. Forest Ecology and Management, Volume 457, 1 February 2020, 117678, https://doi.org/10.1016/j.foreco.2019.117678 ([ldquo]Highlights [ndash] [bull] We review the effect of forest management practices on fungal diversity. [bull] Fungal diversity is positively related with canopy cover, basal area and tree species diversity. [bull] Diversity of deadwood size and decomposition stage is positively related to richness of wood-inhabiting fungi. [bull] The higher is the forest management intensity the lower is the diversity of fungal species. ... If no management practices are performed for a long time, stands may gradually evolve into so-called [ldquo]old-growth forests[rdquo]. In the absence of anthropogenic disturbances, forests may slowly recover the natural disturbance dynamics (forest fires and windstorms, parasite outbreaks, fungal decay, gap creation due to insects) and develop those stand structural features (large living trees, large amount of deadwood, canopy gaps of various size, coexistence of senescent, mature and initial stages) typical of primary forests (Burrascano et al., 2013). ... Old-growth forests are recognized as an important reserve of fungal diversity for several fungal functional guilds. Indeed, a very large number of ectomycorrhizal species can be hosted in old growth stands (Richard et al., 2004; Zhang et al., 2017).[rdquo]). Thus literature review explains that the adverse effects of logging on fungi populations has at least three causes: (i) loss of ectomycorrhizal-hosts and the associated reduction in carbohydrate production and carbohydrate transfer from living trees to the fungal community, (ii) reduction in quantity and diversity of dead wood substrate, and (iii) adverse modification of the microclimate, e.g., rapid wetting and drying, soil compaction, reduced water retention, reduced gas exchange, etc.

The importance of fungal diversity will increase as climate stress increases. As explained by Peter et al (2013)[ndash]

New emerging techniques allow to study the functional diversity of mycorrhizal fungi under natural conditions in forests (Courty et al. 2010). One of the most important functions of these fungi is the enhanced nutrient uptake of forest trees. Therefore, the functional abilities of nutrient mobilisation from organic material were tested in several forest ecosystems and under diverse environmental conditions (Pritsch and Garbaye 2011). These studies show that species do have different functional abilities in enzymatic activities, e.g. for nitrogen acquisition by degrading proteins in the soil or in lignin degradation (see Figure 57, Hutter et al. in prep). Whereas some mycorrhizal species complement each other, some are redundant in these functions but are sometimes adapted to other soil conditions and might be complementary in additional functions such as water uptake (Bu[eacute]e et al. 2007, Jones et al. 2010, Rineau and Courty 2011). Therefore, on the one hand, high diversity in the mycorrhizal fungal community is of great importance for forest trees to optimally exploit soil resources through the different functional abilities of single species. On the other hand, a high diversity allows the mycorrhizal community to respond to changing environmental conditions and disturbances by modifying the community towards better-adapted species that maintain important ecosystem functions. ... With climate warming, it is expected that the severity and duration of drought will increase, and therefore the maintenance of intact mycorrhizal networks will become more critical to the stability of forest ecosystems (Simard and Austin 2010). ... Several factors, such as natural disturbances, forest management, and anthropogenic pollution, impact this diversity and structure, in most cases by changing the competitiveness and dominance of the species present. Under severe disturbances, species richness is impacted, lowering the potential resistance to additional stresses or even reducing ecological function. ... Although the effect of climate change factors and their interaction on mycorrhizal communities is complex and difficult to predict, it is likely that these communities will help stabilize forest ecosystems under the predicted climatic scenarios (Simard and Austin 2010). Management practices should therefore consider the functional importance of mycorrhizal fungi and their networks in the natural regeneration and resilience of forests.

Martina Peter, Marc Bu[eacute]e and Simon Egli 2013. Biodiversity of mycorrhizal fungi as a crucial player in forest ecosystem functioning. In Daniel Kraus and Frank Krumm (eds.) 2013. Integrative approaches as an opportunity for the conservation of forest biodiversity. European Forest Institute. 284 pp.

http://www.integrateplus.org/uploads/images/Mediacenter/integrate_book_2013.pdf.

The importance of conserving mature forest is highlighted by Riitters et al (2012) who compared the decline in total forest area to the decline in interior forest conditions from 2001 to 2006 at 5 spatial scales and found that interior forest is declining faster than total forest at all spatial scales, with greater losses in the largest spatial scales.

These fragmentation effects are clearly evident in the Pacific Northwest.

Riitters, K.H. & Wickham, J.D. (2012) Decline of forest interior conditions in the conterminous United States. Sci. Rep. 2, 653; DOI:10.1038/srep00653.https://www.srs.fs.fed.us/pubs/ja/2012/ja_2012_riitters_002.pdf

The agency must protect mature forests because they are the best candidates to grow and develop into old-growth habitat in the shortest time frame.

1. There is a serious region-scale deficit in mature and old-growth forest habitat. Over time, the Northwest Forest Plan seeks to re-establish 3.44 million acres of mature and old-growth forest (http://web.archive.org/web/20030402090844/http://www.fs.fed.us/land/fm/oldgrow/oldgrow.htm). By continuing to log mature forests we are significantly delaying this recovery. If we are going to make a timely recovery from that deficit, and give struggling species a chance to survive the habitat bottleneck that we have created, we must protect mature forests so that they can become old-growth, and we must manage young forest so they can become mature.

2. The transition from mature forest to old growth is a process that takes time and varies depending on factors such as location and species and disturbance events. In a mature forest, all the ingredients are there to make old growth (e.g., large trees) and the scientists agree that these forests need protection to help meet the current old-growth forest deficit.
3. The architects of the Northwest Forest Plan found that many of our best large intact forest landscapes are mature forests, not old-growth. Some large forest fires burned westside forests between 1840 and 1910 and many such areas were skipped over by the timber harvest planners because they were more intent on converting the very old forests to tree plantations. These former fire areas, now mature forests, offer some of our best hopes of recreating large blocks of intact older forest.
4. Cutting mature forests is not needed for ecological reasons. These forests are already exhibiting the characteristics that provide excellent habitat and they continue to develop and improve without human intervention. As recognized in the Northwest Forest Plan standards and guidelines for Late Successional Reserves, stands over 80 years old do not need to be manipulated to become old-growth. All the ingredients are there, they just need time.
5. Mature forests provide essential habitat for the species we are most concerned with such as: spotted owl, marbled murrelet, Pacific salmon, and most of the [ldquo]survey and manage[rdquo] species.
6. Protecting mature and old-growth forest leads to a real ecological solution, while protecting only old-growth is merely a partial solution to an ecological problem that is bigger than just old-growth.
7. Cutting mature forest will remain controversial and socially unacceptable. If we seek to resolve conflict over management of older forests, protecting the old-growth while leaving mature forests unprotected would be only half a solution and would lead to more conflict. Shifting to a restoration paradigm gets everyone at the table working toward the same goal.
8. If mature forest is left unprotected, some members of the environmental community will distrust the agencies and oppose them on many fronts.
9. Leaving mature forests unprotected would leave substantial areas of roadless lands subject to future conflict. Many westside roadless areas may not qualify as old-growth, but still provide important values as roadless and mature forests.
10. Complicated environmental analysis will be required for logging mature forests compared to thinning plantations. Wildlife surveys will be needed. Environmental Impact Statements will more often be needed instead of abbreviated Environmental Assessments. Formal consultation under the Endangered Species Act will more often be triggered.
11. We do not need to log mature forest to provide jobs. Less than 2% of the jobs in Washington and Oregon are in the lumber and wood products sectors, and only a small fraction of those are on federal land and only a fraction of those are related to mature forest logging. Many more environmentally benign jobs are available in restoring roads, streams, thinning young plantations, and managing fire and recreation.
12. We do not need to log mature forest to prop up the economy. The NW economy has greatly diversified in the last decade. Our economy typically creates more new jobs every year than exist in the entire lumber and wood products sectors.
13. We do not need to log mature forest to prop up the timber industry. Less than 10% of the logging in Oregon and Washington in recent years has been on federal lands. Only a fraction of that is mature forest. Much more environmentally benign and socially acceptable timber can be derived from thinning young plantations or small diameter fuel reduction where it is appropriate.
14. Since managing these stands is not "needed" for any ecological reason or any economic or social reason, what would be the objective?
15.
Standing in a mature forest, once gets the distinct feeling that [ldquo]this beautiful place should not be destroyed by logging.[rdquo]

Each substantive issue discussed in these comments should be (i) incorporated into the purpose and need for the project, (ii) used to develop NEPA alternatives that balance tradeoffs in different ways, (iii) carefully analyzed and documented as part of the effects analysis, and (iv) considered for mitigation.

Note: If any of these web links in this document are dead, they may be resurrected using the Wayback Machine at Archive.org. http://wayback.archive.org/web/

Sincerely,

Doug Heiken

for Oregon Wild, Cascadia Wildlands (Wildlands Director, Rebecca White), and Sierra Club, Many Rivers Group (Conservation Chair, Fergus McLean)

Attached: Supplemental Materials, mostly related to the Carbon and Climate Analysis

Supplemental MaterialsThe Youngs Rock Rigdon DEIS Analysis of Carbon and Climate Change is Flawed
After considering the comments below the FS should realize that they failed to consider all reasonable alternatives, including alternatives that enhance pine and oak ecosystems, enhance the ecosystem resilience to climate change, while conserving more carbon in the forest and avoiding some substantial carbon emissions associated with logging, and still producing some timber.

The FS also has a NEPA duty to provide high quality information and accurate analysis, including a response to reasonable opposing viewpoints. After reading these comments, the FS will conclude that the DEIS climate analysis is highly biased and skewed toward justifying logging instead of providing a balanced analysis of evidence on the effects of logging.

The last entry in these supplemental materials offers the FS ideas on how to prepare a credible NEPA analysis of climate and carbon, including quantifying emissions, putting those emissions in the cumulative emissions context, and comparing effects using a proxy tools such as the social cost of carbon dioxide emissions.

Cumulative Impacts of GHG Emissions Cannot be Minimized

The DEIS analysis of climate change and GHG emissions says [ldquo]a project of this size makes an extremely small contribution to overall emissions. [hellip] Therefore, at the global and national scales, this proposed action[rsquo]s direct and indirect contribution to GHGs and climate change would be negligible. In addition, because the direct and indirect effects would be negligible, the proposed action[rsquo]s contribution to cumulative effects on global GHGs and climate change would also be negligible[hellip][rdquo] (DEIS p 281). This is misleading and incorrect.

The NEPA analysis must avoid minimizing this project[rsquo]s contribution to carbon emissions and global warming by saying the effects of this project would be negligible on a global scale. This is not an appropriate framework. Global climate change and ocean acidification are the result of the cumulative effects on the global carbon cycle which is spatially distributed. There is no single culprit, nor is there a silver bullet solution. All emissions are part of the problem, and all land management decisions must be part of the solution. Since the global carbon cycle is spatially distributed, carbon storage and carbon emissions will always we spread out around the globe, and the carbon flux at any given place and time may appear small, but cumulatively they help determine the temperature of our climate and the pH of our oceans. Given the current carbon overload in the atmosphere and oceans, the carbon consequences of every project must be carefully considered (rather than dismissed as negligible).

The agency may argue that logging a few small patches of forest won[rsquo]t make a difference in the global scheme of the climate problem, but as Voltaire said, "No snowflake in an avalanche ever feels responsible.[rdquo] The NEPA analysis must recognize that global warming will not be solved by one miraculous technological fix or by changing one behavior or one economic activity. The whole global carbon cycle must be managed to reduce carbon emissions and increase carbon uptake. Recent evidence supports the conclusions that all net emissions of greenhouse gases are adverse to the climate. None can be considered de minimus. [ldquo]We show first that a single pulse of carbon released into the atmosphere increases globally averaged surface temperature by an amount that remains approximately constant for several centuries, even in the absence of additional emissions. We then show that to hold climate constant at a given global temperature requires near- zero future carbon emissions. Our results suggest that future anthropogenic emissions would need to be eliminated in order to stabilize global-mean temperatures. As a consequence, any future anthropogenic emissions will commit the climate system to warming that is essentially irreversible on centennial timescales.[rdquo] H. Damon Matthews and Ken Caldeira. 2009. Stabilizing climate requires near-zero emissions. Nature Vol 455 | 18 September 2008 | doi:10.1038/nature07296.

Every ton of CO_2 emitted to the atmosphere contributes to global climate change and ocean acidification. There is a single global carbon budget for cumulative GHG emissions for the period from the present to the end of the carbon economy which (because we have been slow to act) must occur in the next few decades. Those budgets require significant reductions in carbon emissions and an eventual end to GHG emissions. See Richard Millar, Myles Allen, Joeri Rogelj, Pierre Friedlingstein. 2016. The cumulative carbon budget and its implications. Oxford Review of Economic Policy, Volume 32, Issue 2, SUMMER 2016, Pages 323[ndash]342, https://doi.org/10.1093/oxrep/grw009;

http://pure.iiasa.ac.at/id/eprint/12738/1/The%20cumulative%20carbon%20budget%20and%20its%20implications.pdf. [ldquo]The carbon budget is a key concept in the climate-policy

sphere. It arises directly from the finding that the increase in global mean surface air

temperature is proportional to cumulative CO_2 emissions over time. This finding

is far from trivial, and together with the long-lived nature of CO_2 as a greenhouse gas

leads to two simple but powerful conclusions: 1. We need to cut emissions to zero in order to stop the increase in global temperature. 2. The amount of CO_2 that can be emitted globally in order to a stay within a certain warming limit is finite [ndash] the carbon budget.[rdquo] CONSTRAIN, 2019: ZERO IN ON the remaining carbon budget and decadal

warming rates. The CONSTRAIN Project Annual Report 2019, DOI: https://doi.org/10.5518/100/20; https://constrain-eu.org/wp-content/uploads/2020/02/CONSTRAIN-Zero-In-On-The-Remaining-Carbon-Budget-Decadal-Warming-Rates.pdf. The agency has no basis for concluding that emissions from logging are more important than (and belong in the constrained cumulative carbon budget) than other activities that emit GHG. When the agency says that emissions from logging are minimal or infinitismal on a global scale, it is effectively saying that its emissions belong outside the budget rather than inside the budget. This is fatally wrong. All GHG emissions are part of the cumulative emissions from all sources. None are outside the budget.

Former D.C. Circuit Judge Wald wrote in a 1990 dissenting opinion, which was recently quoted with unanimous approval by the Ninth Circuit in Center for Biological Diversity v. NHTSA:

[W]e cannot afford to ignore even modest contributions to global warming. If global warming is the result of the cumulative contributions of myriad sources, any one modest in itself, is there not a danger of losing the forest by closing our eyes to the felling of the individual trees?

538 F.3d at 1217. Similarly, the U.S. Supreme Court[rsquo]s decision in Massachusetts v. EPA noted that one cannot avoid responsibility to reduce and mitigate the climate problem by attempting to minimize the scale of one[rsquo]s contribution to the problem. ("While it may be true that regulating motor-vehicle emissions will not by itself reverse global warming, it by no means follows that we lack jurisdiction to decide whether EPA has a duty to take steps to slow or reduce it.... In sum, [hellip] [t]he risk of catastrophic harm, though remote, is nevertheless real. That risk would be reduced to some extent if petitioners received the relief they seek." 127 S.Ct. 1438, 1455 (2007) http://web.archive.org/web/20080610172128/http://www.supremecourtus.gov/opinions/06pdf/05-1120.pdf)

[The Prime Minister] claims that we [Australians] are responsible for just 1.3% of global carbon dioxide emissions, as if we are irrelevant. ...

...

Even though Scott Morrison[rsquo]s logic for climate inaction has been debunked many times, let[rsquo]s do it again, ...

...

The [ldquo]too small to matter[rdquo] argument is logically absurd, but it is also morally bankrupt and economically reckless.

We all know that throwing one piece of litter out the window wouldn[rsquo]t ruin the environment, but if all did we[rsquo]d soon be surrounded by rubbish.

How about voting? It is a foundation of our democracy that nobody[rsquo]s voice is so small as to be meaningless.

Likewise, if any one taxpayer stopped paying tax we all know it wouldn[rsquo]t make a measurable difference to the government[rsquo]s bottom line, but if everyone stopped paying tax it would smash consolidated revenue.

Simon Holmes [agrave] Court 2020. When it comes to emissions, the 'too small to matter' argument is absurd, reckless and morally bankrupt. The UK Guardian 8 Jan 2020. https://www.theguardian.com/australia-news/2020/jan/09/when-it-comes-to-emissions-the-too-small-to-matter-argument-is-absurd-reckless-and-morally-bankrupt?CMP=twt_a-environment_b-gdneco.

The responsibility to reduce emissions no matter how small is recognized in international law such as the European Convention on Human Rights.

The fact that the amount of the Dutch emissions is small compared to other countries does not affect the obligation to take precautionary measures in view of the State[rsquo]s obligation to exercise care. After all, it has been established that any anthropogenic greenhouse gas emission, no matter how minor, contributes to an increase of CO_2 levels in the atmosphere and therefore to hazardous climate change.

Urgenda Foundation v. The State of the Netherlands. Hague Court of Appeal. October 9, 2018. https://uitspraken.rechtspraak.nl/inziendocument?id=ECLI:NL:RBDHA:2015:7196.

CEQ draft guidance on NEPA and climate change recognizes that disclosure of the incremental nature of GHG emissions attributable to any given project is merely a restatement of the nature of the climate problem itself and NEPA does not allow agencies to avoid disclosure and consideration of alternatives and mitigation.

CEQ recognizes that many agency NEPA analyses to date have concluded that GHG emissions from an individual agency action will have small, if any climate change effects. Government action occurs incrementally, program-by-program and step-by-step, and climate impacts are not attributable to any single action, but are exacerbated by a series of smaller decisions, including decisions made by the government. Therefore, the statement that emissions from a government action or approval represent only a small fraction of global emissions is more a statement about the nature of the climate change challenge, and is not an appropriate basis for deciding whether to consider climate impacts under NEPA.

Moreover, these comparisons are not an appropriate method for characterizing the potential impacts associated with a proposed action and its alternatives and mitigations. This approach does not reveal anything beyond the nature of the climate change challenge itself: The fact that diverse individual sources of emissions each make relatively small additions to global atmospheric GHG concentrations that collectively have huge impact.

77 Fed. Reg. 77802, 77825. (Dec. 24, 2014).

Agency NEPA analyses often say that the "Literature, however, has not yet defined any specifics on the nature or magnitude of any cause and effect relationship between greenhouse gases and climate change. [and] it is currently beyond the scope of existing science to identify a specific source of greenhouse gas emissions or sequestration and designate it as the cause of specific climate impacts at a specific location."? The agency should stop saying this. Such statements are obviously part of the agency[rsquo]s dismissive boilerplate about climate change but they add nothing to the analysis, but they imply that things are far more uncertain than they are, and that logging-related GHG emissions can't be connected to the crime of global climate change, which is nonsense. What we know is that climate change is caused by cumulative effects. All GHG emissions become globally distributed in our well-mixed atmosphere, so all emissions are related to all harms and effects of global climate change. These effects are set forth in great detail in the scientific literature and IPCC reports. So, GHG emissions are bad and CO2 uptake by forests is good, and the agency's logging program increases GHG emissions and reduces CO2 uptake.

Because individual contributions to climate change are so small, but the cumulative problem is so large, meaningfully disclosing the impact of greenhouse gas emissions requires some tool beyond merely identifying physical changes in the environment attributable to an individual project[rsquo]s emissions.

Climate change is the quintessential cumulative impact problem, and a good way to disclose the incremental effects of individual contributions to the cumulative problems is to monetize the effects using tools that quantify the social cost of carbon dioxide emissions. Social Cost of Carbon 2010, https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/foragencies/Social-Cost-of-Carbon-for-RIA.pdf.

Individual physical changes that will result from any particular action will inevitably appear insignificant. Just as the public and decisionmakers [ldquo]cannot be expected to convert curies or mrems into such costs as cancer deaths,[rdquo] the EIS[rsquo]s readership cannot be expected to understand whether an individual project[rsquo]s miniscule marginal increase contribution to increased temperature, sea levels, etc. is cause for concern. Natural Res. Def. Council, Inc. v. U. S. Nuclear Regulatory Comm[rsquo]n, 685 F.2d 459, 487 n.149 (D.C. Cir. 1982) rev[rsquo]d on other grounds sub nom. Baltimore Gas & Elec. Co. v. Natural Res. Def. Council, Inc., 462 U.S. 87, 106-107 (1983).

Estimates of the social cost of carbon dioxide emissions are based on reasonable forecasts of the actual physical effects that each incremental unit of greenhouse gas emissions will have on the environment, including temperature, sea level rise, ecosystem services, and other physical impacts, together with assessments of how these physical changes will impact agriculture, human health, etc. The social cost protocol identifies the social cost imposed by a ton of emissions[rsquo] pro rata contribution to these environmental problems. This either amounts to an assessment of physical impacts or the best available generally accepted alternative to such an assessment; either way, the tool is appropriate for use under NEPA. 40 C.F.R. [sect] 1502.22(b)(4).

Any assertion that it is impossible to discuss the impact or significance of the Project[rsquo]s greenhouse gas emissions is arbitrary. Agencies must use available generally accepted tools to address the impact of these emissions, 40 C.F.R. 1502.22, and employ reasonable forecasting in its analysis. The agency[rsquo]s refusal to use available modeling tools, such as the estimates of the social cost of carbon and other greenhouse gases, violates NEPA.

Forest Degradation just as bad as Deforestation

The DEIS analysis of climate change and GHG emissions says [ldquo]This land management project is not considered a major source of GHG emissions. [because] . Forested land would not be converted into a developed or agricultural condition or otherwise result in the loss of forested area.[rdquo] (DEIS p 282. This is misleading and incorrect. The physics governing the [ldquo]greenhouse effect[rdquo] in the atmosphere responds to the cumulative emission of CO2 molecules in exactly the same way, whether those molecules are from deforestation or other types of logging. Labelling emissions as [ldquo]not deforestation[rdquo] does not erase their climate impacts.

The agency often says [ldquo]This project does not fall within any of these main contributors of greenhouse gas emissions. [hellip] The main activity in this [forestry] sector associated with GHG emissions is deforestation, which is defined as removal of all trees, most notably the conversion of forest and grassland into agricultural land or developed landscapes (IPCC 2000).[rdquo] The agency is again minimizing the effects of its activities and avoiding its dual responsibilities to produce accurate NEPA analysis and help store carbon in forests. All emissions are a problem. Categories do not really matter. The atmosphere sees each molecule of CO2 and other GHG equally. Climate authorities recognize [ldquo]forest degradation[rdquo] is just as bad as deforestation. In fact, the urgency to maintain and enhance biogenic terrestrial carbon stores has long been recognized and is reflected in the inclusion of the land sector in the report of the United Nations Framework Convention on Climate Change (UNFCCC). The official title of UN program related to reducing GHG emissions from land use includes the words deforestation AND [ldquo]forest degradation[rdquo] i.e., Reducing Emissions from Deforestation and Forest Degradation (REDD). This clearly refutes the agency[rsquo]s assertion that forest management activities that fall short of deforestation are not among the categories of concern regarding global GHG emissions.

The Copenhagen Accord recognizes the need to avoid dangerous climate change and the role of forests in climate mitigation.

[ldquo][hellip]To achieve the ultimate objective of the Convention to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, we shall, recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius [hellip] enhance our long-term cooperative action to combat climate change. We recognize the crucial role of

reducing emission from deforestation and forest degradation and the need to enhance removals of greenhouse gas emission by forests and agree on the need to provide positive incentives to such actions[rdquo]

http://www.climatesciencewatch.org/file-uploads/Copenhagen_Accord.pdf. This likely requires reducing atmospheric CO2 concentrations below 350 ppm[1] and avoiding logging that would increase atmospheric carbon emissions. Boucher, D., and K. Belletti-Gallon, 2015. Halfway There? What the Land Sector Can Contribute to Closing the Emissions Gap. Union of Concerned Scientists. http://www.ucsusa.org/sites/default/files/attach/2015/01/ucs-halfway-there-2015-full-report.pdf ([ldquo]Enormous amounts of carbon are released into the atmosphere when forests are cleared. [ldquo]Forest degradation[rdquo] activities, such as selective logging, [hellip] are also significant emissions sources.[rdquo])

Forest degradation should be defined from a climate change perspective to include any human land-use activity that reduces the carbon stocks of a forested landscape relative to its carbon carrying capacity. The climate change imperative demands that we take a fresh look at our forest estate. The carbon impacts of all land uses, including commercial logging, must be brought explicitly into our calculations in terms of their direct and indirect effects on forest degradation.

Brendan G. Mackey, Heather Keith, Sandra L. Berry and David B. Lindenmayer. 2008. Green Carbon: The role of natural forests in carbon storage. Part 1. A green carbon account of Australia[rsquo]s south-eastern Eucalypt forests, and policy implications. Australian National University. http://epress.anu.edu.au/green_carbon/pdf/whole_book.pdf.

The agency must account for all forest carbon loses, not just from deforestation, but also degradation. Sophie Yeo 2015. Blog - Forest degradation as bad for climate as deforestation, says report. 08 Apr 2015, http://www.carbonbrief.org/blog/2015/04/forest-degradation-as-bad-for-climate-as-deforestation,-says-report/

?A study by Erb et al (2017) shows that deforestation represents only about half of the cumulative carbon emissions from land use. Most of the other half is from forest degradation. ?

Scientists just presented a sweeping new estimate of how much humans have transformed the planet

By Chris Mooney, Washington Post
December 20 , 2017

https://www.washingtonpost.com/news/energy-environment/wp/2017/12/20/scientists-present-a-sweeping-new-estimate-of-how-much-humans-have-altered-the-planet/

...
Razing forests or plowing grasslands puts carbon in the atmosphere just like burning fossil fuels does.
Now, new research provides a surprisingly large estimate of just how consequential our treatment of land surfaces and vegetation has been for the planet and its atmosphere.
...
[T]he study also presented an even larger and perhaps more consequential number: 916 billion tons. That[rsquo]s the amount of carbon, the research calculated, that could reside in the world[rsquo]s vegetation

[mdash] so not in the atmosphere [mdash] if humans somehow entirely ceased all uses of land and allowed it to return to its natural state. The inference is that current human use of land is responsible for roughly halving the potential storage of carbon by that land.

...

The study found that there are two far-less-recognized components of how humans have subtracted from Earth[rsquo]s potential vegetation [mdash] and that in combination they are just as substantial as deforestation. Those are large-scale grazing and other uses of grasslands, as well as forest [ldquo]management.[rdquo] With the latter, many trees and other types of vegetation are subtracted from forests [mdash] often the larger and older trees due to logging [mdash] but the forests as a whole don[rsquo]t disappear. They[rsquo]re just highly thinned out.

[ldquo]This effect is quite massive, more massive than we expected actually,[rdquo] Erb said.

...

The research means that so-called degraded land [mdash] not fully deforested but not [ldquo]natural[rdquo] or whole, either [mdash] is a phenomenon to be reckoned with.

[ldquo]It suggests that the amount of carbon released to the atmosphere from land use is approximately equal to the amount still retained,[rdquo] said Tom Lovejoy, an ecologist at George Mason University who was not involved in the work. [ldquo]That means the restoration agenda is even more important than previously thought and highlights the enormous amount of degraded land in the world.[rdquo]

...

[ldquo]Scenarios that limit global warming to 1.5 or 2 degrees [Celsius] require not only rapid cessation of greenhouse gas emissions but also removal of somewhere between about 100 and 300 billion tons of carbon from the atmosphere,[rdquo] Phil Duffy, president of the Woods Hole Research Center, said in an email.

[ldquo]This paper suggests that restoring vegetation around the world could in principle achieve that,[rdquo] Duffy continued, noting that if all the potential vegetation were restored it would offset some 50 years of global carbon emissions. While [ldquo]the full theoretical potential will never be realized in practice [hellip] this paper indicates that restoring vegetation could make an extremely important contribution to controlling global climate change.[rdquo]

See Karl-Heinz Erb et al. 2017. Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature. Published online 20 Dec 2017. doi:10.1038/nature25138.

https://www.nature.com/articles/nature25138.epdf

Arneth et al (2017) showed that global vegetation models often make unrealistic assumptions about forests (such as that areas maintained in forest cover suffer no decline in carbon storage) and therefore underestimate both the carbon flux from logging as well as the carbon benefits of forest conservation.

[hellip] Dynamic global vegetation model simulations suggest that CO_2 emissions from land-use change have been substantially underestimated because processes such as tree harvesting and land clearing from shifting cultivation have not been considered. As the overall terrestrial sink is constrained, a larger net flux as a result of land-use change implies that terrestrial uptake of CO_2 is also larger, and that terrestrial ecosystems might have greater potential to sequester carbon in the future. Consequently, reforestation projects and efforts to avoid further deforestation could represent important mitigation pathways, with co-benefits for biodiversity. [hellip]

[hellip]

Wood Harvesting

Until recently, global DGVM studies that accounted for LULCC concentrated on the representation of conversion of natural lands to croplands and pastures, whereas areas under forest cover were represented as natural forest, and hence by each model[rsquo]s dynamics of establishment, growth and mortality. Two-thirds to three-quarters of global forests have been affected by human use, which is mainly due to timber harvest; but forests are also a source of firewood or secondary products; or used for recreational purposes13. Between 1700 and 2000 an estimated 86 PgC has been removed globally from forests due to wood harvesting (WH)14. WH leads to reduced carbon density on average in managed forests15 and can ultimately result in degradation in the absence of sustainable management strategies. Furthermore, the harvesting of wood can reduce litter input, which lowers soil pools13. Bringing a natural forest under any harvesting regime probably will lead to net-CO2 emissions to the atmosphere [mdash] with a magnitude and time-dependency conditional on harvest intensity and frequency, regrowth and the fate and residence time of the wood products.

Impacts of land-management processes on the carbon cycle

The few published DGVM studies that account for the management of land more realistically16,19[ndash]21 consistently suggest a systematically larger FLULCC over the historical period compared to estimates that ignored these processes, with important implications for our understanding of the terrestrial carbon cycle and its role for historical (and future) climate change. [hellip]

[hellip]

Implications for the future land carbon mitigation potential

Our calculated increases in FLULCC, in absence of a clear understanding of the processes underlying FRL, notably strengthen the existing arguments to avoid further deforestation (and all ecosystem degradation) [mdash] an important aspect of climate change mitigation, with considerable co-benefits to biodiversity and a broad range of ecosystem service supply.

Arneth, A., Sitch, S., Pongratz, J. et al (2017) Historical carbon dioxide emissions caused by land-use changes are possibly larger than assumed. NATURE GEOSCIENCE | VOL 10 | FEBRUARY 2017. http://bstocker.net/wp-content/uploads/2016/09/arneth17natgeo.pdf.

When forest carbon accounting looks only at forest clearing, significant forgone carbon sequestration caused by forest degradation are overlooked. [ldquo][N]ew research shows that we should be taking much better care of our last great intact forests because doing so has remarkable climate benefits. ... A single episode of serious damage can lead to decades of [lsquo]lost earnings[rsquo] in the carbon accounts.[rdquo] Tom Evans, Sean Maxwell 2019. The Carbon Bomb - A new report shows that deforestation released a shocking 626 percent more CO2 between 2000 and 2013 than previously thought. Scientific American. November 8, 2019. https://blogs.scientificamerican.com/observations/the-carbon-bomb/citing Sean L. Maxwell, Tom Evans, James E. M. Watson et al 2019. Degradation and forgone removals increase the carbon impact of intact forest loss by 626%. Science Advances 30 Oct 2019: Vol. 5, no. 10, eaax2546. DOI: 10.1126/sciadv.aax2546. https://advances.sciencemag.org/content/5/10/eaax2546. ([ldquo][W]e encourage national governments to better account for the full carbon impact of intact forest retention. For example, emission baselines that account for selective logging and other more cryptic degradation processes would reduce the disproportionate emphasis on recent forest clearance[rdquo]).

Logging Does Not Increase Capacity for Growing Trees

The DEIS analysis of climate change and GHG emissions says [ldquo]forest stands are being retained and [hellip] maintain a vigorous condition that supports enhanced tree growth and productivity, thus contributing to long-term carbon uptake and storage [hellip] [A]ny initial carbon emissions from this proposed action would be balanced and possibly eliminated as the stand recovers and regenerates, because the remaining trees and newly established trees typically have higher rates of growth and carbon storage (Hurteau and North 2009, Dwyer et al. 2010, McKinley et al. 2011).[rdquo] (DEIS p 282). This is misleading and incorrect. Logging will reduce carbon storage, increase GHG emissions, and future forest growth will never catch up with the carbon storage in the unlogged alternative and never fully mitigate for the warming caused by the extra CO2 in the atmosphere caused by logging.

The NEPA analysis suggests that logging will increase forest productivity, but there is no evidence that this is true. The agency often says [ldquo]Projects like the proposed action that create forests or improve forest conditions and capacity to grow trees are positive factors in carbon sequestration.[rdquo]

[ldquo]I am unaware of a single study, or plausible mechanism, by which tree removal increases stand-level productivity (and by extension carbon stocks). For instance, the CFCP fairly cites Battles et al. (2015) as empirical evidence that thinned forests can [ldquo]within a decade or two[rdquo] regain the carbon lost due to the removal of smaller trees, but fails to acknowledge that the un-thinned control forests in this same study continued to grow over this period and, at all times, contained more carbon that the thinned ones. Even when one considers the protection thinning affords forests from carbon losses in high-severity fire, thinned forests contain less carbon over space and time than do fire suppressed ones (provided conditions afford timely post-fire regeneration). Such is well-established in several reviews of the subject, all of which are notable missing from the CFCP citations (Campbell et al., 2012; Restaino and Peterson 2013; Young, 2015; Kalies and Kent 2016).[rdquo]

Campbell, J.L. 2017, Comments on the Jan 2017 draft California Forest Carbon Plan. http://www.fire.ca.gov/fcat/downloads/FCAT_PublicComment/Campbell_CFCP_Review_Final-2nd.pdf. The [ldquo]capacity to grow trees[rdquo] (i.e., net ecosystem productivity) on this landscape will actually be adversely affected by the proposed action to the extent the FS builds roads, compacts soil, removes biomass, etc.

In the context of carbon and climate change, the agency cannot define [ldquo]improve forest conditions[rdquo] in way that justifies logging that increases GHG emissions at the expense of maintaining forest carbon storage.

Also, this project will cause far more tree mortality by logging than would be avoided via natural mortality. See discussion in DeCicco J.M. 2013. Biofuel[rsquo]s carbon balance: doubts, certainties and implications. Climatic Change (2013) 121:801[ndash]814. DOI 10.1007/s10584-013-0927-9 http://download.springer.com/static/pdf/522/art%253A10.1007%252Fs10584-013-0927-9.pdf?auth66=1398528430_ad123a71083ade45750f8bec9a091a43&ext=.pdf ([ldquo]A first-order model shows that biofuels are beneficial only to the extent that their production effectively enhances net ecosystem production.[rdquo]).

Where clear-cutting of long-established virgin forest is followed by the establishment of commercial plantation forests or agroforestry systems, it is doubtful that the C released to the atmosphere will ever be fully recovered within the ecosystem.

Matthews R.W. et al. (1996) WG3 Summary: Evaluating the role of forest management and forest products in the carbon cycle. In: Apps M.J., Price D.T. (eds) Forest Ecosystems, Forest Management and the Global Carbon Cycle. NATO ASI Series (Series I: Global Environmental Change), vol 40. Springer, Berlin, Heidelberg. http://www.sysecol2.ethz.ch/pdfs/Ma121-lq.pdf

William R. Moomaw, Susan A. Masino, and Edward K. Faison. 2019. Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good Front. For. Glob. Change, 11 June 2019 | https://doi.org/10.3389/ffgc.2019.00027; https://www.frontiersin.org/articles/10.3389/ffgc.2019.00027/full ([ldquo]ABSTRACT: Climate change and loss of biodiversity are widely recognized as the foremost environmental challenges of our time. Forests annually sequester large quantities of atmospheric carbon dioxide (CO2), and store carbon above and below ground for long periods of time. Intact forests[mdash]largely free from human intervention except primarily for trails and hazard removals[mdash]are the most carbon-dense and biodiverse terrestrial ecosystems, with additional benefits to society and the economy. Internationally, focus has been on preventing loss of tropical forests, yet U.S. temperate and boreal forests remove sufficient atmospheric CO2 to reduce national annual net emissions by 11%. U.S. forests have the potential for much more rapid atmospheric CO2 removal rates and biological carbon sequestration by intact and/or older forests. The recent 1.5 Degree Warming Report by the Intergovernmental Panel on Climate Change identifies reforestationand afforestation as important strategies to increase negative emissions, but they face significant challenges: afforestation requires an enormous amount of additional land, and neither strategy can remove sufficient carbon by growing young trees during the critical next decade(s). In contrast, growing existing forests intact to their ecological potential[mdash]termed proforestation[mdash]is a more effective, immediate, and low-cost approach that could be mobilized across suitable forests of all types. Proforestation serves the greatest public good by maximizing co-benefits such as nature-based biological carbon sequestration and unparalleled ecosystem services such as biodiversity enhancement, water and air quality, flood and erosion control, public health benefits, low impact recreation, and scenic beauty. ... Proforestation produces natural forests as maximal carbon sinks of diverse species (while supporting and accruing additional benefits of intact forests) and can reduce significantly and immediately the amount of forest carbon lost to nonessential management. Because existing trees are already growing, storing carbon, and sequestering more carbon more rapidly than newly planted and young trees (Harmon et al., 1990; Stephenson et al., 2014; Law et al., 2018; Leverett and Moomaw, in preparation), proforestation is a near-term approach to sequestering additional atmospheric carbon: a significant increase in [ldquo]negative emissions[rdquo] is urgently needed to meet temperature limitation goals. The carbon significance of proforestation is demonstrated in multiple ways in larger trees and older forests. For example, a study of 48 undisturbed primary or mature secondary forest plots worldwide found, on average, that the largest 1% of trees [considering all stems [ge]1 cm in diameter at breast height (DBH)] accounted for half of above ground living biomass (The largest 1% accounted for [sim]30% of the biomass in U.S. forests due to larger average size and fewer stems compared to the tropics) (Lutz et al., 2018). Each year a single tree that is 100 cm in diameter adds the equivalent biomass of an entire 10[ndash]20 cm diameter tree, further underscoring the role of large trees (Stephenson et al., 2014). Intact forests also may sequester half or more of their carbon as organic soil carbon or in standing and fallen trees that eventually decay and add to soil carbon (Keith et al., 2009). Some older forests continue to sequester additional soil organic carbon (Zhou et al., 2006) and older forests bind soil organic matter more tightly than younger ones (Lacroix et al., 2016).[rdquo]) See also, How to fight climate change? Save existing forests. Guest column by William R. Moomaw, Bob Leverett, Robert A. Jonas and Monica Jakuc Leverett. 7-24-2019. https://www.gazettenet.com/Guest-column-by-William-R-Moomaw-Bob-Leverett-Robert-A-Jonas-and-Monica-Jakuc-Leverett-27110056.

FEN MONTAIGNE 2019. Why Keeping Mature Forests Intact Is Key to the Climate Fight. Yale e360 OCTOBER 15, 2019. https://e360.yale.edu/features/why-keeping-mature-forests-intact-is-key-to-the-climate-fight ([ldquo]... [P]reserving existing mature forests will have an even more profound effect on slowing global warming in the coming decades, since immature trees sequester far less CO2 than older ones. ... [lsquo]The most effective thing that we can do is to allow trees that are already planted, that are already growing, to continue growing to reach their full ecological potential, to store carbon, and develop a forest that has its full complement of environmental services,[rsquo] said Moomaw. ... [I]n order to meet our climate goals, we have to have greater sequestration by natural systems now. So that entails protecting the carbon stocks that we already have in forests. ... We[rsquo]ve seen a lot of interest lately in planting more trees. And planting trees is great and it makes us all feel good and it[rsquo]s a wonderful thing to do ... but they will not make much of a difference in the next two or three decades because little trees just don[rsquo]t store much carbon. Letting existing natural forests grow is essential to any climate goal we have.[rdquo])

As climate stress increases, maintaining forest productivity will require conserving fungal diversity, which in turn requires conserving the trees and dead wood that support fungal diversity. As explained by Peter et al (2013) [ndash]

New emerging techniques allow to study the functional diversity of mycorrhizal fungi under natural conditions in forests (Courty et al. 2010). One of the most important functions of these fungi is the enhanced nutrient uptake of forest trees. Therefore, the functional abilities of nutrient mobilisation from organic material were tested in several forest ecosystems and under diverse environmental conditions (Pritsch and Garbaye 2011). These studies show that species do have different functional abilities in enzymatic activities, e.g. for nitrogen acquisition by degrading proteins in the soil or in lignin degradation (see Figure 57, Hutter et al. in prep). Whereas some mycorrhizal species complement each other, some are redundant in these functions but are sometimes adapted to other soil conditions and might be complementary in additional functions such as water uptake (Bu[eacute]e et al. 2007, Jones et al. 2010, Rineau and Courty 2011). Therefore, on the one hand, high diversity in the mycorrhizal fungal community is of great importance for forest trees to optimally exploit soil resources through the different functional abilities of single species. On the other hand, a high diversity allows the mycorrhizal community to respond to changing environmental conditions and disturbances by modifying the community towards better-adapted species that maintain important ecosystem functions. ... With climate warming, it is expected that the severity and duration of drought will increase, and therefore the maintenance of intact mycorrhizal networks will become more critical to the stability of forest ecosystems (Simard and Austin 2010). ... Several factors, such as natural disturbances, forest management, and anthropogenic pollution, impact this diversity and structure, in most cases by changing the competitiveness and dominance of the species present. Under severe disturbances, species richness is impacted, lowering the potential resistance to additional stresses or even reducing ecological function. ... Although the effect of climate change factors and their interaction on mycorrhizal communities is complex and difficult to predict, it is likely that these communities will help stabilize forest ecosystems under the predicted climatic scenarios (Simard and Austin 2010). Management practices should therefore consider the functional importance of mycorrhizal fungi and their networks in the natural regeneration and resilience of forests.

Martina Peter, Marc Bu[eacute]e and Simon Egli 2013. Biodiversity of mycorrhizal fungi as a crucial player in forest ecosystem functioning. In Daniel Kraus and Frank Krumm (eds.) 2013. Integrative approaches as an opportunity for the conservation of forest biodiversity. European Forest Institute. 284 pp.

http://www.integrateplus.org/uploads/images/Mediacenter/integrate_book_2013.pdf.

A literature review by Tomao et al (2020) explains that the adverse effects of logging on fungi populations has at least three causes: (i) loss of ectomycorrhizal-hosts and the associated reduction in carbohydrate production and carbohydrate transfer from living trees to the fungal symbionts, (ii) reduction in quantity and diversity of dead wood substrate, and (iii) adverse modification of the microclimate, e.g., rapid wetting and drying, soil compaction, reduced water retention, reduced gas exchange, etc.

Highlights [ndash]

[bull] We review the effect of forest management practices on fungal diversity.

[bull] Fungal diversity is positively related with canopy cover, basal area and tree species diversity.

[bull] Diversity of deadwood size and decomposition stage is positively related to richness of wood-inhabiting fungi.

[bull] The higher is the forest management intensity the lower is the diversity of fungal species. ...

If no management practices are performed for a long time, stands may gradually evolve into so-called [ldquo]old-growth forests[rdquo]. In the absence of anthropogenic disturbances, forests may slowly recover the natural disturbance dynamics (forest fires and windstorms, parasite outbreaks, fungal decay, gap creation due to insects) and develop those stand structural features (large living trees, large amount of deadwood, canopy gaps of various size, coexistence of senescent, mature and initial stages) typical of primary forests (Burrascano et al., 2013). ... Old-growth forests are recognized as an important reserve of fungal diversity for several fungal functional guilds. Indeed, a very large number of ectomycorrhizal species can be hosted in old growth stands (Richard et al., 2004; Zhang et al., 2017).

Antonio Tomao, Jos[eacute] Antonio Bonet, Carles Casta[ntilde]o, Sergiode-Miguel, 2020. How does forest management affect fungal diversity and community composition? Current knowledge and future perspectives for the conservation of forest fungi. Forest Ecology and Management, Volume 457, 1 February 2020, 117678, https://doi.org/10.1016/j.foreco.2019.117678.

Stenzel et al (2021) showed that thinning Ponderosa pine increased net primary productivity on a tree basis, but reduced carbon storage on a stand basis, even after accounting for carbon stored in wood products. The carbon deficit caused by thinning is expected to last for at least several decades. Stenzel, J. E., Berardi, D. B., Walsh, E. S., & Hudiburg, T. W. (2021). Restoration thinning in a drought-prone Idaho forest creates a persistent carbon deficit. Journal of Geophysical Research: Biogeosciences, 126, e2020JG005815. https://doi.org/10.1029/2020JG005815. ([ldquo][hellip] [R]esults suggested that thinned stand NEP would exceed control NEP in subsequent years following several years of canopy recovery due to increases in available mineral nitrogen and increased allocation of carbon to wood (and a resulting decrease in biomass turnover). However, a carbon deficit relative to control remained due to the removal of [sim]40% of live ecosystem carbon as well as the subsequent release of [sim]60% of removed biomass by 2050. Despite the continued storage of a portion of removed biomass in long-lived wood products, large immediate and short-term emissions were associated with slash combustion, on-site decomposition, and short-term product chain emissions (i.e., waste and paper), and do not represent avoided emissions through 2050.[rdquo]). The climate does not benefit if a few trees increase productivity, it only benefits if more carbon remains stored and less greenhouse gas is emitted to the atmosphere. Logging does NOT accomplish this goal.

Risk reduction logging does not help store carbon.

The DEIS analysis of climate change and GHG emissions says

[ldquo]reducing stand density, one of the goals of this proposed action, is consistent with adaptation practices to increase resilience of forests to climate-related environmental changes (Joyce et al. 2014). This proposed action is consistent with options proposed by the IPCC for minimizing the impacts of climate change on forests, thus meeting objectives for both adapting to climate change and mitigating GHG emissions (McKinley et al. 2011). [hellip] The relatively small quantity of carbon released to the atmosphere and the short-term nature of the effect of the proposed action on the forest ecosystem are justified, given the overall change in condition increases the resistance to wildfire, drought, insects and disease, or a combination of disturbance types that can reduce carbon storage and alter ecosystem functions (Millar et al. 2007, Amato et al. 2011). [hellip] [B]y reducing stand density, the proposed action may also reduce the risk of more severe disturbances, such as insect and disease outbreak and severe wildfires, which may result in lower forest carbon stocks and greater GHG emissions[rdquo]

(DEIS p 282-283). This is inaccurate and misleading. Logging does not mitigate global climate change, even when it is intended to limit emissions from natural disturbance, because in virtually every case, the carbon emissions from logging at a scale necessary to control natural disturbance exceeds the carbon emissions from natural disturbance. The FS made no effort to develop a NEPA alternative that harmonizes climate resilience and climate mitigation.

Logging proponents often claim that logging will increase carbon storage in the forest by limiting carbon emissions caused by natural processes such as fire and insect-induced mortality. This is simply counter-factual. In most cases, managing forests in an effort to control natural processes that release carbon will only make things worse by releasing MORE carbon. This is mostly because no one can predict where fire or insects will occur, so the treatments must be applied to broad landscapes, yet the probability of fire or insects at any given location remains low, and only a small fraction of the treated areas will actually experience fire or insects. As a result, many acres will be treated "unnecessarily" and therefore the cumulative carbon emissions from logging to control fire and insects (plus the carbon emissions from fire and insects that occur in spite of control efforts) are greater than emissions from fire and insects alone. A careful analysis shows that logging to control fire and expecting to increase carbon storage is analogous to rolling a die and expecting to roll a six every time.

This is an example of the [ldquo]base rate fallacy[rdquo] or [ldquo]neglecting priors[rdquo] from Bayesian statistics. The probability of a forest stand NOT burning are far greater than the probability of a forest stand burning. Attempts to address a problem that is unlikely to occur, such as by thinning a forest that is unlikely to burn, runs a high risk that unintended negatives effects will overwhelm beneficial effects. https://en.wikipedia.org/wiki/Base_rate_fallacy

[T]here 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.

Law, B. 2021. Response to Questions for the Record, attached to 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 [ldquo]WILDFIRE IN A WARMING WORLD: OPPORTUNITIES TO IMPROVE COMMUNITY COLLABORATION,

CLIMATE RESILIENCE, AND WORKFORCE CAPACITY[rdquo] https://naturalresources.house.gov/imo/media/doc/Law,%20Beverly%20-%20Testimony%20-%20NPFPL%20Ov%20Hrg%2004.29.21.pdf (link to Statement, without Response to Questions).

The 2018 US Forest Service Northwest Forest Plan Science Synthesis concluded that fuel reduction is unlikely to be an effective climate mitigation strategy.

Some studies from other regions in the Western United States (i.e., the Southwest and Sierra Nevada) suggest that thinning and fuel reduction can mitigate carbon loss from fire. Fuel reduction may reduce losses of carbon at stand levels compared with the consequences of high-severity wildfire burning in stands with high fuel loads (Finkral and Evans 2008; Hurteau and North 2009; Hurteau et al. 2008, 2011, 2016; North and Hurteau 2011; North et al. 2009, Stephens et al. 2009). However, because the probability of treated areas burning is generally low (Barnett et al. 2016), and most biomass is not consumed by fire, slight differences in losses resulting from combustion in fire compared with losses from fuel reduction are unlikely to make fuel reduction a viable mitigation strategy (Ager et al. 2010, Campbell et al. 2012, Kline et al. 2016, Mitchell et al. 2009, Restaino and Peterson 2013, Spies et al. 2017).

USDA 2018. Synthesis of Science to Inform Land Management Within the Northwest Forest Plan Area. General Technical Report. PNW-GTR-966 Vol. 1. June 2018. https://www.fs.fed.us/pnw/pubs/pnw_gtr966_vol1.pdf.

Let[rsquo]s start with a simple truism of risk management:

Speculative negative emissions technologies may be worse than chimeras if they result in the false comfort that continued [hellip] emissions can simply be offset, thereby diverting financial and policy resources from conventional mitigation. This would be reckless. It is clearly less risky not to emit a tonne of CO_2 in the first place, than to emit one in expectation of being able to sequester it for an unknown period of time, at unknown cost, with unknown consequences, at an unknown date and place in the future.

Carbon Brief staff 2016. In-depth: Experts assess the feasibility of [lsquo]negative emissions[rsquo] citing Rob Bailey, Director of Energy, Environment and Resources, Chatham House. http://www.carbonbrief.org/in-depth-experts-assess-the-feasibility-of-negative-emissions#bailey

Law & Harmon (2011) conducted a literature review and concluded [hellip]

Thinning forests to reduce potential carbon losses due to wildfire is in direct conflict with carbon sequestration goals, and, if implemented, would result in a net emission of CO_2 to the atmosphere because the amount of carbon removed to change fire behavior is often far larger than that saved by changing fire behavior, and more area has to be harvested than will ultimately burn over the period of effectiveness of the thinning treatment.

Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1).
https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf.

Campbell and Agar (2013) conducted a sensitivity analysis and found robust results indicating that fuel reduction does not increase forest carbon storage.

[hellip] we attempt to remove some of the confusion surrounding this subject by performing a sensitivity analysis wherein long-term, landscape-wide carbon stocks are simulated under a wide range of treatment efficacy, treatment lifespan, fire impacts, forest recovery rates, forest decay rates, and the longevity of wood products. Our results indicate a surprising insensitivity of long-term carbon stocks to both management and biological variables. After 80 years, [hellip] a 1600% change in either treatment application rate or efficacy in arresting fire spread resulted in only a 10% change in total system carbon. This insensitivity of long-term carbon stocks is due in part by the infrequency of treatment/wildfire interaction and in part by the controls imposed by maximum forest biomass. None of the fuel treatment simulation scenarios resulted in increased system carbon.

Campbell, J, Agar, A (2013) Forest wildfire, fuel reduction treatments, and landscape carbon stocks: A sensitivity analysis. Journal of Environmental Management 121 (2013) 124-132 http://fes.forestry.oregonstate.edu/sites/fes.forestry.oregonstate.edu/files/PDFs/Campbell_2013_JEM.pdf

This graph shows that logging for fuel reduction rarely interacts with wildfire, which explains why the carbon emissions from widespread fuel reduction logging vastly exceeds the carbon emissions avoided in the rare cases where fuel reduction does interact favorably with wildfire.

There are now webtools available that can help the agencies deal with uncertainty surrounding the efficacy of fuel reduction. For instance, this web-based spreadsheet (http://getguesstimate.com/) allows users to create models with confidence intervals around input variables. Then it runs thousands of Monte Carlo simulations to come up with estimates of model behavior. The agencies could use this to better estimate the improbability that fuel treatments would interact with fire and estimate the improbable carbon benefits of fuel reduction logging.

Before attributing carbon benefits to fuel reduction logging please consider the conclusions of:

* John L Campbell, Mark E Harmon, and Stephen R Mitchell. 2011. Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions? Front Ecol Environ 2011; doi:10.1890/110057http://forestpolicypub.com/wp-content/uploads/2011/12/campbell-2011.pdf. (Results suggest that the protection of one unit of C from wildfire combustion comes at the cost of removing three units of C in fuel treatments.)
* Mitchell, Harmon, O[rsquo]Connell. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. 19(3), 2009, pp. 643[ndash]655. http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_mitchell001.pdf. ([ldquo][hellip]reducing the fraction by which C is lost in a wildfire requires the removal of a much greater amount of C, since most of the C stored in forest biomass (stem wood, branches, coarse woody debris) remains unconsumed even by high-severity wildfires. For this reason, all of the fuel reduction treatments simulated for the west Cascades and Coast Range ecosystems as well as most of the treatments simulated for the east Cascades resulted in a reduced mean stand C

storage[hellip]. We suggest that forest management plans aimed solely at ameliorating increases in atmospheric CO2 should forego fuel reduction treatments [hellip][rdquo])
* Reinhardt, Elizabeth, and Lisa Holsinger 2010. Effects of fuel treatments on carbon-disturbance relationships in forests of the northern Rocky Mountains. Forest Ecology and Management 259 (2010) 1427[ndash]1435. http://www.fs.fed.us/rm/pubs_other/rmrs_2010_reinhardt_e002.pdf ([ldquo]Although wildfire emissions were reduced by fuel treatment, the fuel treatments themselves produced [carbon] emissions, and the untreated stands stored more carbon than the treated stands even after wildfire. [hellip] Our results show generally long recovery times [hellip][rdquo])
* Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf ([ldquo]Thinning forests to reduce potential carbon losses due to wildfire is in direct conflict with carbon sequestration goals, and, if implemented, would result in a net emission of CO2 to the atmosphere because the amount of carbon removed to change fire behavior is often far larger than that saved by changing fire behavior, and more area has to be harvested than will ultimately burn over the period of effectiveness of the thinning treatment.[rdquo])
* Restaino, Joseph C.; Peterson, David L. 2013. Wildfire and fuel treatment effects on forest carbon dynamics in the western United States. Forest Ecology and Management 303:46-60. http://www.fs.fed.us/pnw/pubs/journals/pnw_2013_restiano001.pdf ([ldquo][hellip] C costs associated with fuel treatments have can exceed the magnitude of C reduction in wildfire emissions, because a large percentage of biomass stored in forests (i.e., stem wood, branches, coarse woody debris) remains unconsumed, even in high-severity fires (Campbell et al., 2007; Mitchell et al., 2009). [hellip] Wildfire occurrence in a given area is uncertain and may never interact with treated stands with reduced fire hazard, ostensibly negating expected C benefits from fuel treatments. Burn probabilities in treated stands in southern Oregon are less than 2%, so the probability that a treated stand encounters wildfire and creates C benefits is low (Ager et al., 2010).)[rdquo]
* Goslee, K., Pearson, T., Grimland, S., Petrova, S., Walls, J., Brown, S., 2010. Final Report on WESTCARB Fuels Management Pilot Activities in Lake County, Oregon. California Energy Commission, PIER. DOE Contract No.: DE-FC26-05NT42593. http://uc-ciee.org/downloads/Fuels_Management_LakeCo.pdf; AND Pearson, T.R.H., Goslee, K., Brown, S., 2010. Emissions and Potential Emission Reductions from Hazardous Fuel Treatments in the WESTCARB Region. California Energy Commission, PIER. CEC-500-2014-046. http://www.energy.ca.gov/2014publications/CEC-500-2014-046/CEC-500-2014-046-AP.pdf. (Summarized by Restaino & Peterson (2013) as follows: [ldquo]Pearson et al. (2010) and Goslee et al. (2010) developed methodologies to evaluate C dynamics associated with fuel treatment projects in low to mid-elevation forest in northern California and Oregon. The authors, with consultation from teams of scientists, quantify C storage and release within the context of a six-point conceptual framework: annual fire risk, treatment emissions, fire emissions, forest growth and re-growth, re-treatment, and the shadow effect (i.e., treatment effect outside the treated area). Results indicate that the mean annual probability of wildfire for the study region is less than 0.76%/year, and treatments reduce C stocks by an average of 19%. Where timber is removed, 30% of extracted biomass is stored in long-lasting wood products. Wildfire emissions in treated stands, quantified with the Fuel Characteristic Classification System, are reduced by 6% relative to untreated stands. Growth estimates for a 60-year simulation horizon, derived from FVS, indicate that in the absence of wildfire, untreated stands sequester 17% more C than treated stands. However, in simulations that include wildfire, treated stands sequester 63% more C than untreated stands. The shadow effect is unlikely to be large enough to affect net GHG emissions. In summary, initial reductions in C stocks (e.g., thinning), combined with low annual probability of wildfire, preclude C benefits associated with fuel treatments, even if harvest residues are used for biomass energy.[rdquo])
* Chiono, Lindsay 2011. Balancing the Carbon Costs and Benefits of Fuels Management. Research Synthesis for Resource Managers. Joint Fire Science Program Knowledge Exchange. http://static1.squarespace.com/static/545a90ede4b026480c02c5c7/t/5527ebd9e4b0f620d0cb5b58/1428679641640/CFSC_Chiono_Carbon_and_Fuel_Mngmt.pdf ([ldquo][T]he net carbon impact of fuel treatments is further complicated by the probabilistic nature of wildfire occurrence and the impermanence of post-treatment stand

conditions [hellip] [T]reatment activities produce an immediate carbon emission while future wildfire emissions are uncertain [hellip] Depending on the intensity of treatment, the quantity of carbon removed may be substantial enough to negate gains from avoided wildfire emissions. [hellip] cumulative emissions from fuels reduction activities repeated in order to maintain low hazard conditions over time can overwhelm avoided wildfire emissions, resulting in a net carbon loss.[rdquo])

* Dina Fine Maron 2010. FORESTS: Researchers find carbon offsets aren't justified for removing understory (E&E Report 08/19/2010, reporting on the WESTCARB Project) https://pacificforest.org/pft-in-the-media-2010-climatewire-8-19-10.html. ([ldquo][rsquo]The take-home message is we could not find a greenhouse gas benefit from treating forests to reduce the risk of fire,[rsquo] said John Kadyszewski, the principal investigator for the terrestrial sequestration projects of the West Coast Regional Carbon Sequestration Partnership. WESTCARB, ... Since there is a relatively low risk of fire at any one site, large areas need to be treated -- which release their own emissions in the treatment process. The researchers have concluded that the expected emissions from treatments to reduce fire risk exceed the projected emissions benefits of treatment for individual projects.[rdquo])

* Rachel A. Loehman, Elizabeth Reinhardt, Karin L. Riley 2014. Wildland fire emissions, carbon, and climate: Seeing the forest and the trees [ndash] A cross-scale assessment of wildfire and carbon dynamics in fire-prone, forested ecosystems. Forest Ecology and Management 317 (2014) 9[ndash]19. http://www.fs.fed.us/rm/pubs_other/rmrs_2014_loehman_r001.pdf ([ldquo][hellip] management of carbon in fire-prone and fire-adapted forests is more complex than simply minimizing wildfire carbon emissions and maximizing stored carbon in individual stands. The stochastic and variable nature of fires, the relatively fine scale over which fuels treatments are implemented, and potentially high carbon costs to implement them suggest that fuel treatments are not an effective method for protecting carbon stocks at a stand level (Reinhardt et al., 2008; Reinhardt and Holsinger, 2010).[rdquo])

* Jim Cathcart, Alan A. Ager, Andrew McMahan, Mark Finney, and Brian Watt 2009. Carbon Benefits from Fuel Treatments. USDA Forest Service Proceedings RMRS-P-61. 2010.

* Chiono, L. A., D. L. Fry, B. M. Collins, A. H. Chatfield, and S. L. Stephens. 2017. Landscape-scale fuel treatment and wildfire impacts on carbon stocks and fire hazard in California spotted owl habitat. Ecosphere 8(1):e01648. 10.1002/ecs2.1648. http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1648/full ([ldquo]We used a probabilistic framework of wildfire occurrence to (1) estimate the potential for fuel treatments to reduce fire risk and hazard across the landscape and within protected California spotted owl (Strix occidentalis occidentalis) habitat and (2) evaluate the consequences of treatments with respect to terrestrial C stocks and burning emissions. Silvicultural and prescribed fire treatments were simulated on 20% of a northern Sierra Nevada landscape in three treatment scenarios [hellip] [A]ll treatment scenarios resulted in higher C emissions than the no-treatment scenarios.[rdquo])

*

Stenzel, J. E., Berardi, D. B., Walsh, E. S., & Hudiburg, T. W. (2021). Restoration thinning in a drought-prone Idaho forest creates a persistent carbon deficit. Journal of Geophysical Research: Biogeosciences, 126, e2020JG005815. https://doi.org/10.1029/2020JG005815 ([ldquo]Forest thinning in a young ponderosa pine plantation resulted in observed and modeled decreases in ecosystem and forest sector carbon storage over unmanaged control plots through the year 2050. Despite increased tree-level production and water use in a location characterized by growing season drought stress, this study affirms inherent site tradeoffs between individual tree vigor and stand carbon storage over time. We estimate that thinned plot carbon stocks will return to prethinned levels by 2035 (Figure 6), but forest sector carbon parity (Mitchell et al., 2012) with untreated plots will not occur by 2050 and therefore represents a relative carbon source to the atmosphere in the absence of disturbance. [hellip][A] carbon deficit relative to control remained due to the removal of [sim]40% of live ecosystem carbon as well as the subsequent release of [sim]60% of removed biomass by 2050. Despite the continued storage of a portion of removed biomass in long-lived wood products, large immediate and short-term emissions were associated with slash combustion, on-site decomposition, and short-term product chain emissions (i.e., waste and paper), and do not represent avoided emissions through 2050. A multidecadal ecosystem biomass (i.e., carbon) deficit following moderate and heavy partial harvest is supported by most analyses of mid to long-term thinning structural impacts (James et al., 2018; Zhou et al., 2013), [hellip][rdquo]).

Mitchell, Harmon, O'Connell. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. 19(3), 2009, pp. 643[ndash]655 http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_mitchell001.pdf

ABSTRACT:... Our simulations indicate that fuel reduction treatments in these ecosystems consistently reduced fire severity. However, reducing the fraction by which C is lost in a wildfire requires the removal of a much greater amount of C, since most of the C stored in forest biomass (stem wood, branches, coarse woody debris) remains unconsumed even by high-severity wildfires. For this reason, all of the fuel reduction treatments simulated for the west Cascades and Coast Range ecosystems as well as most of the treatments simulated for the east Cascades resulted in a reduced mean stand C storage. One suggested method of compensating for such losses in C storage is to utilize C harvested in fuel reduction treatments as biofuels. Our analysis indicates that this will not be an effective strategy in the west Cascades and Coast Range over the next 100 years. We suggest that forest management plans aimed solely at ameliorating increases in atmospheric CO2 should forego fuel reduction treatments in these ecosystems, with the possible exception of some east Cascades Ponderosa pine stands with uncharacteristic levels of understory fuel accumulation. Balancing a demand for maximal landscape C storage with the demand for reduced wildfire severity will likely require treatments to be applied strategically throughout the landscape rather than indiscriminately treating all stands.

Notes on Mitchell & Harmon:

1. The authors assumed that fire severity was determined exclusively by fuel variables but not weather. This may over-estimate the efficacy of fuel treatments on fire severity. The conclusion that fuel manipulation leads to reduced fire behavior may be an unavoidable result of the assumptions, rather than a reflection of reality.
2. The only treatment that showed some promise was understory removal (not canopy removal) in fire-suppressed dry pine stands, but the carbon storage benefit from reduced fire severity in this best case scenario was minuscule, only about 0.6-1.2%. The modeled treatments on the eastside of the Cascades failed to include canopy removal which is a common practice in fuel reduction efforts and one that removes more carbon than understory treatments.

This latter point is reinforced by Matt Hurteau (2015 blog post)

[hellip] we found that the treatments that included only burning or only thinning small trees recaptured the carbon that was lost from treatment in ten years. The treatment that included thinning small trees and burning still had less carbon than it did initially, indicating that we need to keep some more medium-sized trees. The treatments that harvested big trees still have a carbon debt from treatment. This work provides additional evidence that we can restore these fire-prone forests without having too big an impact on the climate, as long as the trees keep growing.

New Paper - The Carbon Balance of Reducing Wildfire Risk 10-years After Treatment. 8/3/2015. http://www.hurteaulab.org/blog/new-paper-the-carbon-balance-of-reducing-wildfire-risk-10-years-after-treatment. See also, Wiechmann, ML, MD Hurteau, MP North, GW Koch, L Jerabkova. 2015. The carbon balance of reducing wildfire risk and restoring process: an analysis of 10-year post-treatment carbon dynamics in a mixed-conifer forest. Climatic Change, 132:709-719.

https://www.fs.fed.us/psw/publications/north/psw_2015_north002_wiechmann.pdf ("Retaining additional midsized trees may reduce the carbon impacts of understory thinning and burning.")

Similar results were found at the stand scale by Reinhardt and Holsinger (2010):

We simulated effects of fuel treatments on 140 stands representing seven major habitat type groups of the northern Rocky Mountains using the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS). Changes in forest carbon due to mechanical fuel treatment (thinning from below to reduce ladder fuels) and prescribed fire were explored, as well as changes in expected fire behavior and effects of subsequent wildfire. Results indicated that fuel treatments decreased fire severity and crown fire occurrence and reduced subsequent wildfire emissions, but did not increase post-wildfire carbon stored on-site. Conversely, untreated stands had greater wildfire emissions but stored more carbon. [hellip] The results do not support the use of fuel treatments soley to protect carbon stocks or reduce emissions. Although wildfire emissions were reduced by fuel treatments, the fuel treatments themselves produced emissions, and the untreated stands stored more carbon than the untreated stands even after wildfire. [and even considering carbon stored in wood products derived from treated stands.]

Reinhardt, Elizabeth, and Lisa Holsinger 2010. Effects of fuel treatments on carbon-disturbance relationships in forests of the northern Rocky Mountains. Forest Ecology and Management 259 (2010) 1427[ndash]1435.

And by Campbell, Harmon & Mitchell 2011.

Abstract

It has been suggested that thinning trees and other fuel-reduction practices aimed at reducing the probability of high-severity forest fire are consistent with efforts to keep carbon (C) sequestered in terrestrial pools, and that such practices should therefore be rewarded rather than penalized in C-accounting schemes. By evaluating how fuel treatments, wildfire, and their interactions affect forest C stocks across a wide range of spatial and temporal scales, we conclude that this is extremely unlikely. Our review reveals high C losses associated with fuel treatment, only modest differences in the combustive losses associated with high-severity fire and the low-severity fire that fuel treatment is meant to encourage, and a low likelihood that treated forests will be exposed to fire. Although fuel-reduction treatments may be necessary to restore historical functionality to firesuppressed ecosystems, we found little credible evidence that such efforts have the added benefit of increasing terrestrial C stocks.

...

In a nutshell:

[bull] Carbon (C) losses incurred with fuel removal generally exceed what is protected from combustion should the treated area burn

[bull] Even among fire-prone forests, one must treat about ten locations to influence future fire behavior in a single location

[bull] Over multiple fire cycles, forests that burn less often store more C than forests that burn more often

[bull] Only when treatments change the equilibrium between growth and mortality can they alter long-term C storage

[hellip]

Conclusions

Across a range of treatment intensities, the amount of C removed in treatment was typically three times that saved by altering fire behavior.

[hellip]

the protection of one hectare of forest from wildfire required the treatment of 10 hectares, owing not to the low efficacy of treatment but rather to the rarity of severe wildfire event.

[hellip]

Long-term simulations of forest growth, decomposition, and combustion illustrate how, despite a negative feedback between fire frequency and fuel-driven severity, a regime of low-frequency, high-severity fire stores more C over time than a regime of high-frequency, low-severity fire.

John L Campbell, Mark E Harmon, and Stephen R Mitchell. 2011. Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions? Front Ecol Environ 2011; doi:10.1890/110057http://forestpolicypub.com/wp-content/uploads/2011/12/campbell-2011.pdf It is important to recognize that [ldquo]the equilibrium between growth and mortality[rdquo] must consider all forms of mortality, not just that caused by fire, but also mortality caused by logging.

Restaino & Peterson (2013) conducted a literature review of this issue and reported:

[ldquo]All studies agree unequivocally that untreated stands release more emissions to the atmosphere during wildfire than treated stands[hellip]. However, most studies in this review include assumptions of future wildfire frequency and probability that skew long-term trade-off analyses by overestimating the ability of fuel treatments to reduce wildfire emissions over long time scales. For example, fuel treatments have a finite life expectancy, and fire hazard increases over time as fuels accumulate in treated areas. Repetition and maintenance of fuel treatments are necessary in order to effectively maintain reduced fire hazard over time (Peterson et al., 2005; Johnson et al., 2007, 2011) and thus must be included in analyses of long-term C storage. Although Rhodes and Baker (2008) suggest that 2.0[ndash]4.2% of areas treated to reduce surface fuels are likely to encounter wildfires that would otherwise be high or moderate-high severity without treatment, most studies assume future wildfire probability of 100%, reporting inferences that essentially detail a [lsquo][lsquo]best-case scenario[rsquo][rsquo] for wildfire missions mitigation. Annual probability of wildfire in dry temperate forests for a given stand is approximately 1% (Ager et al., 2010; Pearson et al., 2010; Campbell et al., 2011). [hellip] To benefit total ecosystem C storage, the removal and release of C through fuel treatments must not exceed the expected reductions in wildfire emissions. Substantial treatment costs through timber harvest, prescribed fire, and milling waste exceed observed and simulated reductions in wildfire emissions. [hellip] The ability of fuel treatments to mitigate future fire behavior and move forest structure to a more fire-resistant condition is well documented. However, C costs associated with fuel treatments have can exceed the magnitude of C reduction in wildfire emissions, because a large percentage of biomass stored in forests (i.e., stem wood, branches, coarse woody debris) remains unconsumed, even in high-severity fires (Campbell et al., 2007; Mitchell et al., 2009). [hellip] Wildfire occurrence in a given area is uncertain and may never interact with treated stands with reduced

fire hazard, ostensibly negating expected C benefits from fuel treatments. Burn probabilities in treated stands in southern Oregon are less than 2%, so the probability that a treated stand encounters wildfire and creates C benefits is low (Ager et al., 2010).)

Restaino, Joseph C.; Peterson, David L. 2013. Wildfire and fuel treatment effects on forest carbon dynamics in the western United States. Forest Ecology and Management 303:46-60. http://www.fs.fed.us/pnw/pubs/journals/pnw_2013_restiano001.pdf. Keep in mind that even if climate change increases fire frequency, it might not make a big difference, because fire frequency is low and multiple of small numbers are still small numbers. The peer review of the NWFP Science Synthesis (p 63) says:

Use caution with this argument about increasing fire activity being specially important on the wetter side of the study area. We hear this claim (even in a few scientific papers) that the % increase in fire frequency could be highest on the west side compared to the east side. But remember, we are dealing with exceedingly low burn probabilities on the west side as it is [ndash] e.g., fire rotations of 300-800 years so annual burn probabilities of 0.0033 to 0.0013. So an X% increase in fire probability on the west side amounts to multiplying a very small number which will still yield a very small number. Arguably, an X% increase in burn probabilities is more important on the east side because the higher current fire probabilities mean greater increases in actual burn acreage.

Ecological Society of America. 7 April 2017. Peer review of the NWFP Science Synthesis. https://www.fs.fed.us/pnw/research/science-synthesis/ESA%20Peer%20review%20nwfp%20synthesis%20final%20all.pdf.

Lindsay Chiono (2011) of the Wildland Fire Science Laboratory at UC Berkeley prepared a synthesis of the research for resource managers and said:

[T]he net carbon impact of fuel treatments is further complicated by the probabilistic nature of wildfire occurrence and the impermanence of post-treatment stand conditions [hellip] [T]reatment activities produce an immediate carbon emission while future wildfire emissions are uncertain [hellip] Depending on the intensity of treatment, the quantity of carbon removed may be substantial enough to negate gains from avoided wildfire emissions. East of the Cascade crest in Oregon, a modeling study of carbon dynamics that included modeled wildfires found that while understory removal treatments slightly enhanced carbon storage over the long term, higher levels of biomass removal reduced mean ecosystem carbon (Mitchell et al., 2009).[rdquo] [hellip] [W]hen treatments must be repeated in the interim between wildfires in order to maintain low hazard conditions. Similarly, when wildfire frequency is low, the quantity of carbon removed in treatments over time can overwhelm likely wildfire losses. Net emissions were most pronounced in the west Cascades where historical fire return intervals were very long[hellip] [I]n southern Oregon and northern California, Goslee and others (2010) took an approach that incorporates the stochastic nature of wildfire occurrence. Rather than scheduling a wildfire event soon after fuel treatment, a calculation that maximizes treatment benefits, they used an estimate of the local fire return interval for the period of 2001 to 2008 -- an annual burn probability of 0.6% -- to assess carbon emissions. Partly owing to this low wildfire risk, they found that fuel treatments, which included commercial timber harvest and pile burning of noncommercial biomass, produced an effective immediate net emission of 10-20.8 tons of carbon per acre. [hellip] [S]ome general principles have begun to emerge. Achieving a net carbon gain appears more likely when the quantity of carbon removed during treatment is minimized, when harvested biomass is converted to long-lived wood products, and where the risk of wildfire occurrence is high[hellip] Conversely, cumulative emissions from fuels reduction activities repeated in order to maintain low hazard conditions over time can overwhelm avoided wildfire emissions, resulting in a net carbon loss.

Chiono, Lindsay 2011. Balancing the Carbon Costs and Benefits of Fuels Management. Research Synthesis for

Resource Managers. Joint Fire Science Program Knowledge Exchange. https://static.squarespace.com/static/50083efce4b0c6fedbca9def/t/51632bf8e4b00b25a8fa21d3/1365453816037/CFSC_Chiono_Carbon_and_Fuel_Mngmt.pdf

Even the Chief of the Forest Service recognizes these trade-offs. [ldquo][M]anagement practices, designed to restore ecosystem health, may in the near-term reduce total stored carbon below current levels.[rdquo] Gail Kimball, March 2009 Testimony before House Committee On Natural Resources, Subcommittee On National Parks, Forests, And Public Lands. http://www.fs.fed.us/congress/111thCongress/Documents/CY%202009%20Hearings/HNRC%202009-03-03%20Climate%20Change/2009-03-03A.Kimbell.pdf.

Strategies for reducing carbon dioxide emissions include substitution of fossil fuel with bioenergy from forests, where carbon emitted is expected to be recaptured in the growth of new biomass to achieve zero net emissions, and forest thinning to reduce wildfire emissions3. Here, we use forest inventory data to show that fire prevention measures and large-scale bioenergy harvest in US West Coast forests

lead to 2[ndash]14% (46[ndash]405 Tg C) higher emissions compared with current management practices over the next 20 years.

[hellip]

In our study region, we found that thinning reduced NBP under all three treatment scenarios for 13 of the 19 ecoregions, representing 90% of the region[rsquo]s forest area. The exceptions where NBP was not reduced were primarily due to high initial fire emissions compared to NEP (for example, Northern Basin and North Cascades; Supplementary Fig. S2). The dominant trend at the ecoregion level was mirrored at the regional level, with the bioenergy production scenario (highest thinning level) resulting in the region becoming a net carbon source (Supplementary Table S2 and discussion of state-level estimates). Regionally, forest biomass removals exceeded the potential losses from forest fires, reducing the in situ forest carbon sink even after accounting for regrowth, as found in previous studies with different approaches or areas of inference8,18. Because we have assumed high reductions in fire emissions for the areas treated in each scenario, it is unlikely we are underestimating the benefit of preventive thinning on NBP.

Tara W. Hudiburg, Beverly E. Law, Christian Wirth, and Sebastiaan Luyssaert. 2011. Regional carbon dioxide implications of forest bioenergy production. Nature - Climate Change. Letters. 23 OCTOBER 2011 | DOI: 10.1038/NCLIMATE1264. http://www.dnr.wa.gov/Publications/em_fp_biomass_regional_carbon_dioxide_implications_of_forest_bioenergy_production.pdf

Recent studies (Hurteau and North, 2008, 2010; Hurteau et al., 2008a; North et al., 2009; Reinhardt and Holsinger, 2010) have focused on carbon responses to fire in individual forest stands as a basis for gaining insight into terrestrial-atmospheric carbon fluxes. Suggested management treatments to protect, maintain, or enhance forest carbon stocks forest carbon stores include mechanical fuels treatments, prescribed fire, and suppression of wildfires (Canadell and Raupach, 2008; Hurteau and North, 2008, 2010; Hurteau et al., 2008b; McKinley et al., 2011; Stephens et al., 2012). Results from these studies suggest that fuel treatments can reduce wildfire severity and protect forest carbon stocks from future loss from severe wildfires (Hurteau and North, 2008;

Hurteau et al., 2008b; Stephens et al., 2009b), but management of carbon in fire-prone and fire-adapted forests is more complex than simply minimizing wildfire carbon emissions and maximizing stored carbon in individual stands. The stochastic and variable nature of fires, the relatively fine scale over which fuels treatments are implemented, and potentially high carbon costs to implement them suggest that fuel treatments are not an effective method for protecting carbon stocks at a stand level (Reinhardt et al., 2008; Reinhardt and Holsinger, 2010).

Rachel A. Loehman, Elizabeth Reinhardt, Karin L. Riley 2014. Wildland fire emissions, carbon, and climate: Seeing the forest and the trees [ndash] A cross-scale assessment of wildfire and carbon dynamics in fire-prone, forested ecosystems. Forest Ecology and Management 317 (2014) 9[ndash]19.
http://www.fs.fed.us/rm/pubs_other/rmrs_2014_loehman_r001.pdf

North and Hurteau (2009) note that the carbon costs of fuel reduction may be mitigated by focusing on small fuels -

When evaluating carbon released by different fuels treatments, managers will need to weigh tradeoffs between immediate prescribed burn emissions, increased fuel reduction with thinning and an increase in milling waste, and potential future wildfire emissions. [hellip] Previous Teakettle studies (Innes et al. 2006, North et al. 2007, Hurteau and North 2009) coupled with this research suggest treatments could be modified to more effectively minimize carbon stock reductions while still significantly reducing fuels and promoting large tree development. Significant increases in wildfire resistance can be achieved by thinning only smaller ladder fuels and fire-sensitive intermediate trees without reducing the majority of the live-tree carbon pool in intermediate pines and large trees of all species. [hellip] Thinning and prescribed fire treatments that reduce small tree densities may influence stand development by redirecting growth resources and carbon storage into more stable stocks such as large, long-lived fire-resistant pines (Hurteau and North 2009). [hellip] Our research suggests most of the benefits of increased stand-level fire resistance can be achieved with small reductions in carbon pools.

North, Hurteau, Innes. 2009. Fire suppression and fuels treatment effects on mixed-conifer carbon stocks and emissions. Ecological Applications, 19(6), 2009, pp. 1385[ndash]1396.
http://www.plantsciences.ucdavis.edu/affiliates/north/Publications/Eco%20Apps%20article%20North%20et%20al%20Fuel%20treatments%20forest%20carbon.pdf

The NEPA analysis should also recognize that as the climate warms, fire occurrence becomes more decoupled from fuel conditions. There is almost always enough fuel to carry fire. The agency can never remove so much fuel as to [ldquo]prevent[rdquo] fire, while climate conditions will become more conducive to fire (e.g. longer fire season) regardless of fuel conditions.

Avoid [ldquo]before-and-after[rdquo] carbon accounting

The YRR DEIS analysis of climate change and GHG emissions says [ldquo][C]arbon emissions during the implementation of the proposed action would have only a momentary influence on atmospheric carbon concentrations, because carbon would be removed from the atmosphere with time as the forest regrows, further minimizing or mitigating any potential cumulative effects. [hellip] [A]ny initial carbon emissions from this proposed action would be balanced and possibly eliminated as the stand recovers and regenerates[hellip][rdquo] (DEIS p 281-282). This is misleading and incorrect. Climate effects need to be compared among alternatives, including no action, that is, GHG emissions with the project compared to without the project, NOT comparing GHG emissions in two time periods. Such an analysis will show that carbon emissions from logging will causes warming during the period when extra CO2 is in the atmosphere and that warming will not be mitigated after the forest regrows, because the unlogged forest continued to grow and absorb carbon and reduce climate effects during the entire period that the logged forest is trying (and failing) to [ldquo]catch up[rdquo] with the unlogged forest. Furthermore, CO2 has a very long residence time in the atmosphere.

NEPA analyses say that logging is minimal or carbon neutral because the forest captures and stores the same pre-harvest amount of carbon after a period of regrowth. This is highly misleading. The proper analysis requires comparison of the amount of carbon with the project and without the project, not before and after logging. This is not only required to accurately determine the effect of vegetation removal on forest carbon storage but it is also consistent with NEPA requirements to compare action and no action alternatives.

Comparing carbon in the system at two points in time is unscientific. A proper analysis requires measuring carbon in the system of interest over time compared to a reference or control.

The approach shown above is improper. As explained by Mark Harmon:

All too often explanations of forest carbon dynamics are not science-based. Why? They involve using the system as its own reference or control. That is not a scientific assessment method. So while it sounds scientific to explain how after a harvest the forest regrows and hence there is no carbon impact, one cannot tell the impact. We can tell over time that the amount returns to the original level, but we still cannot assess the impact scientifically. The fact the system is renewable and sustainable is largely irrelevant in answering the question of whether the system is carbon neutral.

Mark Harmon 2020. Forest Carbon Basics: Five Key Guidelines, Presentation to Many Rivers Group of the Sierra Club, Banking on Carbon Webinar, Oct 13, 2020.

A better approach is shown below, and explained by Mark Harmon:

Here is an example in which there is an independent control or alternative. We can see that there is a difference between the two systems and that the so-called renewable, sustainable system stores on average 35% less than the reference. So if we switch from the reference system to the renewable, sustainable system we must lose carbon from that part of the system.

NEPA requires comparison of alternatives based on high quality information and accurate scientific analysis, which requires evaluating the carbon consequences of different forest management systems and comparing that to the carbon consequences of not logging.

Similarly, Cardellichio et al (2010) explain:

The only way to properly evaluate the net carbon impacts of energy from forest biomass [or any vegetation management] is to estimate [hellip] net change in atmospheric CO2 levels over time with and without the harvest of wood biomass for energy. [hellip][I]t is necessary to construct a baseline, or control, scenario (that is no biomass harvest). [hellip] Once a baseline is established, one can assess how switching to wood biomass would change atmospheric carbon levels. [hellip] [T]he information provided by only comparing forest carbon stocks before and after biomass harvest could be a very misleading indicator of the impact of biomass energy on the atmosphere.

Cardellichio, P., Walker, T. 2010. Commentary: The Manomet Study Got the Biomass Carbon Accounting Right. The Forestry Source. 4 Nov 2010. https://web.archive.org/web/20110420145203/http://www.nxtbook.com:80/nxtbooks/saf/forestrysource_201011/index.php.

Even a before-after ecological study design should employ a control. See Krebs, C. J. 1999. Ecological methodology. Second edition. Addison Wesley Longman Inc, Menlo Park, California, USA.

Any analysis that asserts that carbon uptake via future forest growth will mitigate for GHG emissions caused by logging must carefully account for several factors:

1. The climate impacts of the extra GHG in the atmosphere during the period of regrowth. Logging causes a real and significant transfer of GHG to the atmosphere and those emissions have greenhouse effects that begin immediately and do not subside until the forest has fully regrown (or more accurately reaches climate parity), which might take decades or hundreds of years. A proper NEPA analysis requires accounting for the additional warming caused by extra GHG in the atmosphere during the regrowth period.

2. Future climate benefits from future carbon uptake must be discounted. Under well-established economic principles of uncertainty and discounting, it is clear that the net present value of current carbon storage in existing mature forests exceeds the net present value of distant future benefits of forest regrowth or substitution. This graph shows why the near term matters (most of the warming happens within 20 years and then slowly continues to increase):

3. Near-term carbon storage (and avoided emissions) are far more valuable as a climate solution compared to carbon uptake in the distant future. Near-term climate solutions are critically important while the economy transitions to low carbon technologies, yet it will take over a century for forest regrowth or substitution to off-set the initial carbon debt caused by logging.

The IPCC made a policy decision to place more emphasis on emissions in the near-term because the majority of warming happens within 10-20 years after emissions. The importance avoiding emissions in the near-term highlights the fact that forests are more valuable as places to store carbon and wood products are less valuable. This is because every effort to transfer carbon from the forest into wood products results in a net near-term pulse of carbon to the atmosphere, and this carbon "debt" is not repayed until the distant future when the replacement forest grows (not to the point that it stores the same amount of carbon as before harvest, but rather to a point that recaptures all the carbon PLUS mitigates for the climate impacts caused during the "carbon debt" payback period.) See Katsumasa Tanaka & Brian C. O[rsquo]Neill. 2018. The Paris Agreement zero-emissions goal is not always consistent with the 1.5[thinsp][deg]C and 2[thinsp][deg]C temperature targets. Nature Climate Change (2018) doi:10.1038/s41558-018-0097-x.https://www.nature.com/articles/s41558-018-0097-x#Abs1, and see Brack, Duncan 2017. Woody Biomass for Power and Heat: Impacts on the Global Climate. Chatham House. https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2017-02-23-woody-biomass-global-climate-brack-embargoed.pdf.

Dead Trees Store Carbon Too

The DEIS analysis of climate change and GHG emissions says [ldquo]In the absence of commercial thinning, the forest where this proposed action would take place would thin naturally from mortality-inducing natural disturbances and other processes resulting in dead trees

that would decay over time, emitting carbon to the atmosphere. Conversely, the wood and fiber

removed from the forest in this proposed action would be transferred to the wood products sector [hellip][rdquo] (DEIS p 282). This is misleading. The NEPA analysis must avoid any implication that dead trees emit carbon while wood products store carbon.

[ldquo]Longevity of carbon stocks determines the degree of climate benefit. ... [T]he dead wood generated by fire is longer-lived than 95% of wood products.[rdquo] INTACT Factsheet: Primary Temperate Forests Harbor Unique Biodiversity And Ecosystem Services, Including Climate Regulation. International Action for Primary Forests. https://primaryforest.org/fact-sheets/

Dr. John Campbell provided comments on a draft California Forest Carbon Plan, saying:

[hellip] the document need also rectify a persistent mischaracterization of dead trees as solely a source of carbon emissions compromising the capacity of California forests to function as net sinks. So long as mortality outpaces decay, which appears to be the case for many California forests today, dead trees collectively represent an aggrading carbon pool, not a shrinking one; just like that regularly claimed to occur in products made from wood thinned from forests. Moreover, there is no evidence I am aware of that trees surviving pulses of natural mortality pulses do not experience compensatory growth in the same manner in which trees surviving selective harvest are regularly claimed to. [hellip] As currently written, the CFCP is peppered with claims that dead trees are driving California forests into a net sink (pages 1, 49, 59, 62, 75), but nowhere is this miss-calculation so glaring than in Tables 12 and 13 where forest carbon balance is compared across ownership classes. In this otherwise informative section, net forest carbon stores are calculated as growth minus mortality minus harvest when net forest carbon stores are, by definition, growth minus decomposition of dead trees minus harvest. Simply put, the sequestration of carbon in forests is defined by stocks, not fluxes, and dead trees are carbon stocks which function to keep carbon away from the atmosphere regardless of the fact that they are releasing it. The

CFCP[rsquo]s dogmatic obsession with minimizing natural mortality, dismissing dead trees as a carbon loss, and building markets to afford their salvage runs counter to its stated objective of thinning forests, returning natural disturbance to the ecosystem, and building carbon stocks on the landscape.

Campbell, J.L. 2017, Comments on the Jan 2017 draft California Forest Carbon Plan. http://www.fire.ca.gov/fcat/downloads/FCAT_PublicComment/Campbell_CFCP_Review_Final-2nd.pdf.

The Carbon Value of Wood Products is Over-estimated.
The DEIS analysis of climate change and GHG emissions says [ldquo]Carbon can be stored in

wood products for a variable length of time, depending on the commodity produced. ... In addition, a substitution effect occurs when wood products are used in place of other products that emit more GHGs in manufacturing, such as concrete and steel (Gustavasson et al. 2006, Lippke et al. 2011, and McKinley et al. 2011). In fact, removing carbon from forests for human use can result in a lower net contribution of GHGs to the atmosphere than if the forest were not managed (McKinley et al. 2011, Bergman et al. 2014, and Skog et al. 2014)[rdquo] (DEIS pp 282-283). This is inaccurate and misleading.

From a climate perspective, wood products represent net carbon emissions, NOT net carbon sequestration, because only a small fraction of the carbon in a logged forest ends up in wood products. Logging to create wood products causes the majority of forest carbon to be transferred to the atmosphere, not to wood products. Science clearly shows that carbon is more safely stored in forests, not in wood products.

More than 200 scientists recently wrote to Congress saying [ndash]

We find no scientific evidence to support increased logging to store more carbon in wood products, such as dimensional lumber or cross-laminated timber (CLT) for tall buildings, as a natural climate solution. The growing consensus of scientific findings is that, to effectively mitigate the worst impacts of climate change, we must not only move beyond fossil fuel consumption but must also substantially increase protection of our native forests in order to absorb more CO2 from the atmosphere and store more, not less, carbon in our forests (Depro et al. 2008, Harris et al. 2016, Woodwell 2016, Erb et al. 2018, IPCC 2018, Law et al. 2018, Harmon 2019, Moomaw et al. 2019).

Over 200 Top U.S. Climate and Forest Scientists Urge Congress: Protect Forests to Mitigate Climate Crisis, May 13, 2020. https://johnmuirproject.org/wp-content/uploads/2020/05/200TopClimateScientistCongressProtectForestsForCimateChange13May20.pdf.

Some argue that wood products are a good place to store carbon. This is a counter-productive climate strategy, because [ndash]

Only a small fraction of carbon from logged forests ends up in long-term storage in wood products, most is transferred to the atmosphere. Of all the carbon that is killed and/or exposed to accelerated decay in a logging operation only a small fraction ends up as durable goods and buildings -- most ends up as slash, sawdust, waste/trim, hog fuel, and non-durable goods like paper. Some say that converting forest to wood products "delays" emissions, but in fact logging accelerates emissions because they are the result of a process that kills trees that would continue to actively sequester carbon if not logged, and logging involves tremendous waste in the logging process, milling process, construction/manufacturing process.

OFRI says [ldquo]in 2013. Of the [log] volume delivered to sawmills, 49.4% became finished lumber or other sawn products and 48% became mill residues[hellip][rdquo] Kuusela, Rossi et al 2019. Forest Resources And Markets: Trends And Economic Impacts. The 2019 Forest Report. OFRI. https://theforestreport.org/wp-content/uploads/2019/07/OFRI-2019-Forest-Sector-Economic-Report-Web.pdf. There are additional losses throughout the wood products supply chain, resulting in logging waste, milling waste, plus GHG emissions from processing and transportation.

Carbon remains stored much longer in forests than in wood products. Much of the wood products which can reasonably be considered "durable" are in fact less durable than leaving the carbon stored safely inside a mature tree that might live to be hundreds of years old. Most of our wood products are disposable. It turns out that well-conserved forests on average store carbon more securely than our [ldquo]throw-away[rdquo] culture and economy does. Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf ([ldquo]To the extent that management can direct carbon into longer lived pools, it can increase the stores of carbon in the forest sector. Harvest of carbon is one proposed strategy to increase carbon stores. However, harvesting carbon will increase the losses from the forest itself and to increase the overall forest sector carbon store, the lifespan of wood products carbon (including manufacturing losses) would have to exceed that of the forest. Under current practices this is unlikely to be the case. A substantial fraction (25[ndash]65%) of harvested carbon is lost to the atmosphere during manufacturing and construction depending on the product type and manufacturing method. The average lifespan of wood buildings is 80 years in the USA, which is determined as the time at which half the wood is no longer in use and either decomposes, burns or, to a lesser extent, is recycled. However, many forest trees have the potential to live hundreds of years (e.g. 800 years in the Pacific northwest USA). Mortality rates of trees are generally low, averaging less than 2% of live mass per year in mature and old forests; for example, in Oregon, mortality rates average 0.35[ndash]1.25% in forests that are older than 200 years in the Coast Range and Blue Mountains, respectively [8]. Moreover, the average longevity of dead wood and soil carbon is comparable to that of live trees. When the loss of carbon associated with wood products manufacturing is factored in, it is highly unlikely that harvesting carbon and placing it into wood products will increase carbon stores in the overall forest sector. This explains why in all analyses conducted to date, wood products stores never form the majority of total forest sector stores.[rdquo])

[ldquo]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).[rdquo] Law, B. 2021. Response to Questions for the Record, attached to 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 [ldquo]WILDFIRE IN A WARMING WORLD: OPPORTUNITIES TO IMPROVE COMMUNITY COLLABORATION, CLIMATE RESILIENCE, AND WORKFORCE CAPACITY[rdquo] https://naturalresources.house.gov/imo/media/doc/Law,%20Beverly%20-%20Testimony%20-%20NPFPL%20Ov%20Hrg%2004.29.21.pdf (link to Statement, without Response to Questions) citing Hudiburg, T.W, B.E. Law, W.R. Moomaw, M.E. Harmon, J.E. Stenzel. 2019. Meeting GHG reduction targets requires accounting for all forest sector emissions. Env. Res. Lett. 14: 095005. https://iopscience.iop.org/article/10.1088/1748-9326/ab28bb/pdf.

Reliance on wood products prevents forests from reaching their potential for carbon storage. Shanks (2008) said [ldquo]There are also losses of carbon that occur during the creation of forest products. These losses to decay and wood products make carbon sequestration slower when harvesting is allowed. The young timberlands that replace older harvested lands grow quickly, but hold less in total carbon stores than their older counterparts; the net sequestration from forest products adds to total carbon stores, but does not come close to the vast amounts of carbon stored in non-harvested older timberlands. This finding differs from other papers that have shown that the highest carbon mitigation can be reached when high productivity lands are used exclusively for wood products creation (Marland and Marland, 1992). The wood products considered in these studies were either long lasting or used for fuel purposes. Allowing harvested timber to be allocated to all types of wood products increases carbon emissions and results in no harvest regimes sequestering more carbon.[rdquo] Alyssa V. Shanks. 2008. Carbon Flux Patterns on U.S. Public Timberlands Under Alternative Timber Harvest Policies. MS Thesis. March 2008. http://ir.library.oregonstate.edu/dspace/bitstream/1957/8326/1/A_Shanks_Thesis_04%2002%2008_final.pdf.

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.

[hellip]

[W]estern 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, [hellip]

Law, B. 2021. Response to Questions for the Record, attached to 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 [ldquo]WILDFIRE IN A WARMING WORLD: OPPORTUNITIES TO IMPROVE COMMUNITY COLLABORATION,

CLIMATE RESILIENCE, AND WORKFORCE CAPACITY[rdquo] https://naturalresources.house.gov/imo/media/doc/Law,%20Beverly%20-%20Testimony%20-%20NPFPL%20Ov%20Hrg%2004.29.21.pdf (link to Statement, without Response to Questions).

[ldquo][W]ood product usage is reducing the potential annual sink by an average of 21%, suggesting forest carbon storage can become more effective in climate mitigation through reduction in harvest, longer rotations, or more efficient wood product usage. ... Allowing forests to reach their biological potential for growth and sequestration, maintaining large trees (Lutz et al 2018), ... will remove additional CO2 from the atmosphere. Global vegetation stores of carbon are 50% of their potential including western forests because of harvest activities (Erb et al 2017). Clearly, western forests could do more to address climate change through carbon sequestration if allowed to grow longer.[rdquo] Tara W Hudiburg, Beverly E Law, William R Moomaw, Mark E Harmon and Jeffrey E Stenzel 2019. Meeting GHG reduction targets requires accounting for all forest sector emissions. 23 August 2019. Environmental Research Letters, Volume 14, Number 9. https://iopscience.iop.org/article/10.1088/1748-9326/ab28bb/pdf.

Diaz et al (2018) showed that Washington's forest practice rules are better for the climate than Oregon[rsquo]s forest practice rules, in part because Washington requires greater riparian retention. This study accounted for the total carbon stored both in the forest and in wood products. Riparian retention does nothing more than allow trees to grow and accumulate more carbon. If some retention is good for the climate, more retention is better, and 100% retention is best. Diaz, D.D.; Loreno, S.; Ettl, G.J.; Davies, B. 2018. Tradeoffs in Timber, Carbon, and Cash Flow under Alternative Management Systems for Douglas-Fir in the Pacific Northwest. Forests 2018 9, 447. https://www.mdpi.com/1999-4907/9/8/447, https://www.sierraclub.org/sites/www.sierraclub.org/files/program/documents/Ecotrust%20FSC%20v%20BAU%20forestry%20study.pdf. ([ldquo]In general, policies encouraging or incentivizing increased riparian protections, green tree retention, or the extension of rotation ages are likely to translate into greater carbon storage. [hellip] Both green tree retention and greater RMZ protections are likely to correspond to other additional values including water quality and habitat for fish and wildlife that are not quantified here. [hellip] Our work clearly demonstrates that the adoption of certain forest practices including expanded riparian protections, increased green tree retention, and the extension of rotation ages can translate into substantially higher carbon storage than contemporary common practice for Douglas-fir management in the Pacific Northwest.[rdquo]).

The amount of carbon missing from our forests vastly greater than the amount of carbon that can be accounted for in wood products storage. BLM[rsquo]s Western Oregon Plan Revision FEIS shows that decades of converting old growth forests to plantations has reduced current forest carbon stores on BLM lands in western Oregon by 149 million tons, while some of that wood was converted into wood products, only 11 million tons of that carbon remains stored in wood products today, so logging our public forests to make wood products results in approximately 13 times more carbon emissions than carbon storage. This is pieced together from WOPR FEIS Figures 3-17 (p 3-221) and Figure 3-18 (p 3-224). Further logging of mature forests will exacerbate this outcome. See also, Tara W Hudiburg, Beverly E Law, William R Moomaw, Mark E Harmon and Jeffrey E Stenzel 2019. Meeting GHG reduction targets requires accounting for all forest sector emissions. Environmental Research Letters, Volume 14, Number 9. https://iopscience.iop.org/article/10.1088/1748-9326/ab28bb/pdf ([ldquo][hellip] over 100 years of wood product usage is reducing the potential annual sink by an average of 21%, suggesting forest carbon storage can become more effective in climate mitigation through reduction in harvest, longer rotations, or more efficient wood product usage. Of the [sim]10,700 million metric tonnes of carbon dioxide equivalents removed from west coast forests since 1900, 81% of it has been returned to the atmosphere or deposited in landfills.[rdquo])

A lot of wood products are [ldquo]stored[rdquo] in landfills where they emit methane which has a global warming effect much greater than CO2. Ingerson, A. 2009 Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis? Washington, D.C.: The Wilderness Society. http://web.archive.org/web/20100601080813/http://wilderness.org/files/Wood-Products-and-Carbon-Storage.pdf.

([ldquo]Key Points - 1. When wood is removed from the forest, most of it is lost during processing. The amount lost varies tremendously by region, tree species and size, and local infrastructure. 2. The majority of long-term off-site wood carbon storage occurs in landfills, where decomposing wood gives off significant amounts of methane, a gas with high global warming potential. 3. In addition to wood processing losses, fossil fuels are required to turn raw logs into finished products and ship them from forest to mill to construction site to landfill. 4. Once wood losses and fossil emissions are accounted for, the process of harvesting wood and turning it into products may release more greenhouse gases than the emissions saved by storing carbon in products and landfills. [hellip] 9. Properly managed, wood can be a renewable source of building materials and fuels, but solving the climate crisis will require reducing the use of all materials and energy.[rdquo])

Living trees store and accumulate carbon better than dead wood products. Even a suppressed tree stores carbon better than a dead tree after it is logged, limbed, bucked, debarked, milled, planed, processed, trimmed, manufactured, used, and then discarded. Recent evidence shows that slower-growing older trees tend to channel their energy into structural support and defense compounds to [ldquo]maximize durability while minimizing [hellip] damage[rdquo]. Colbert & Pederson. 2008. Relationship between radial growth rates and lifespan within North American tree species. Ecoscience 15(3), 349-357 (2008). http://fate.nmfs.noaa.gov/documents/Publications/Black_et_al_2008_Ecoscience.pdf. See also, University of Montana. June 18, 2019. Cell structure linked to longevity of slow-growing Ponderosa Pines. https://www.sciencedaily.com/releases/2019/06/190618174358.htm ([ldquo]Slow-growing ponderosa pines may have a better chance of surviving longer than fast-growing ones, especially as climate change increases the frequency and intensity of drought, according to new research from the University of Montana. ... [A] key difference between fast and slow growers resides in a microscopic valve-like structure between the cells that transport water in the wood, called the pit membrane. The unique shape of this valve in slow-growing trees provides greater safety against drought, but it slows down water transport, limiting growth rate.[rdquo]) citing Beth Roskilly, Eric Keeling, Sharon Hood, Arnaud Giuggiola, Anna Sala. Conflicting functional effects of xylem pit structure relate to the growth-longevity trade-off in a conifer species. Proceedings of the National Academy of Sciences, 2019; 201900734 DOI: 10.1073/pnas.1900734116.

The [ldquo]substitution[rdquo] value of wood products is vastly over-estimated. Some say that using wood as a building material is better for the climate than using steel and cement because steel and cement are so energy intensive. It is important to recognize that steel and cement may be energy intensive but energy is fungible and can be produced renewably, so these alternative building materials can theoretically be decarbonized, whereas wood is made of carbon and is an integral part of the global carbon cycle. It can never be decarbonized.

The timber industry vastly over-states the alleged climate benefit of storing carbon in wood products or using wood as a substitute for alternative building materials. While wood may be preferable to other materials in some applications and there is a grain of truth in the substitution analysis, the timber industry[rsquo]s efforts to show a [ldquo]substitution[rdquo] benefit from short-rotation forestry is severely flawed. Most of the analyses that tout this effect are produced and advocated by the timber industry with unreasonable assumptions that don[rsquo]t stand up to scrutiny. Note that the mission of the CORRIM group is to promote the use of wood products, not to develop sound forest policy or climate policy. The substitution argument is an example of the timber industry carefully choosing assumptions to guarantee a certain result and then stopping the analysis short of a complete picture of the issue.

Substitution of wood for more fossil carbon intensive building materials has been projected to result in major climate mitigation benefits often exceeding those of the forests themselves. A reexamination of the fundamental assumptions underlying these projections indicates long-term mitigation benefits related to product substitution may have been overestimated 2- to 100-fold. This suggests that while product substitution has limited climate mitigation benefits, to be effective the value and duration of the fossil carbon displacement, the longevity of buildings, and the nature of the forest supplying building materials must be considered. ... Conversion of older, high carbon stores forests to short rotation plantations would over the long term likely lead to more carbon being added to the atmosphere despite some of the harvested carbon being stored and production substitution occurring.

Mark E Harmon 2019. Have product substitution carbon benefits been overestimated? A sensitivity analysis of key assumptions. Environ. Res. Lett. in presshttps://doi.org/10.1088/1748-9326/ab1e95.

The timber industry must not be allowed to continue business-as-usual and call it [ldquo]climate friendly[rdquo] because logging mature & old-growth forests on public lands and short-rotation clear-cutting on private lands are NOT climate friendly. Many in the timber industry like to promote logging as a solution to climate change because (they say) building with wood helps off-set construction using alternative materials such as steel and cement that may release more CO_2 during their manufacture. (See e.g., CORRIM analysis, http://www.corrim.org/reports/2005/swst/140.pdf , http://www.masonbruce.com/wfe/2004Program/1B1_Bruce_Lippke.pdf) Others appropriately promote protection of mature and old-growth forests as more reliable ways to store carbon in forests and long-rotation forestry as the most appropriate way to obtain wood products. It[rsquo]s absurd to conclude that we can continue to destroy our forests to save the climate. Life on earth, especially forests, are the bilge pump that keeps our climate boat afloat.

The benefits of wood product substitution are vastly over-stated:

1) Wood, concrete and steel are not the only building materials. The analysis must consider a wider range of alternatives, including reducing demand for building materials. Or, what if we converted annual plants such as grasses into long-term storage in buildings? Here's an idea: Take a portion of the land devoted to growing subsidized livestock feed and instead grow annual or semi-annual fiber crops that are made into wood substitutes. Unlike wood from trees that could better protect the climate if allowed to grow and store carbon hundreds of years, these alternative fiber products will store carbon far longer than the annual lifecycle of the fiber crops. We can grant legitimate carbon credits to promote their use. Then we can let forests grow and help save the climate.

2) Buildings made of steel and concrete have longer useful lifespans than wood and might outperform wood, over the long term. A credible analysis of substitution must account for factors such as the time it takes to reabsorb the carbon after forests are logged, differences in the useful lifespan of different building materials (steel and cement typically last longer), the improving carbon efficiency of the energy input used to make alternative building materials, the possibility of demand-side policies such as recycling and [ldquo]demand reduction.[rdquo]

3) Like trees, cement abosorbs CO_2 during it[rsquo]s life time. [ldquo][R]esearchers estimate that between 1930

and 2013, cement has soaked up 4.5 gigatons of carbon or more than 16 gigatons of CO2, 43% of the total carbon emitted when limestone was converted to lime in cement kilns.[rdquo] Warren Cornwall 2016. Cement soaks up greenhouse gases. AAAS Science. Nov. 21, 2016. doi:10.1126/science.aal0408https://www.sciencemag.org/news/2016/11/cement-soaks-greenhouse-gasesciting Xi, F., Davis, S., Ciais, P. et al. Substantial global carbon uptake by cement carbonation. Nature Geosci 9, 880[ndash]883 (2016). https://doi.org/10.1038/ngeo2840, https://authors.library.caltech.edu/72406/2/ngeo2840-s1.pdf.

4) Making steel and cement requires energy, but that energy does not need to come from fossil fuels. They can be made with electricity which is becoming increasingly renewable. Ellis et al 2019. Toward electrochemical synthesis of cement[mdash]An electrolyzer-based process for decarbonating CaCO3 while producing useful gas streams. PNAS September 16, 2019 https://doi.org/10.1073/pnas.1821673116. https://www.pnas.org/content/pnas/early/2019/09/10/1821673116.full.pdf. In effect, the carbon footprint of steel and concrete shrink as the energy sector becomes decarbonized via expansion of wind and solar. Mooney 2016. Wind power is going to get a lot cheaper as wind turbines get even more enormous. The Washington Post, Sept 12, 2016. https://www.washingtonpost.com/news/energy-environment/wp/2016/09/12/wind-power-is-going-to-get-a-lot-cheaper-as-wind-turbines-get-enormous/. Justin Gillis. NYT, October 16, 2019. The Steel Mill That Helped Build the American West Goes Green - Wind and solar power will replace coal at a Colorado furnace. https://www.nytimes.com/2019/10/16/opinion/solar-colorado-steel-mill.html?smtyp=cur&smid=tw-nytimesscience. See also, Just Have a Think - Fossil Free Steel - Another giant step towards net carbon zero? https://youtu.be/ywHJt88H5YQ Dec 13, 2020, and news of a new steel plant in Sweden that uses hydrogen from renewable electricity. Dan Gearino 2021. Inside Clean Energy: From Sweden, a Potential Breakthrough for Clean Steel - A Swedish partnership is cheering a milestone in its quest to make steel in a way that sharply reduces emissions. Inside Climate News. June 24, 2021 https://insideclimatenews.org/news/24062021/inside-clean-energy-clean-steel-sweden/

5) Substitution is speculative because the alleged benefits are in the distant future, and it takes more than a century to off-set the carbon emissions (carbon debt) caused by logging forests. Only a small fraction of the carbon in a logged forest ends up in long-term storage in wood products. Most of the carbon in a logged forest is subject to an accelerated transferred to the atmosphere where it causes warming and ocea acidification. For every ton of carbon stored in wood products, there are several times more carbon from the forest prematurely transferred to the atmosphere. Since the alleged carbon benefits from substitution are typically realized in the distant future and must be discounted. The CORRIM study appears to assume a 0% discount rate which is inconsistent with rational decision making because it effectively places no value on the carbon stored in forests in the short-term under a no-harvest scenario compared to a harvest scenario. Near-term carbon storage is critically important while the economy transitions to low carbon methods, yet it will take over a century for substitution to off-set the initial carbon deficit associated with logging mature forests.

Under well-established principles of discounting, it is clear that the net present value of current carbon storage in existing mature forests exceeds the net present value of distant future benefits of substitution. This graph shows why the near term matters (most of the warming happens within 20 years and then slowly continues to increase):

Related: the IPCC made a policy decision to place more value on the near-term because the majority of warming happens within 10-20 years after emissions. If it is true that we need to be more concerned about the near-term, then we can also say that forests are more valuable as places to store carbon and wood products are less valuable. This is because every effort to transfer carbon from the forest into wood products results in a net near-term pulse of carbon to the atmosphere, and this carbon "debt" is not repayed until the distant future when the replacement forest grows (not to the poin that it stores the same amount of carbon as before harvest) but rather to a point that recaptures all the carbon PLUS mitigates for the climate impacts caused during the "carbon debt" payback period. See Katsumasa Tanaka & Brian C. O[rsquo]Neill. 2018. The Paris Agreement zero-emissions goal is not always consistent with the 1.5[thinsp][deg]C and 2[thinsp][deg]C temperature targets. Nature Climate Change (2018) doi:10.1038/s41558-018-0097-x.https://www.nature.com/articles/s41558-018-0097-x#Abs1, and see Brack, Duncan 2017. Woody Biomass for Power and Heat: Impacts on the Global Climate. Chatham House.
https://www.chathamhouse.org/sites/files/chathamhouse/publications/research/2017-02-23-woody-biomass-global-climate-brack-embargoed.pdf.

6) [ldquo]If wood buildings are replaced by wood buildings, substitution is not occurring, and because wood is preferred for construction of single-family housing in North America, some of our substitution values are overestimated (Sathre and O[rsquo]Connor 2010). Wood

products store carbon temporarily, and a larger wood product pool increases decomposition emissions over time (figure 3).[rdquo] Tara W Hudiburg, Beverly E Law, William R Moomaw, Mark E Harmon and Jeffrey E Stenzel 2019. Meeting GHG reduction targets requires accounting for all forest sector emissions. Environmental Research Letters, Volume 14, Number 9. https://iopscience.iop.org/article/10.1088/1748-9326/ab28bb/pdf.

7) Many analyses of substitution fail to account for the carbon debt associated with logging. They do this by starting with "bare ground" instead of an existing forest, which biases the analysis by crediting wood products with growing the forest in the first place instead of debiting wood products for dramatically reducing the carbon stored in an existing forest.

8) Substitution offers no guarantees that fossil fuels will stay in the ground. Fossil fuel use associated with the manufacture of steel and concrete will not be permanently avoided, but just delayed. The longest it could be delayed will be the earlier of:

* The point in time when the rising price of fossil fuels is undercut by the declining price of renewable energy.
* The point in time when we stop using fossil fuels for making steel and cement.
* The point in time when the fossil fuels that would have been used to make steel and cement are extracted and used for some alternative activity.

9) The CORRIM analysis fails to recognize that the production techniques used to make steel and concrete are continually improving leading to increased energy efficiency. For instance, steel recycling rates are always increasing, the addition of fly ash during the manufacture of concrete reduces its carbon footprint. Cement producers recently agreed to a voluntary 25% reduction in carbon emissions.
http://www.reuters.com/article/GCA-GreenBusiness/idUSTRE54J5L420090520;

http://www.wbcsdcement.org/pdf/agenda.pdf; There are several ways that emissions from cement and steel can be reduced, e.g., Reduce use; Clinker substitution; Carbon capture & storage; Alternative 'novel' cement https://www.carbonbrief.org/qa-why-cement-emissions-matter-for-climate-change ([ldquo]Progress so far has come in three main areas. First, more efficient cement kilns have made production less energy-intensive. This can improve further ... [R]educing the proportion of Portland clinker in cement has also cut emissions. [ldquo]High-blend[rdquo] cements can reduce emissions per kilogram by up to four times, ... Geopolymer-based cements, for example, have been a focus of research since the 1970s. These do not use calcium carbonate as a key ingredient, harden at room temperature and release only water. Zeobond and banahUK are among firms producing these, with both claiming around 80-90% reduction in emissions compared to Portland cement. There are also several firms developing [ldquo]carbon-cured[rdquo] cements, which absorb CO2, rather than water, as they harden. If this CO2 absorption can be made higher than CO2 released during their production, cements could potentially be used as a carbon sink. US firm Solidia, for example, claims its concrete emits up to 70% less CO2 than Portland cement, including this sequestering step. The firm is now in a partnership with major cement producer LafargeHolcim. ... Other firms are using completely different materials to make cement. North Carolina-based startup Biomason, for example, uses bacteria to grow cement bricks which it says are both similarly strong to traditional masonry and carbon-sequestering.[rdquo]). The energy grid that powers the steel mills and concrete plants are always becoming less carbon intensive. For instqance, here in Oregon, only about 32% of electricity is from coal:

http://www.oregon.gov/energy/energy-oregon/Pages/Electricity-Mix-in-Oregon.aspx.

A company backed by Bill Gates called Solidia has a new cement product that requires less energy to produce and rapidly cures with CO2 instead of water, and it[rsquo]s stronger than regular cement, so it could be used to put carbon waste streams into lonmg-term storage. FACTSHEET: Solidia Impact Statement. https://assets.ctfassets.net/jv4d7wct8mc0/4LwjKXYDVgu9KVuDbrMcEq/6119b7ef7efdb4aba7b1dab5b1b1fa5b/Solidia_Technologies_Impact_Statement_9.6.19.pdf; FACTSHEET: The Science Behind Solidia. https://assets.ctfassets.net/jv4d7wct8mc0/5DwEAeEYqsFAYA9UC53EF7/4f8b7566221a8d9cb38f970867003226/Solidia_Science_Backgrounder_11.21.19__5_.pdf; Jeffrey Rissman 2018. CEMENT[rsquo]S ROLE IN A CARBON-NEUTRAL FUTURE. Energy Innovation LLC. NOVEMBER 2018. https://energyinnovation.org/wp-content/uploads/2018/11/The-Role-of-Cement-in-a-Carbon-Neutral-Future.pdf

See also, Johanna Lehne and Felix Preston. 2018. Making Concrete Change - Innovation in Low-carbon Cement and Concrete. Chatham House Report. https://www.chathamhouse.org/sites/default/files/publications/2018-06-13-making-concrete-change-cement-lehne-preston-final.pdf; Maddie Stone 2019. CONCRETE JUNGLE - Cement has a carbon problem. Here are some concrete solutions. Grist Nov 20, 2019. https://grist.org/article/cement-has-a-carbon-problem-here-are-some-concrete-solutions/; Oberhaus, D. 2019. A Solar 'Breakthrough' Won't Solve Cement's Carbon Problem - A Bill Gates[ndash]backed startup called Heliogen uses concentrated solar power to produce cement. Wired 11-22-2019. https://www.wired.com/story/a-solar-breakthrough-wont-solve-cements-carbon-problem/

Additionally, researchers have been incorporating bacteria into concrete formulations to absorb carbon dioxide from the air and to improve its properties. Start-ups pursuing [ldquo]living[rdquo] building materials include BioMason in Raleigh, N.C., which [ldquo]grows[rdquo] cementlike bricks using bacteria and particles called aggregate. And in an innovation funded by DARPA and published in February in the journal Matter, researchers at the University of Colorado Boulder employed photosynthetic microbes called cyanobacteria to build a lower-carbon concrete. They inoculated a sand-hydrogel scaffold with bacteria to create bricks with an ability to self-heal cracks.

Mariette DiChristina 2020. Low-Carbon Cement Can Help Combat Climate Change - Microbes will help decarbonize the construction industry. Scientific American, November 10, 2020, https://www.scientificamerican.com/article/low-carbon-cement-can-help-combat-climate-change/.

People must give fair treatment to the merits of the competing ideas by disclosing the flaws and caveats associated with the substitution argument.

Law et al (2018) said:

Increased long-term storage in buildings and via product substitution has been suggested as a potential climate mitigation option. Pacific temperate forests can store carbon for many hundreds of years, which is much longer than is expected for buildings that are generally assumed to outlive their usefulness or be replaced within several decades (7). By 2035, about 75% of buildings in the United States will be replaced or renovated, based on new construction, demolition, and renovation trends (31, 32). Recent analysis suggests substitution benefits of using wood versus more fossil fuel-intensive materials have been overestimated by at least an order of magnitude (33). Our LCA accounts for losses in product substitution stores (PSSs) associated with building life span, and thus are considerably lower than when no losses are assumed (4, 34). While product substitution reduces the overall forest sector emissions, it cannot offset the losses incurred by frequent harvest and losses associated with product transportation, manufacturing, use, disposal, and decay. Methods for calculating substitution benefits should be improved in other regional assessments.

Beverly E. Law, Tara W. Hudiburg, Logan T. Berner, Jeffrey J. Kent, Polly C. Buotte, Mark E. Harmon. 2018. Land use strategies to mitigate climate change in carbon dense temperate forests. Proceedings of the National Academy of Sciences Mar 2018, 201720064; DOI: 10.1073/pnas.1720064115

https://web.archive.org/web/20180727130028/http://www.pnas.org/content/pnas/115/14/3663.full.pdf.

Shafer et al (2011) state:

An alternative to increasing carbon stores within the forest is to harvest wood and store some of this carbon within wood products (Perez-Garcia et al., 2005). Under current manufacturing, use, and disposal practices this alternative is unlikely to increase the overall carbon store of the forest sector, which includes the forest and wood products derived from the forest (Harmon et al., 2009). Manufacturing, use, and disposal of harvested wood all entail significant carbon losses that are either as large as or larger than those in the forest itself (Krankina and Harmon, 2007). Wood products carbon offsets associated with biofuels and substitution of wood for more energy intensive building materials, such as steel and concrete, can theoretically increase the carbon [ldquo]stores[rdquo] of wood products beyond that stored in the forest itself (Perez-Garcia et al., 2005; Lippke et al. 2010). However, several issues need to be recognized regarding these offsets. First, most analyses have presented theoretical maximum product substitution offsets and ignored the effects of additionality (i.e., degree to which practices differ from business as usual or statutory requirements), permanence and replacement of existing wood products, and enduser preferences for building materials. If these factors are included, then substitution effects are substantially lower than the theoretical maximum and unlikely to surpass carbon stores in forests for many centuries if at all. Second, depending on the starting condition of the forest, both product substitution and forest-related biofuels can create carbon debts that delay carbon benefits. For example, biofuels harvested from existing forests could offset fossil fuel releases of carbon, but recent studies have indicated that carbon debts associated with the energy used during biofuel harvests, decreased carbon stores in forests, and differences in carbon to energy ratios could persist for decades to centuries, implying a significant temporal lag in net carbon uptake (Fargione et al., 2008; Searchinger et al., 2009). Third, being offsets, the effectiveness of both biofuel and product substitution will vary with the duration of the offset; the longer the delay in releasing fossil fuel carbon, the more effective offsets become: An offset with a 1 year delay would have little impact on atmospheric CO2 concentrations, whereas an offset of hundreds of years would have a much greater impact. Unfortunately, the duration of offsets is not well understood at this point, but it is unlikely to be infinite as tacitly assumed in many current analyses. Finally, while offsets are often counted as carbon stores, they are difficult to directly inventory because they are not physically in an identifiable location, whereas carbon stored in forests can be more directly inventoried and quantified.

Sarah L. Shafer, Mark E. Harmon, Ronald P. Neilson, Rupert Seidl, Brad St. Clair, Andrew Yost 2011. Oregon Climate Assessment Report (OCAR) http://occri.net/ocar Chapter 5. The Potential Effects of Climate Change on Oregon[rsquo]s Vegetation. http://occri.net/wp-content/uploads/2011/04/chapter5ocar.pdf.

If the agency wishes to rely on substitution to justify carbon emissions from logging, they cannot assume the project will result in the theoretical maximum substitution benefits. They must instead consider and analyze the real world substitution effects based on several key factors. Fain et al (2018) explain--

[S]ubstitution is a key variable in determining cumulative carbon benefits over time. Franklin et al. discuss 6 key factors in determining the magnitude of substitution effects through time: (1) the amount of product-in-use created from the harvest, (2) the displacement factor, (3) percent of the harvest that will substitute for non-wood products like concrete or steel, (4) the cumulative nature of the substitution effects, (5) the length of time the substitution effect accumulates, and (6) the effect on the average lifespan of buildings if wood is substituted for fossil fuel intensive materials. ... The displacement factor ... varies depending on the building system and the embedded GHG emissions factor within displaced materials. ... [E]ngineering studies found the average displacement factor value to be 2.1, ... [T]his number is a global reference average and likely not accurate for any given place and time. Uniquely local and dynamic biological and socio-economic factors such as, silvicultural systems, tree species, form and age of trees, amount of wood degrade, mortality rates, market demand, economics of transporting to processing facilities, and supply quota agreements, greatly influence commercial wood products and thus any attempts to quantify substitution rates and life cycles. ... [A]s technology, wood use, and energy sources evolve into the future, so will the displacement factor associated with substitution, most likely declining.

Fain, S.J.; Kittler, B.; Chowyuk, A. Managing Moist Forests of the Pacific Northwest United States for Climate Positive Outcomes. Forests 2018; 9(10):618. https://www.mdpi.com/1999-4907/9/10/618citing Franklin, J.; Johnson, N.; Johnson, D. Ecological Forest Management; Waveland Press: Long Grove, IL, USA, 2018.

[hellip] benefits attributed to product substitution are commonly overestimated. Substituting wood for aluminum and steel can displace fossil fuel emissions, but the displacement period needs to be part of the accounting. Displacement occurs until the building is replaced, and then the substitution can be renewed by a new building or it can be lost by using a material with a higher energy cost. In addition, it is often assumed that product

substitution will reduce the demand for fossil fuel. However, due to human behavior and current economic systems that ignore adverse externalities, reducing resource consumption through substitution or improvements in efficiency rarely reduce fossil fuel use (York, 2012). Therefore, benefits may be substantially lower and the payback period much longer and smaller for the carbon debt from intensified management and avoided fossil fuel combustion than commonly assumed (Haberl et al., 2013).

Law, B.E., Waring, R.H. 2015. Review and synthesis - Carbon implications of current and future effects of drought, fire and management on Pacific Northwest forests. Forest Ecology and Management 355 (2015) 4[ndash]14. http://people.forestry.oregonstate.edu/richard-waring/sites/people.forestry.oregonstate.edu.richard-waring/files/publications/Law%20and%20Waring%202015.pdf

?Law & Harmon conducted a literature review and concluded [hellip]

Most LCA [life cycle analysis] studies rely heavily on wood product substitution for GHG benefits, and these have been grossly overestimated, with many ambiguous assertions that gloss over forest carbon dynamics; for example:
 [middot] Biofuel emissions are assumed to be zero because they are balanced by net growth, yet this would depend on the state of the preceding forest system [ndash] they could be positive, neutral or negative;
 [middot]   Old forests are assumed to always be carbon sources, while young forests are always assumed to be carbon sinks, contrary to forest carbon dynamics findings;
 [middot] Dead wood and soil carbon stores are either not included or assumed to be constant;
 [middot] In one LCA, dead wood is not present in older forests, contrary to findings in the extensive ecological literature;
 [middot] The wood product pool is assumed to be an increasing carbon stock over time.

[hellip]

Substitution of more energy-intensive building materials with a less energy intensive one can, in theory, result in a fossil fuel offset; for example, when wood replaces a construction material with higher emissions (e.g., concrete or steel), the fossil CO_2 emission avoided by choosing wood is credited as an offset. Thus, harvest of forest carbon and placement into buildings can impact the overall carbon balance of the forest sector [33,42]. However, several additional factors need to be considered. First, changes in the carbon stores of the forest ecosystem have to be considered relative to a base case that includes a lower level of harvests. As noted above, decreasing the interval between harvests, or increasing harvest intensity will lower the carbon store in the forest [9[ndash]11,31]; the question is whether stores in forest products combined with substitution offsets surpass losses from shorter rotations. Since the forest has a maximum carrying capacity, just the growth in carbon stores and offsets would seem to eventually exceed old forest carbon, although it could take centuries to happen, even using the most generous substitution effects. With more realistic substitution effects, it may never happen. In some cases, the amount of live and dead biomass in unharvested forests was grossly underestimated leading to an overestimation of the relative benefits of substitution. Second, in substitution effects calculations, it is often tacitly assumed that wood that is removed from forests and used in long-term wood products, specifically buildings, continues to accumulate infinitely over time. While building carbon stores have increased in many areas (e.g., the USA), this is largely because more forest area is being harvested and not because the harvest-related stores per harvest area are increasing. The trend that is being used as evidence of increasing building stores is based on the fact that because a greater area has been harvested, the total store has increased. This is not the same thing as the increase associated with a particular area of forest. A fixed per area basis is how substitution effects have largely been evaluated in the past, so arguing on an expanding area basis is inappropriate. The reason that wood products saturate is that housing and other wood products have a finite lifespan and are eventually replaced [43]. Although there can be some reuse of wood, essentially assuming an infinite lifespan or 100% reuse of wood products is completely unrealistic. Carbon is always lost as wood products are used or disposed of, which means release of CO2 to the atmosphere. Since long-term storage in forest products saturates over time (i.e., eventually does not increase), the effect of substituting wood for fossil fuel energy is also likely to saturate. Third, in most cases, the substitution offset was calculated based on the assumption that each time a house is to be built, the preference is for nonwood materials. This results in an estimate of the maximum substitution effect possible, but does not account for actual preferences for building materials. Granted, preferences vary by region and over time, but without accounting for these one cannot possibly estimate realistic substitution benefits. Fourth, current substitution accounting appears to violate a key principle of carbon offsets, namely permanence. In fact the ever-increasing substitution offset presented in these analyses appears to depend on impermanence of wooden buildings. Fifth, most, if not all, current analyses of substitution effects ignore the effects of additionality and whether wooden buildings are initially present. Given that many forests have already been harvested to produce wood products, replacing wooden buildings with more wooden buildings results in no additional substitution effect. Finally, these studies assume that it is a permanent benefit to GHG removal from the atmosphere. That is, they assume there is a continual increase in the carbon credit, and maintenance of a sustainable productive forest dedicated to providing substitutes for nonwood fuels and materials [44].

These caveats all suggest that while there is likely to be some building material substitution effect that is valid, it is far lower than generally estimated and as subject to saturation as other forest-related carbon pools. In summary, the substitution effect appears to have been grossly overestimated. Substitution is an offset, not a store. Offsets depend on the use of appropriate accounting rules. Until rules such as permanence, additionality and leakage are followed, the values being presented in many analyses are not credible.

[hellip]

Life cycle analysis (including substitution, proposed considerations)

[hellip]

[middot] Substitution of more energy intensive building materials with less energy intensive ones can in theory result in a fossil fuel offset, but important considerations suggest that the substitution effect is substantially lower than estimated, and is subject to saturation.

Beverly Elizabeth Law & Mark E Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf.

Although we estimated the stores in forest products, we did not include the so-called substitution effects of using wood versus other more energy intensive materials for construction. As pointed out by Hennigar and others (2008), there is

little consensus on the values to be used (that is, they vary 10-fold). The other issue is that these estimates represent maximal values that assume that all future buildings will be primarily constructed of materials other than wood. Thus, it

counts the substitution effect over and over even when a wooden building is replaced by a wooden building.

Mark E. Harmon, Adam Moreno, and James B. Domingo. 2009. Effects of Partial Harvest on the Carbon Stores in Douglas-fir/Western Hemlock Forests: A Simulation. Ecosystems (2009) 12: 777-791. DOI: 10.1007/510021-009-9256-2 ECOSYSTEMS. https://www.fs.fed.us/pnw/pubs/journals/pnw_2009_harmon001.pdf

[hellip] the document need also rectify a persistent mischaracterization of dead trees as solely a source of carbon emissions compromising the capacity of California forests to function as net sinks. So long as mortality outpaces decay, which appears to be the case for many California forests today, dead trees collectively represent an aggrading carbon pool, not a shrinking one; just like that regularly claimed to occur in products made from wood thinned from forests. Moreover, there is no evidence I am aware of that trees surviving pulses of natural mortality pulses do not xperience compensatory growth in the same manner in which trees surviving selective harvest are regularly claimed to. [hellip] As currently written, the CFCP is peppered with claims that dead trees are driving California forests into a net sink (pages 1, 49, 59, 62, 75), but nowhere is this miss-calculation so glaring than in Tables 12 and 13 where forest carbon balance is compared across ownership classes. In this otherwise informative section, net forest carbon stores are calculated as growth minus mortality minus harvest when net forest carbon stores are, by definition, growth minus decomposition of dead trees minus harvest. Simply put, the sequestration of carbon in forests is defined by stocks, not fluxes, and dead trees are carbon stocks which function to keep carbon away from the atmosphere regardless of the fact that

they are releasing it. The CFCP[rsquo]s dogmatic obsession with minimizing natural mortality, dismissing dead trees as a carbon loss, and building markets to afford their salvage runs counter to its stated objective of thinning forests, returning natural disturbance to the ecosystem, and building carbon stocks on the landscape.

Campbell, J.L. 2017, Comments on the Jan 2017 draft California Forest Carbon Plan. http://www.fire.ca.gov/fcat/downloads/FCAT_PublicComment/Campbell_CFCP_Review_Final-2nd.pdf.

The UK Royal Academy of Engineering (Royal Society) looked at the potential for wood buildings to serve as a method of Greenhouse Gas Removal (GGR) and found --

Generally, the lifespan of wooden buildings and lifetime emissions associated with electricity and heating costs are comparable to that of concrete and steel structures149. ... Life cycle assessment studies of the carbon emissions saved by timber building relative to steel and concrete have been inconclusive153,154. ... [A]t the end of their lives the wooden infrastructure materials would have to be repurposed for the carbon to remain captured, which may be a challenge if adopted at scale. ... [I]ncreased afforestation will compete with agricultural

land. ... There is an additional risk that processing and transportation reduce the extent of the benefits of this GGR method. ... The benefits of extending the longevity and security of carbon storage, originally created through forestation, in the built environment needs to be recognised by carbon accounting agreements. ... Incentives for tree planting and sustainable forest management would be needed to significantly expand the scale of building with wood. ... As with BECCS, if biomass used for building is imported, there will need to be international agreement about the country that can claim the carbon credit and a mechanism to monitor the storage.

Royal Society 2018. Greenhouse gas removal. https://royalsociety.org/~/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdfciting (149) Aye L, Ngo T, Crawford RH, Gammampila R, Mendis P. Life cycle greenhouse gas emissions and energy analysis of prefabricated reusable building modules. Energy and Buildings. 2012 Apr;47:159[ndash]68. Available from: http://dx.doi.org/10.1016/j.enbuild.2011.11.049; (153) Buchanan AH, Honey BG. Energy and carbon dioxide implications of building construction. Energy and Buildings. 1994 Jan;20(3):205[ndash]17.

http://dx.doi.org/10.1016/0378-7788(94)90024-8; (154) Gustavsson L, Sathre R. Variability in energy and carbon dioxide balances of wood and concrete building materials. Building and Environment. 2006 Jul;41(7):940[ndash]51. http://dx.doi.org/10.1016/j.buildenv.2005.04.008.

The courts also understand that indirect effects, such as downstream emissions of GHG caused by federal actions, must be accounted for even if there may be off-setting factors such as displacement or substitution:

The Commission is wrong to suggest that downstream emissions are not reasonably foreseeable simply because the gas transported by the Project may displace existing natural gas supplies or higher-emitting fuels. Indeed, that position is a total non-sequitur: as we explained in Sierra Club, if downstream greenhouse-gas emissions otherwise qualify as an indirect effect, the mere possibility that a project[rsquo]s overall emissions calculation will be favorable because of an [ldquo]offset . . . elsewhere[rdquo] does not [ldquo]excuse[][rdquo] the Commission [ldquo]from making emissions estimates[rdquo] in the first place. 867 F.3d at 1374[ndash]75.

...

Although it is true that [ldquo][a]n agency has no obligation to gather or consider environmental information if it has no statutory authority to act on that information,[rdquo] in the pipeline certification context the Commission does have statutory authority to act. Sierra Club, 867 F.3d at 1372. As we explained in Sierra Club, [ldquo]Congress broadly instructed the [Commission] to consider [lsquo]the public convenience and necessity[rsquo] when evaluating applications to construct and operate interstate pipelines.[rdquo] Id. at 1373 (quoting 15 U.S.C. [sect] 717f(e)). Because the Commission may therefore [ldquo]deny a pipeline certificate on the ground that the pipeline would be too harmful to the environment, the agency is a [lsquo]legally relevant cause[rsquo] of the direct and indirect environmental effects of pipelines it approves[rdquo][mdash]even where it lacks jurisdiction over the producer or distributor of the gas transported by the pipeline. Id. Accordingly, the Commission is [ldquo]not excuse[d] . . . from considering these indirect effects[rdquo] in its NEPA analysis. Id.

...

[ldquo]NEPA analysis necessarily involves some [lsquo]reasonable forecasting,[rsquo] and . . . agencies may sometimes need to make educated assumptions about an uncertain future.[rdquo] Sierra Club, 867 F.3d at 1374 (quoting Delaware Riverkeeper Network, 753 F.3d at 1310)). It should go without saying that NEPA also requires the Commission to at least attempt to obtain the information necessary to fulfill its statutory responsibilities. See Delaware Riverkeeper Network, 753 F.3d at 1310 ([ldquo]While the statute does not demand forecasting that is not meaningfully possible, an agency must fulfill its duties to the fullest extent possible.[rdquo] (internal quotation marks omitted)); see also Barnes v. U.S. Department of Transportation, 655

F.3d 1124, 1136 (9th Cir. 2011) ([ldquo]While foreseeing the unforeseeable is not required, an agency must use its best efforts to find out all that it reasonably can.[rdquo] (internal quotation marks omitted)).

BIRCKHEAD v. FERC (D.C. Circ.) No. 18-1218. June 4, 2019. https://www.cadc.uscourts.gov/internet/opinions.nsf/F280040B0F48BE8C8525840F004D7275/$file/18-1218.pdf. In the context of federal land management, the agencies have broad authority to decide whether, where, and how to manage vegetation and those decisions have direct impact on GHG emissions.

NEPA Analysis of Climate Change

We have established that the analysis in the DEIS is inadequate. Here are some ideas to produce a credible analysis of climate change and GHG emissions in the FEIS. At a minimum, the analysis should quantify and compare carbon emissions from each alternative and describe a proxy for those emissions, such as the social cost of carbon dioxide emissions, described above.

The Forest Service is now on record in the New York Times stating that carbon consequences of forest management are relevant to project-level decision-making.

[hellip] occasionally, when tour groups come through, someone will ask what role the trees might play as the nation addresses global warming. After all, forests soak up carbon dioxide as they grow. [ldquo]We[rsquo]ve always said that[rsquo]s outside the scope of this project,[rdquo] said Michael Keown,... [ldquo]But those days have come and gone.[rdquo]

WILLIAM YARDLEY 2009. Protecting the Forests, and Hoping for Payback. The New York Times November 29, 2009. http://www.nytimes.com/2009/11/29/science/earth/29trees.html. The Forest Service[rsquo]s Dave Cleaves said [ldquo]Forests serve an important role in sequestering or removing carbon dioxide from the atmosphere and today, their role is even more important because of climate change. [hellip] Forests are the solution to absorbing carbon dioxide from the atmosphere and regulating temperatures. We must take an active role in keeping, planting and respecting forests for all they provide for us such as carbon, wood, flood control, wildlife habitat, and all the rest.[rdquo] [FS newsletter] Engaging a Climate Ready Agency from Dave Cleaves, Forest Service Climate Change Advisor. April 30, 2013.
http://www.fs.fed.us/climatechange/updates/April%202013%20Climate%20Update.pdf.

On March 28, 2017 the Trump Administration issued an executive order titled [ldquo]Presidential Executive Order on Promoting Energy Independence and Economic Growth[rdquo] which attempts to relieve agencies from the requirement to consider the effects of GHG emissions and climate change. https://www.whitehouse.gov/the-press-office/2017/03/28/presidential-executive-order-promoting-energy-independence-and-economi-1. Among other things, this executive order rescinds the CEQ guidance regarding consideration of climate change in federal decision-making, but the E.O. also recognizes that [ldquo][t]his order shall be implemented consistent with applicable law[rdquo] and [ldquo]all agencies should take appropriate actions to promote clean air and clean water for the American people, while also respecting the proper roles of the Congress and the States concerning these matters in our constitutional republic.[rdquo] Trump seems to ignore the Constitutional principle that the job of the executive branch is to faithfully implement the will of Congress expressed through proper lawmaking. Congress passed NEPA which requires agencies to take a [ldquo]hard look[rdquo] at ALL relevant direct, indirect, and cumulative effects of major federal actions. The Trump administration cannot tell agencies to put on blinders to the effects of GHG emissions and climate change because NEPA requires that they take the blinders off. In short, Trump[rsquo]s executive order attempts to unilaterally amend an act of Congress. This is not a proper exercise of executive authority. The agencies must therefore continue to carefully consider the effects of GHG emissions and climate change in all of their decisions.

Every decision subject to NEPA should recognize climate change as a reasonably foreseeable event and should carefully consider and analyze the issue of climate change from two perspectives: first, the cumulative effects of the proposed action plus the anticipated effects of climate change on the resources directly and indirectly affected the proposal, and second the extent to which the proposed action will tend to mitigate or exacerbate climate change by directly or indirectly emitting or sequestering greenhouse gases from both fossil deposits and the biosphere. This will help meet the objectives of NEPA by leading to more informed decision-making at all levels of government. See Petition Requesting That The Council On Environmental Quality Amend Its Regulations To Clarify That Climate Change Analyses Be Included In Environmental Review Documents. The

International Center for Technology Assessment, NRDC, Sierra Club. February 28, 2008. http://web.archive.org/web/20100307220404/http://www.icta.org/doc/CEQ%20Petition%20Final%20Version%202-28-08.pdf

GAO[rsquo]s recent report finds that federal resource agencies including the Forest Service have not done enough to incorporate climate change mitigation and adaptation into their management. Out of 155 National Forests and 20 National Grasslands only 12 have land management plans that address climate change. GAO urged that all forest plans be amended to address climate change.

In its written comments [on the GAO Report], Agriculture[rsquo]s FS agreed with our recommendation, acknowledging the need to develop clear, written communication for resource managers that explains how they should address the effects of climate change, and the need to coordinate with other departments and agencies on resource management practices in preparing this guidance. FS said that the agency will work to address clarity in communicating climate change mitigation and adaptation strategies to field units.

GAO. 2007. CLIMATE CHANGE [mdash] Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources. GAO 07-863. http://www.gao.gov/new.items/d07863.pdf. The GAO Report also notes [ldquo]FS headquarters officials said that, although they have not provided specific guidance on addressing the effects of climate change, the agency[rsquo]s planning process is designed to identify emerging issues, such as climate change, and respond in ways to promote the sustainability of the nation[rsquo]s land and water resources [fn31] The FS land management planning handbook states the following: [lsquo]Where data are available, consider the influence of climate change on the characteristics of ecosystem diversity.[rsquo][rdquo]

On July 10, 2007 Forest Service Chief Kimball responded to GAO asserting that [mdash]

[ldquo]Forest Service field managers address the effects of climate change by managing for resilient ecosystems that sustain the production of goods and services in the face of uncertain future conditions. [hellip] [and] Climate change mitigation and adaptation strategies will be included in future [forest plan] revisions. [and] the Four Threats emphasize two immediate consequences of climate change for land management agencies: forest fire and invasive species. [and] Forest Service researchers are firmly established as world leaders in forest-carbon measurement and carbon accounting. [and] USDA[rsquo]s Global Change Program Office was established to ensure that climate change issues are fully integrated into research, planning, and decision-making.[rdquo]

http://www.gao.gov/new.items/d07863.pdf. It[rsquo]s time for the agencies to walk the talk and do the things it claims to be doing. Climate change represents significant new information that should trigger immediate re-evaluation of forest plan provisions allowing carbon stored in large old forests to be removed through logging.

On September 14, 2009 the Secretary of Interior issued a Secretarial Order No. 3289 mandating that [ldquo]the Department must [hellip] continue its work [hellip] identifying [hellip] ways to reduce the Department[rsquo]s carbon footprint. [including] develop[ing] [hellip] methodologies [hellip] for biological (e.g. forests and rangelands) carbon storage, [and] enhance[ing] carbon storage [hellip] in plants and soils.[rdquo] http://web.archive.org/web/20091001133221/http://www.doi.gov/climatechange/SecOrder3289.pdf. Not logging mature & old-growth and documenting the carbon consequences of thinning young stands is a good start.

The NEPA analysis should start with an accurate and up-to-date inventory of carbon storage and carbon flows on federal lands in the project area. This is required by both the National Forest Management Act (16 USC [sect]1601(a)(1)&(2)) and the Federal Land Policy & Management Act (43 USC [sect]1711(A)). The NEPA analysis should disclose and consider that logging has several adverse consequences on GHG pools and flows:

1. Logging kills growing trees that would otherwise continue to capture and sequester carbon through photosynthesis. Logging therefore represents a forgone opportunity for carbon sequestration. Killing the trees also stops them from pumping carbon into the soil where a lot of carbon is stored. Forests deliver massive amounts of carbon into the soil as photosynthate that supports a vast below-ground ecosystem and as course woody debris. Logging kills the food supply for the below-ground ecosystem. [ldquo]Contrary to commonly accepted patterns of biomass stabilization or decline, biomass was still increasing in stands over 300 years old in the Coast Range, the Sierra Nevada and the West Cascades, and in stands over 600 years old in the Klamath Mountains.[rdquo] Tara Hudiburg, Beverly Law, David P. Turner, John Campbell, Dan Donato, And Maureen Duane 2009. Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. Ecological Applications, 19(1), 2009, pp. 163[ndash]180 http://terraweb.forestry.oregonstate.edu/pubs2/Hudiburg2009EA.pdf. Recent science affirms the carbon value of large and old trees:

[ldquo][T]rees accelerate their growth as they get older and bigger, a global study has found. The findings, reported by an international team of 38 researchers in the journal Nature, overturn the assumption that old trees are less productive. It could have important implications for the way that forests are managed to absorb carbon from the atmosphere. "This finding contradicts the usual assumption that tree growth eventually declines as trees get older and bigger," said Nate Stephenson, the study's lead author and a forest ecologist with the US Geological Survey (USGS). "It also means that big, old trees are better at absorbing carbon from the atmosphere than has been commonly assumed." [hellip] "Rapid growth in giant trees is the global norm, and can exceed 600kg per year in the largest individuals," say the authors. The study also shows old trees play a disproportionately important role in forest growth. Trees of 100cm in diameter in old-growth western US forests comprised just 6% of trees, yet contributed 33% of the annual forest mass growth.[rdquo]

Vidal, John 2014. NEWS: Trees accelerate growth as they get older and bigger, study finds - Findings contradict assumption that old trees are less productive and could have important implications for carbon absorption[rdquo] The Guardian, Jan 15, 2014. http://www.theguardian.com/environment/2014/jan/15/trees-grow-more-older-carbon [citing Stephenson, N. L., A. J. Das, et al. 2014. Rate of tree carbon accumulation increases continuously with tree size. Nature | Letter (2014) doi:10.1038/nature12914https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/47239/HarmonMarkForestryRateTreeCarbon.pdf ([ldquo]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. The apparent paradoxes of individual tree growth increasing with tree size despite declining leaf-level8, 9, 10 and stand-level10 productivity can be explained, respectively, by increases in a tree[rsquo]s total leaf area that outpace declines in productivity per unit of leaf area and, among other factors, age-related reductions in population density.[rdquo])]. Also, [ldquo]foregone CO2 sequestration has the same impact on the climate as increased CO2 emissions.[rdquo] Are Forests the New Coal? A Global Threat Map of Biomass Energy Development. http://environmentalpaper.org/wp-content/uploads/2018/11/Threat-Map-Briefing-Are-Forests-the-New-Coal-01.pdfciting Brack, Duncan. The Impacts of the Demand for Woody Biomass for Power and Heat on Climate and Forests. Chatham House. February 2017. https://www.chathamhouse.org/publication/impacts-demand-woody-biomass-power-and-heat-climate-and-forests

1. Thinning and partial logging are not carbon neutral. D. Zhou, S. Q. Zhao, S. Liu, and J. Oeding. 2013. A meta-

analysis on the impacts of partial cutting on forest structure and carbon storage. Biogeosciences, 10, 3691[ndash]3703, 2013. https://www.biogeosciences.net/10/3691/2013/bg-10-3691-2013.pdf ([ldquo][W]e compiled a database of 81 papers published between 1973 and 2011 that reported the impacts of partial cutting on either the forest structure and/or C storage [hellip] Overall, partial cutting decreased stand basal area and volume significantly by 34.2 and 28.4 %, [hellip] relative to the uncut controls in our compiled dataset. Closely related to the structure dynamics, the C stored in AGBC [aboveground biomass carbon] decreased significantly by 43.4% [hellip] [C]utting intensity had a significant and negative correlation with stand basal area, volume, and AGBC, [hellip] , [I]t will remain difficult to determine how much time is needed for a complete recovery since there were no observations on AGBC longer than 42 yr in our synthesized database.[rdquo])
2. The final report of the Oregon Global Warming Commission[rsquo]s Forest Carbon Accounting Project found that "Based on credible evidence today, forest harvest does not appear to result in net carbon conservation when compared to carbon retention in unharvested forests. ... The evidence is that significant amounts of carbon are lost at each stage in timber harvest and processing into wood products, and in decomposition at the end of useful product life. Meanwhile, trees remaining in forests are actively withdrawing carbon from the atmosphere. The forest stores and conserves carbon more effectively and for longer periods of time than do most products derived from harvested trees. While individual trees will die and release their carbon, the forest can continue to renew itself, maintaining and adding to its quantities of sequestered carbon. ... [E]xtractive logging for all purposes [ndash] that is, harvesting and removing (mostly) live trees with their carbon stores [ndash] will reduce the total amount of carbon that otherwise might be expected to remain in long-term forest storage." Oregon Global Warming Commission 2018. Forest Carbon Accounting Project [ndash] Final Report. November 2018. https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/5c094beaaa4a99fa6ad4dcde/1544113138067/2018-OGWC-Forest-Carbon-Accounting-Report.pdf
3. Logging [ldquo]captures mortality[rdquo] and truncates the [ldquo]essential link between live and dead biomass pools[rdquo] which interferes with the process of accumulation of dead wood biomass. [ldquo]As forest stands grow older, dead biomass pools increase unless timber harvest removes live trees. Aggressive management reduces tree mortality which is input into dead biomass carbon pools; the result is the extremely low level of dead biomass, especially coarse woody debris in intensively managed forests.[rdquo] Krankina, O. 2008. REVIEW of Sierra Pacific Industries Report [ndash] [ldquo]Carbon Sequestration in Californian Forests: Two Case Studies in Managed Watersheds[rdquo] prepared for Defenders of Wildlife and others. http://web.archive.org/web/20081121203052/http://savethesierra.org/downloads/SPI_Review.pdf. [ldquo]Allocation of C to dead wood pools increases with forest stand development and, in some cases, compensates for declining growth rates in older trees in terms of total ecosystem biomass accumulations (Harmon, 2001).[rdquo] Nunery, J.S., Keeton, W.S., Forest carbon storage in the northeastern United States: Net effects of harvesting frequency, post-harvest retention, and wood products. Forest Ecol. Manage. (2010), doi:10.1016/j.foreco.2009.12.029.http://www.maforests.org/Keeton.pdf
4. Avoided logging of mature & old-growth forest = avoided emissions of GHG. Logging accelerates the rate of decomposition of wood through several mechanisms.
5.
1. Logging raises soil temperature thereby increasing the rate of microbial respiration and decay of woody debris and soil carbon, which converts carbon to gaseous CO2 that is readily transferred to the atmosphere. Caitlin E. Hicks Pries, C. Castanha, R. Porras, M. S. Torn. 2017. The whole-soil carbon flux in response to warming. PUBLISHED ONLINE 09 MAR 2017. DOI: 10.1126/science.aal1319. http://science.sciencemag.org/content/early/2017/03/08/science.aal1319. Also, Margaret Torn et al 2014. The Effects of a Warmer Climate on Soil Carbon Cycling (presentation). https://dl.sciencesocieties.org/publications/meetings/download/pdf/2014am/85430 (Soil warming [ldquo]increases decomposition of both old and recently-fixed soil carbon.[rdquo])
2. Logging decreases the average piece size, and increases the surface area of the wood, thereby increasing the area exposed to biological decomposition.
3. Logging debris is often burned, or as hog fuel, biomass, etc.

6. Some argue that logging is helpful because carbon is sequestered in wood products, but this assertion needs

scrutiny.

The agency should fully mitigate for the effects of increased warming due to carbon emissions that result from logging for the full time period that the logging alternative stores less carbon than the no-logging alternative.

Projects involving partial removal should analyze and consider the following factors:

* As stands develop from young to mature to old they recruit large amounts of material from the live tree pool to the dead wood pool which continues to accumulate large amounts of carbon for centuries. Logging, even thinning, captures that mortality and can dramatically affect the accumulation of carbon in the dead wood pool.
* Thinning might help or hinder forest growth. Focusing tree growth of fewer stems may, over the long-term, increase the size, vigor, and longevity of the trees and increase ratio of wood volume to surface area which helps slow decay. But even if the growth rate of individual trees may be enhanced by thinning, the growth rate of the stand as a whole will decrease due to the removal of many growing trees. The increase in volume growth on retained trees is less than the total volume growth of the whole stand in the absence of thinning. Furthermore, thinning can damage residual trees[rsquo] roots, stems, and canopies which may inhibit growth rates (See Table 2 in Han-Sup Han and Loren D. Kellogg. 2000. Damage Characteristics in Young Douglas-fir Stands from Commercial Thinning with Four Timber Harvesting Systems. Western Journal of Applied Forestry. 15(1):27-33. http://andrewsforest.oregonstate.edu/research/related/ccem/pdf/WJAF.pdf);
* Opening the canopy warms the soil and litter layers and increases the rate of soil respiration and CO_2 emissions which is controlled in part by temperature. The agencies should maintain the cooling effect of forest canopy in order to keep soil carbon immobilized. J. A. Forrester, D. J. Mladenoff, A. W. D[rsquo]Amato, S. Fraver, D. L. Lindner, N. J. Brazee, M. K. Clayton, S. T. Gower. 2015. Temporal trends and sources of variation in carbon flux from coarse woody debris in experimental forest canopy openings. Oecologia, July 2015 http://link.springer.com/article/10.1007%2Fs00442-015-3393-4 ([ldquo]Pulses of respiration from coarse woody debris (CWD) have been observed immediately following canopy disturbances [hellip] CO_2 flux from CWD was strongly and positively related to wood temperature[hellip][rdquo]); Fang, J. 2010. Soils emitting more carbon dioxide - Trend could exacerbate global warming. Scientific American | March 24, 2010. http://www.scientificamerican.com/article.cfm?id=soils-emit-carbon-dioxide. Bond-Lamberty and Thomson, 2010. Temperature-associated increases in the global soil respiration record, Nature 464, 579-582 (25 March 2010) | doi:10.1038/nature08930,http://www.nature.com/nature/journal/v464/n7288/full/nature08930.html ; Karhu, K., Fritze, H., H[auml]m[auml]l[auml]inen, K., Vanhala, P., Jungner, H., Oinonen, M., Sonninen, E., Tuomi, M., Spetz, P. & Liski, J. 2010. Temperature sensitivity of soil carbon fractions in boreal forest soil. Ecology 91(2): 370-376. http://www.ymparisto.fi/default.asp?contentid=351875&lan=en. Francesca M. Hopkins, Margaret S. Torn, and Susan E. Trumbore. 2012. Warming accelerates decomposition of decades-old carbon in forest soils. PNAS June 26, 2012 vol. 109 no. 26 E1753-E1761. http://www.pnas.org/content/109/26/E1753.full.pdf ([ldquo]Consistent with global ecosystem model predictions, the temperature sensitivity of the carbon fixed more than a decade ago was the same as the temperature sensitivity for carbon fixed less than 10 y ago. However, we also observed an overall increase in the mean age of carbon respired at higher temperatures[hellip][rdquo]). PNW Research Station 2012. Science Findings: Logging Debris Matters: Better Soil, Fewer Invasive Plants. issue one hundred forty five / August 2012. Mazza, R. ed.http://www.fs.fed.us/pnw/sciencef/scifi145.pdf ([ldquo]... cooler soil temperatures led to slower soil respiration, and thus less carbon dioxide was released to the atmosphere[hellip][rdquo]); Kristiina Karhu, Marc D. Auffret, Jennifer A. J. Dungait, David W. Hopkins, James I. Prosser, Brajesh K. Singh, Jens-Arne Subke, Philip A. Wookey, G[ouml]ran I. [Aring]gren, Maria-Teresa Sebasti[agrave], Fabrice Gouriveau, G[ouml]ran Bergkvist, Patrick Meir, Andrew T. Nottingham, Norma Salinas, Iain P. Hartley. 2014. Temperature sensitivity of soil respiration rates enhanced by microbial community response. Nature. Volume 513, page 81. 4 Sept 2014.

Doi:10.1038/nature13604.http://www.nature.com/articles/nature13604.epdf. [Summarized: [ldquo]The microbes that break down stored carbon are also likely to become more active in a warmer world, according to a 2014 study published in Nature. The study looked at microbes in 22 different kinds of soil from along a climatic gradient, testing samples of soil from the Arctic to the Amazon. They found that as temperature increased, the respiratory activity of the microbes in the soil also increased, releasing more carbon dioxide [mdash] and that effect was most pronounced in northern soils, which tend to store more carbon than soils at other latitudes.[rdquo] NATASHA GEILING. Is 2015 The Year Soil Becomes Climate Change[rsquo]s Hottest Topic? APRIL 29, 2015. Think Progress. http://thinkprogress.org/climate/2015/04/29/3652020/global-soil-week-forum-recap/]; Caitlin E. Hicks Pries, C. Castanha, R. Porras, M. S. Torn. 2017. The whole-soil carbon flux in response to warming. PUBLISHED ONLINE 09 MAR 2017. DOI: 10.1126/science.aal1319. http://science.sciencemag.org/content/early/2017/03/08/science.aal1319; Margaret Torn et al 2014. The Effects of a Warmer Climate on Soil Carbon Cycling (presentation). https://dl.sciencesocieties.org/publications/meetings/download/pdf/2014am/85430 (Soil warming [ldquo]increases decomposition of both old and recently-fixed soil carbon.[rdquo]); J. M. Melillo, S. D. Frey, K. M. Deangelis, W. J. Werner, M. J. Bernard, F. P. Bowles, G. Pold, M. A. Knorr, A. S. Grandy. 2017. Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world. Science. 06 Oct 2017: Vol. 358, Issue 6359, pp. 101-105. DOI: 10.1126/science.aan2874. http://science.sciencemag.org/content/358/6359/101;

* Increased light levels could increase the rate of photodegradation of lignin thus allowing increased microbial access to cellulose and increasing respiration rates. Amy T. Austin, Carlos L. Ballar[eacute]. 2010. Dual role of lignin in plant litter decomposition in terrestrial ecosystems. PNAS March 9, 2010. Vol. 107 no. 10 4618-4622. doi:10.1073/pnas.0909396107http://www.pnas.org/content/107/10/4618.full.pdf .
* Thinning may increase or decrease fire hazard depending on the complex interaction of fuel structure (thinning may reduce small surface and ladder fuels or increase slash and remove medium and large trees that are relatively fire tolerant) and microclimate effects (thinning makes the stand hotter-drier-windier);
* Thinning may increase stand diversity and the fraction of carbon stored in species other than dominant crop trees.
* Thinning in mid-seral and mature forests will [ldquo]capture mortality[rdquo] and truncate the important process of accumulating carbon pools in the forest floor. See Geisen, T. et al. 2008. Four centuries of soil carbon and nitrogen change after stand-replacing fire in a forest landscape of the western Cascade Range of Oregon. Canadian Journal of Forest Resources 38:2455-2464; and Thomas William Giesen. 2005. Four Centuries of Soil Carbon and Nitrogen Change After Severe Fire in a Western Cascades Forest Landscape. MS THESIS. Oregon State University. Building up carbon stores in the forest floor takes time, and if the slow-to-decompose large material is removed from the site, the high rates of carbon accumulation found in old forests are not likely to materialize.
* There is no bonus wood from thinning. [ldquo]In this as in other LOGS installations, the unthinned plots have consistently produced more total volume (CVTS) than any of the thinning treatments.[rdquo] Curtis, Robert O.; Marshall, David D. 2009. Levels-of-growing-stock cooperative study in Douglas-fir: report no. 18[mdash]Rocky Brook, 1963[ndash]2006. Res. Pap. PNW-RP-578. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 91 p. http://www.fs.fed.us/pnw/pubs/pnw_rp578.pdf. [ldquo][T]he data have not supported early expectations of [lsquo]bonus[rsquo] volume from thinned stands compared with unthinned. [hellip] [T]hinnings that are late or heavy can actually decrease harvest volume considerably.[rdquo] Talbert and Marshall. 2005. Plantation Productivity in the Douglas-fir Region Under Intensive Silvicultural Practices: Results From Research And Operations. Journal of Forestry. March 2005. pp 65-70 citing Curtis and Marshall. 1997. LOGS: A Pioneering Example of Silvicultural Research in Coastal Douglas-fir. Journal of Forestry 95(7):19-25. Also, [ldquo]Thinning as a traditional forestry tool is fundamentally a density management technique that manages the trade-offs between stand-level productivity and individual tree vigor (Long 1985).[rdquo] Blue Mountains Forest Plan Revision FEIS, p 252. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd584613.pdf.
* In May of 2011, a study on the effects of thinning and biomass utilization on carbon release and storage was published by Oregon State University. Among the findings of the study were: [bull] Forest carbon pools always

immediately decreased as a result of thinning, with reductions increasing as a function of heavier thinning. [bull] After thinning, carbon pools remain lower throughout a 50-year period. [bull] Carbon pool estimates for thinned stands remained lower even after accounting for carbon transferred to wood products. Clark, J., J. Sessions, O. Krankina, T. Maness. 2011. Impacts of Thinning on Carbon Stores in the PNW: A Plot Level Analysis. College of Forestry, Oregon State University. Corvallis, OR
http://switchboard.nrdc.org/blogs/ngreene/Impacts%20of%20Thinning%20on%20Carbon%20Stores%20in%20the%20PNW_Final%20Report.pdf
*
See also, Center for Biological Diversity et al., March 17, 2017 comments on the California Forest Carbon Plan (January 20, 2017 Draft).
http://www.biologicaldiversity.org/campaigns/debunking_the_biomass_myth/pdfs/Forest_Carbon_Plan_Comments.pdf; and CBD et al, April 8, 2016 Comments on the California Forest Carbon Concept Paper.
http://www.fire.ca.gov/fcat/downloads/CBD-Comments_reFCAT_ForestCarbonPlanConceptPaper_04082016.pdf

What does adequate NEPA analysis look like? http://web.law.columbia.edu/climate-change/resources/nepa-and-state-nepa-eis-resource-center#Federal Guidelines. The Forest Service has started to answer that question [hellip]

[ldquo]In recognizing agency responsibility to consider climate change, the responsible official can cite the Forest Service mission to [lsquo]sustain the health, diversity, and productivity of the Nation[rsquo]s forests and grasslands to meet the needs of present and future generations[rsquo] and state how their decision considered climate change issues.

[hellip] Climate change effects include the effects of agency action on global climate change and the effects of climate change on a proposed project.

[hellip] Scoping is useful to determine if climate change issues are specifically related to the proposed action. Refrain from prematurely dismissing climate change issues as [ldquo]outside the scope[rdquo] of the analysis and use the interdisciplinary team and other sources to identify potential cause-effect relationships (if they exist) between the proposal and climate change.

[hellip] Alternatives may include mitigation measures to reduce GHG emissions, affect carbon cycling, or enhance adaptive capacity.

[hellip] Many proposed projects and programs will emit greenhouse gases (direct effect) and, thus, contribute to the global concentration of greenhouse gases that affect climate (indirect effect). Quantifying greenhouse gases emitted and/or sequestered may help choose between alternatives based on relative direct effects trade-offs. Forest Service decisions having the potential to emit or sequester more greenhouse gases; [hellip] may be best informed by quantitative analyses.

[hellip] Qualitative effects disclosure for a project[rsquo]s impacts on GHG emissions and carbon sequestration should be couched in the ecosystem[rsquo]s role in the carbon cycle. [hellip] Forests play a major role in the carbon cycle.

[hellip] It may be appropriate for the decision document rationale to include some indication of how climate change considerations (if any) were weighed during decisionmaking. These statements should reference relevant NEPA documents, assessments, and science to substantiate findings.

[hellip] [W]hen responding to comments about climate change [the agency may] 1. Modify alternatives including

the proposed action. 2. Develop and evaluate alternatives not previously given serious consideration by the Agency. 3. Supplement, improve, or modify the analysis. 4. Make factual corrections. 5. Explain why the comments do not warrant further agency response [hellip][rdquo]

USDA Forest Service. 2009. Climate Change Considerations in Project Level NEPA Analysis. January 13, 2009. http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_nepa_guidance.pdf. http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_cover_letter.pdf. Note this document has some serious shortcomings. It completely misses the contribution of logging to GHG emissions and it fails to recognize the useful role of NEPA[rsquo]s requirement for cumulative impacts analysis to address the programmatic effects of the agencies[rsquo] forest management programs. The project-level effects of logging must be linked to the cumulative global effects of climate change through a credible cumulative effects analysis. The FS[rsquo] assertion that [ldquo]Because the context of individual projects and their effects cannot be meaningfully evaluated globally to inform individual project decisions, it is not possible and it is not expected that climate change effects can be found to be [lsquo]significant[rsquo] under NEPA and therefore require EIS preparation.[rdquo] Is absurd and erroneous. Recognizing the significant global impact of collective project-level actions, it is clear that a programmatic EIS is needed and a project-level FONSIs are inappropriate until one is done.

The following is an excerpt from Ron Bass[rsquo]s presentation, [ldquo]NEPA and Climate Change: What Constitutes a Hard Look?[rdquo]

The recommended 10-step approach takes into consideration the existing provisions of the NEPA regulations, recent court decisions, and various state programs. The steps conform to the main elements of a NEPA document.

Affected Environment

Step 1 [ndash] Describe the existing global context in which climate change impacts are occurring and are expected to continue to occur in the future.

Step 2 [ndash] Summarize any relevant state laws that address climate change.

Step 3 [ndash] Describe any relevant national, statewide, and regional GHG inventories to which the project will contribute.

Environmental Consequences

Step 4 [ndash] Quantify the project[rsquo]s direct and indirect GHG emissions.

Step 5 [ndash] Convert the GHG emissions into carbon equivalents using an established [ldquo]carbon calculator.[rdquo]

Step 6 [ndash] Discuss whether the project would enhance or impede the attainment of applicable state GHG reduction.

Step 7 [ndash] Describe the cumulative global climate change impacts to which the proposed action would contribute, i.e., the impacts of the project on climate change. (This may use the same information as in Step 1.)

Step 8 [ndash] Describe how the impacts of global climate change could manifest themselves in the geographic area in which the project is proposed, and therefore potentially affect the project, i.e., the impacts of climate change on the project (e.g., sea level rise could affect a coastal project).

Alternatives

Step 9 [ndash] Include alternatives that would meet the project objectives but would also reduce GHG emissions.

Mitigation Measures

Step 10 [ndash] Identify mitigation measures that would reduce GHG emissions, including both project design or operational changes and potential compensatory mitigation (e.g., carbon offsets).

DOE 2009. NEPA and Climate Change: [ldquo]Don[rsquo]t Do Nothing[rdquo] NEPA Lessons Learned - Quarterly Report. June 1, 2009. http://energy.gov/sites/prod/files/LLQR-2009-Q2.pdfciting Ron Bass 2008. Evaluating Greenhouse Gases and Climate Change Impacts Under NEPA: Ten Steps to Taking a Hard Look. ICF/Jones & Stokes. Impact Report Nov. 2008. http://www.icfi.com/insights/white-papers/2008/evaluating-greenhouse-gases-and-climate-change-impacts-under-nepa-ten-steps-to-taking-a-hard-look.

NEPA[rsquo]s requirement to take a [ldquo]hard look[rdquo] requires the agency to consider the effects of logging-related GHG emissions. This includes:

Disclose whether the cumulative effects of logging-related GHG emissions are consistent with emissions reduction goalsestablished by state or federal government or international agreements.   In Paris on December 12, 2015 the ?United Nations - Framework Convention on Climate Change? agreed to a landmark climate agreement including Article 5 which says [ldquo]Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the Convention, including forests.[rdquo] #COP21, aka Paris Agreement. http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

[ldquo]In November 2014, in a historic joint announcement with China, President Obama laid out an ambitious but achievable target to reduce greenhouse gas emissions in the United States in the range of 26 to 28 percent below 2005 levels by 2025.[rdquo] https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change

On June 25, 2013, President Obama released his Climate Action Plan which includes forest conservation among the [ldquo]first pillar[rdquo][2] of efforts to reduce emissions, saying: [ldquo]Preserving the Role of Forests in Mitigating Climate Change: America[rsquo]s forests play a critical role in addressing carbon pollution, removing nearly 12 percent of total U.S. greenhouse gas emissions each year. [hellip] Conservation and sustainable management can help to ensure our forests continue to remove carbon from the atmosphere [hellip] [rdquo] http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf [ldquo][A]dvancing efforts to protect our forests[rdquo] is also mentioned in the 6th U.S. Climate Action Report under the United Nations

Framework Convention on Climate Change (UNFCCC). The agency should advance this national climate goal by conserving public forests. Carbon emissions from logging public lands directly conflict with this important national goal and indicate potential significant impacts requiring an EIS.

In 2007, the Oregon legislature passed HB 3543 that codifies Governor Kulongoski[rsquo]s greenhouse gas reduction goals: namely, by 2010 to begin to reduce greenhouse gas emissions, by 2020 to achieve greenhouse gas levels 10% less than 1990 levels and by 2050 to achieve greenhouse gas levels 75% below 1990 levels. ORS [sect] 468A.205. The agency should also strive to harmonize with State of Oregon statewide land-use planning goals (adopted in administrative rules) that prohibit land use activities that exceed the [ldquo]carrying capacity[rdquo] of air and water resources. OAR 660-015-0000(5) - (6). The Department of Land Conservation and Development (DLCD) defines [ldquo]carrying capacity[rdquo] as a [ldquo]Level of use which can be accommodated and continued without irreversible impairment of natural resources productivity, the ecosystem and the quality of air, land, and water resources.[rdquo] There is a large body of science indicating that we are already beyond the level of CO2 in our atmosphere that can be described as safe or reversible.

Logging related GHG emissions (and forgone opportunities for increased storage of carbon in forests) will conflict with these state, federal and international GHG reduction goals.

[1] Rockstr[ouml]m, J., W. Steffen, K. Noone, [Aring]. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. S[ouml]rlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries:exploring the safe operating space for humanity. Ecology and Society 14(2): 32. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art32/.
http://www.stockholmresilience.org/download/18.1fe8f33123572b59ab800012568/pb_longversion_170909.pdf.
http://www.ecologyandsociety.org/vol14/iss2/art32/figure6.html.

[2] U.S. Dept of State 2013. draft 6th Climate Action Report http://www.state.gov/e/oes/climate/ccreport2014/index.htm (page 12).