15 April 2019

TO:   [comments-pacificnorthwest-mthood-clackamasriver@fs.fed.us](mailto:comments-pacificnorthwest-mthood-clackamasriver@fs.fed.us)

**Subject: North Clack Integrated Resource Project Preliminary Assessment — comments**

Dear Forest Service:

Please accept the following comments from Oregon Wild concerning the North Clack Integrated Resource Project Preliminary Assessment, <https://www.fs.usda.gov/project/?project=50475>. Oregon Wild represents 20,000 members and supporters who share our mission to protect and restore Oregon’s wildlands, wildlife, and water as an enduring legacy. Our goal is to protect areas that remain intact while striving to restore areas that have been degraded. This can be accomplished by moving over-represented ecosystem elements (such as logged and roaded areas) toward characteristics that are currently under-represented (such as roadless areas and complex old forest).

The proposed action alternative involves:

* 45 mmbf (enough to fill 9000 log trucks)
* 4592 acres of variable thinning
* 10% gaps and 10% heavy thins within thinned stands
* 5-10% skips (plus riparian buffers, lees than riparian reserves)
* Average tree dbh increases 1.7” - 5.8” over 50 years
* 255 acres of regen harvest
* 105 miles of road work

As stated in our scoping comments, Oregon Wild is not opposed to commercial thinning in dense young plantations (outside of stream buffers) when conducted for the primary purpose of ecological restoration, but regen logging (clearcutting by another name) or repeated thinning entries for the primary purpose of timber production do not make sense given all of the evidence supporting the need for greater forest conservation: clean water, stable stream flows, climate change, spotted/barred owls, quality of life, new information on dead wood habitat, etc... The PA does not adequately disclose and consider the trade-offs associated with regen logging and the cumulative effects of repeated thinning entries.

Oregon Wild scoping comments urged the FS to carefully consider several issues:

* The NEPA analysis should address trade-offs between logging and dead wood habitat (especially when logging methods are regen or repeated thinning entries). Section 3.7.5 of the PA provides grossly inadequate analysis of the significant and long-lasting effects of logging on recruitment of dead wood habitat. The entire effects of the proposed action is 4 sentences long and provides no quantification of effects; no analysis showing that the effects of regen are even more significant and long-lasting than the effects of thinning; no disclosure that current LRMP standards for dead wood habitat are outdated and under-estimate the needs of wildlife; no description of effects of repeated thinning versus single entry thinning; no discussion weighing the small gain in individual tree diameter as a result of thinning compared to the significant adverse effects caused by thinning that reduces the population of green trees available for future snag recruitment; no comparison of future snag recruitment after logging to the dead-wood habitat needs of various wildlife species, e.g. DecAID, an example of which is provided below;



Curran Junetta Thin EA, <http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/32805_FSPLT2_053506.pdf>.

* The purpose and need should include carbon to address climate change. There is new information that should lead the FS to question the continued validity of timber production as a goal for these moist/productive public lands with such high potential for carbon storage. See detailed comments below;
* The trade-offs between logging and wood recruitment in riparian reserves. The analysis in Section 3.4.6.3 of the PA is inadequate. It fails to quantify the loss of wood recruitment in thinned vs unthinned riparian reserves. It fails to recognize that logging will sacrifice NWFP goals for riparian reserves that include optimal habitat for upland species that prefer abundant dead wood throughout the extent of the riparian reserves, not just instream. The PA is misleading when it says logging riparian reserves would result in a “slight reduction in the amount of large wood available for natural recruitment into streams.” In reality, logging the riparian reserves will cause a significant and long-lasting reduction is wood available for recruitment to riparian reserves. See graphic above from the Curran Junetta Thin EA;
* The need to conserve all mature forests to mitigate for the shortage of those forests as a result of past logging and fires. Early seral forest is not rare. It is highly abundant on non-federal land and in areas affected by fire, which are expected to increase as the planet warms. Meanwhile, accelerated disturbance expected as a result of climate change will make it more and more difficult to conserve and restore mature forests, so conservation of those forest must be a priority. The PA failed to address the detailed and multi-faceted rationale for conservation of mature forests in Heiken, Doug. 2009. The Case for Protecting Both Old Growth and Mature Forests, Version 1.8. Oregon Wild. <https://www.dropbox.com/s/4s0825a7t6fq7zu/Mature%20Forests%2C%20Heiken%2C%20v%201.8.pdf?dl=0>;
* Trade-offs between logging and spotted owl conservation, especially in light of new information about the adverse effects of thinning on spotted owl prey (red tree vole, red-backed vole, and flying squirrels). Logging suitable owl habitat also adversely affects the ability of spotted owls to co-exist with competing barred owls that have invaded the range of the spotted owl. Conservation of mature forests is more important today than when the forest plan was adopted. The PA dos not even mention barred owls and the implications for the Northwest Forest Plan. The NWFP reserve system and the rules allowing removal of mature forests in the matrix are based on an assumption that all suitable owl habitat would likely be available for spotted owls to use. The invasion of the barred owl undermines that assumption. Much of the suitable owl habitat that we thought would be available to spotted owls is now occupied and defended by barred owls. This means the reserves are effectively smaller than we assumed in 1994, and the adverse effects of logging mature forest are much greater than assumed in 1994. The PA failed to address this;
* Adverse effects of logging and roads on hydrology, including artificial peak flows during storms; and artificial low flows during summer. Perry & Jones (2016) found “… 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 “hydrologic recovery” following forest disturbance … “ 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://dx.doi.org/10.1002/eco.1790). <http://onlinelibrary.wiley.com/doi/10.1002/eco.1790/full>. Jones & Grant (1996) found “"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.” 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;
* The PA did not address the trade-offs between regen harvest and fire hazard. “[I]n the landscape we studied, intensive plantation forestry appears to have a greater impact on fire severity than decades of fire exclusion.” 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>. See also, Carter Stone, Andrew Hudak, Panelope Morgan 2008. Forest Harvest Can Increase Subsequent Forest Fire Severity. PSW-GTR-208, pp 525-534. <https://www.fs.fed.us/psw/publications/documents/psw_gtr208en/psw_gtr208en_525-534_stone.pdf>, *In* González-Cabán, Armando, tech. coord. 2008. Proceedings of the second international symposium on fire economics, planning, and policy: a global view. Gen. Tech. Rep. PSW-GTR-208, Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 720 p. <https://www.fs.fed.us/psw/publications/documents/psw_gtr208en/>. BLM's proposed regeneration harvest would leave only 6-8 trees per acre and would, in the short-term, increase fire hazard. AR 2697 ("As the stand develops it would represent a shrub fuel model with an increased fire behavior potential as vegetation occupies the site."). Lower Grave timber sale. *KS Wild v BLM.* (D. Or 2019) Case No.: 1:17-cv-997-CL. Judge Mark Clarke, Findings & Recommendations, Feb 20, 2019. The March 2003 Wildfire Effects Evaluation Project for the Umpqua National Forest clearly documents this disproportionate fire intensity of young managed vs. mature unmanaged stands. (“The young vegetation, including plantations, experienced a disproportionately high amount of stand replacement mortality caused by crown fires as compared to older, unmanaged forests. … Plantations had a tendency to increase the rate of fire spread and increased the overall area of stand replacement fire effects by spreading to neighboring stands.” p 4 “This early seral vegetation pattern, and the types and arrangement of fuels present, increased the fire’s rate of spread and the area of stand replacement fire effects.” p 64.) <http://web.archive.org/web/20041118062947/http://www.fs.fed.us/r6/umpqua/publications/weep/weep.html>.

The FS failed to consider the best available science, failed to develop alternatives to highlight the trade-offs raised in the NEPA process, and failed to take a hard look at these significant impacts of logging and roads. Some of these issues may be partially addressed in the specialists reports but the key information never made it into the PA, which is supposed to fairly and honestly inform the public and the decision-maker, and it can only do that by carefully documenting the all relevant environmental information that needs to be considered by the agency in making its decision, otherwise the decision is arbitrary and capricious.

**Access to Units During NEPA Process**

Meaningful public involvement in the NEPA process requires that the FS to ensure public access to units during the comment period. The FS must extend its administrative rights of access to the public in order to fulfill the purposes of NEPA.

**Carbon and Climate**

The FS failed to adequately address carbon storage and climate change. The PA says that forest conservation for carbon storage is incompatible with the forest plan requirements for action management in the matrix. This conflict might be partially true, but the forest plan is 25 years old. Significant new information indicates that the climate crisis facing humanity requires urgent attention. The FS needs to prepare a programmatic EIS to address the carbon consequences of logging. The carbon/climate analysis in the NWFP is inaccurate and outdated as explained below.

## The Purpose and Need should Address The Unmet Need for Carbon Storage

The agency says one of the purposes of this project is provide a supply of wood products to the public. The agency should reconsider this objective in light of the fact that the public needs carbon storage to reduce global climate change much more than they need wood products. The agency needs to recognize that wood products are already under-priced and over-supplied due to “externalities” (costs that are not included in the price of wood, so they 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 GHG emissions). Ecosystem carbon storage on the other hand is under-supplied because there is not a functioning market for carbon storage and climate services. The FS 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>.

The PA fails to a take a hard look at the fact that forest management decisions can make climate change worse (by logging), or better (by avoiding logging and letting forest grow). This is just the kind of trade-off that NEPA is designed to illuminate.

## Harmonize climate change mitigation and adaptation

The Carbon Report highlights the fact that thinning will make trees more resilient to the stresses likely to experience in a warmer world, but thinning also causes GHG emissions that make climate change worse and increase the stresses that trees will experience. The PA failed to take a hard look at the trade-offs between climate adaptation (e.g. stand density reduction), and climate mitigation (e.g. forest conservation for carbon storage). The FS should develop alternative that harmonize these trade-offs as much as possible.

The President has established a clear policy mandate to minimize and mitigate impacts of federal land use:

Section 1. Policy. It shall be the policy of the Departments of Defense, the Interior, and Agriculture; the Environmental Protection Agency; and the National Oceanic and Atmospheric Administration; and all bureaus or agencies within them (agencies); to avoid and then minimize harmful effects to land, water, wildlife, and other ecological resources (natural resources) caused by land- or water-disturbing activities, and to ensure that any remaining harmful effects are effectively addressed, consistent with existing mission and legal authorities. Agencies shall each adopt a clear and consistent approach for avoidance and minimization of, and compensatory mitigation for, the impacts of their activities and the projects they approve.

… Sec 2. Definitions … (f) "Mitigation" means avoiding, minimizing, rectifying, reducing over time, and compensating for impacts on natural resources. As a practical matter, all of these actions are captured in the terms avoidance, minimization, and compensation. These three actions are generally applied sequentially, and therefore compensatory measures should normally not be considered until after all appropriate and practicable avoidance and minimization measures have been considered.

…

Sec. 3. Establishing Federal Principles for Mitigation. … (b) Agencies' mitigation policies should establish a net benefit goal or, at a minimum, a no net loss goal for natural resources the agency manages that are important, scarce, or sensitive, or wherever doing so is consistent with agency mission and established natural resource objectives. When a resource's value is determined to be irreplaceable, the preferred means of achieving either of these goals is through avoidance, consistent with applicable legal authorities. Agencies should explicitly consider the extent to which the beneficial environmental outcomes that will be achieved are demonstrably new and would not have occurred in the absence of mitigation (i.e. additionality) when determining whether those measures adequately address impacts to natural resources.

Presidential Memorandum: Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment. Nov 3, 2015. <https://www.whitehouse.gov/the-press-office/2015/11/03/mitigating-impacts-natural-resources-development-and-encouraging-related> In the context of climate change this means that greenhouse gas emissions should be avoided and that the climate forcing effects of any emissions that do occur must be mitigated.

Sometimes climate change mitigation and adaptation are in complete harmony, such as protecting riparian forests that both store carbon and buffer streams from hydrological extremes caused by climate change. However, there are also times when efforts directed at climate change adaptation conflict with climate change mitigation goals. For instance, some people argue that we should reduce the density of federal forests so they are more resilient to soil-water stress caused by global warming. However, forest density reduction will accelerate the transfer of carbon from the forest to the atmosphere where it will contribute to global climate change.

Federal agencies must strive to harmonize climate change mitigation (carbon storage or avoided emissions) and climate change adaptation (making ecosystems more resilient to climate change). For example, if the agency uses climate change adaptation as a rationale for forest thinning, they must not only fully disclose the increased GHG emissions caused by their proposal, they must also consider alternatives that harmonize these competing goals, such as by thinning very lightly and retaining all of the medium and large trees that store most of the carbon.

There may be climate benefits from thinning but there will also be climate trade-offs in the form of carbon emissions, unless thinning is done very early in stand development. Schaedel et al (2017) said --

Thinning in second growth forests is often suggested as a climate change adaptation strategy (Bradford and D’Amato, 2012; Churchill et al., 2013), because thinning can be used to promote the development of complex stand structures

resilient to disturbances and drought. However, these climate change adaptation outcomes attainable with thinning generally require a tradeoff with climate change mitigation objectives: most studies have shown decreased forest C storage in thinned stands (Bradford and D’Amato, 2012).

...

We found that: (1) fifty-four years after PCT total aboveground C is similar across treatments, due primarily to the increase in mean tree C of trees grown at lower stand densities; (2) deadwood legacies from the pre-disturbance forest still play an important role in long-term C storage 62 years after current stand initiation, accounting for approximately 20–25% of aboveground C stores; and (3) given enough time since early thinning, there is no trade-off between managing stands to promote individual tree growth and development of understory vegetation, and maximizing stand level accumulation of aboveground C over the long term. We infer that early PCT can be used to simultaneously achieve climate change mitigation and adaptation objectives, provided treatments are implemented early in stand development before canopy closure and the onset of intense intertree competition.

Michael S. Schaedel, Andrew J. Larson, David L.R. Affleck, R. Travis Belote, John M. Goodburn, Deborah S. Page-Dumroese. 2017. Early forest thinning changes aboveground carbon distribution among pools, but not total amount. Forest Ecology and Management 389 (2017) 187–198. <https://www.fs.fed.us/rm/pubs_journals/2017/rmrs_2017_schaedel_m001.pdf>. There are actually conflicting results on pre-commercial thinning ...

... precommercial thinning (PCT) when the thinned trees have no commercial value, show inconsistent results. Some PCT studies of this type found that decreasing stand density decreased total forest C stores (Skovsgaard et al., 2006; Jiménez et al., 2011), while others noted that the increased growth rate of trees grown at lower densities can maintain or increase live tree C (Hoover and Stout, 2007; Dwyer et al., 2010), especially in the case of longer-term responses to thinning (Horner et al., 2010). Short-term studies of PCT effects on aboveground C have shown consistent decreases in aboveground C (Campbell et al., 2009; De las Heras et al., 2013; Jiménez et al., 2011; Dwyer et al., 2010), indicating that low densities of small trees do not fully occupy the site (Turner et al., 2016). Given these conflicting results, it is still unclear whether PCT is compatible with the climate change mitigation goal of forest C storage (Jiménez et al., 2011).

This is important because, even if thinning provides climate benefits in future decades, short-term carbon emissions conflict with climate policy priorities. The next few decades are critical to achieving goals related to decarbonizing our economy. Delayed climate benefits should be strongly discounted because we should have decarbonized our economy by then, so future effects are not mearly as important as as near-term effects. If thinning causes a short-term pulse of GHG emissions, that’s a problem.

The Oregon Global Warming Commission’s Roadmap to 2020 (<https://www.keeporegoncool.org/roadmap-to-2020/>) guides the state’s efforts to meet its legislatively mandated GHG emissions reduction goals, including broad objectives for increasing carbon storage in Oregon forests.

The Roadmap also set out general strategies for dry forests east of the Cascade Mountains versus moist west of the Cascades. Based on improved understanding of the carbon storage capacity of the state’s forests, the 2017 Global Warming Commission Report explained that, “The Roadmap sees ‘Eastside forests . . . managed primarily for ecosystem restoration, safety and climate adaptation with a minimum of incurred carbon (loss). West-side forests (are) managed . . . to increase carbon storage . . . private forestlands (are) managed primarily for production of timber and wood products . . . ’ with carbon stores remaining stable or increasing”.

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/1999-4907/9/10/618>. Following this strategy will require the agencies to retain all medium and large trees that store carbon and that do not pose a substantial fire hazard.

The agencies often claim that density reduction treatments are expected to increase the resiliency of treated stands to the projected effects of climate change. But this small increase in resiliency comes at a tremendous cost. The NEPA analysis needs to disclose and consider the fact that logging will result in greenhouse gas emissions that make climate change worse. Think about that trade-off. Logging might make a small area more resilient to climate change while making climate conditions (and ocean acidification) worse for ecosystems all over the rest of the world. This significant trade-off needs to be carefully evaluated in the NEPA document.

Even well-intentioned logging also has impacts that make ecosystems less resilient to climate change. For instance, (i) roads and soil degradation make watershed less resilient to the expected effects of the amplified hydrologic cycle; (ii) reduction of complex forest structure and dense forest conditions makes certain species populations less resilient to climate change, including species associated with relatively dense forests and species associated with snags and dead wood. These species are already stressed by the cumulative effects of non-federal land management and fragmentation caused by past and ongoing management on federal lands; (iii) Also, “High overstory density can be resilient” when ladder fuel are absent and there is a gap between surface and canopy fuels. Terrie Jain (2009) Logic Paths for Approaching Restoration: A Scientis’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/](http://ecoshare.info/projects/central-cascade-%20adaptive-management-partnership/workshops/restoring-westside-%20dry-forests/). New information indicates that El Ninos will likely become stronger even if we are able to limited warming to 1.5 degrees C. Guojian Wang, et al. 2016. Continued increase of extreme El Niño frequency long after 1.5 °C warming stabilization. Nature Climate Change (2017). doi:10.1038/nclimate3351. <https://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate3351.html>. A bet-hedging strategy should retain trees of all sizes and stands of various densities. “Removal of most small trees to reduce wildfire risk may compromise the bet-hedging resilience, provided by small trees and diverse tree sizes and species, against a broad array of unpredictable future disturbances.” William L. Baker and Mark A. Williams. 2015. Bet-hedging dry-forest resilience to climate-change threats in the western USA based on historical forest structure. Front. Ecol. Evol., 13 January 2015 | doi: 10.3389/fevo.2014.00088. <http://journal.frontiersin.org/Journal/10.3389/fevo.2014.00088/full>

Also, wildfire is mostly climate driven, not fuel driven, and the actual effects of fuel reduction on the spatial extent of wildfires is highly variable and fairly modest. “Analysis of simulation results from the 14 wildfires indicates that fuels treatments reduced the average size of any given wildfire by an estimated 7.2%, with amount of change correlated with the proportion of the landscape treated (Spearman’s correlation *p*=0.692, n=14; P=0.008).” M. A. Cochrane, C. J. Moran, M. C. Wimberly, A. D. Baer, M. A. Finney, K. L. Beckendorf, J. Eidenshink, and Z. Zhu. 2012. Estimation of wildfire size and risk changes due to fuels treatments. International Journal of Wildland Fire.  <http://dx.doi.org/10.1071/WF11079>. <http://www.publish.csiro.au/?act=view_file&file_id=WF11079.pdf>. This raises a serious question whether the modest increase in resilience really justifies the adverse effects of landscape fuel treatments on climate, wildlife, soil, water, etc.

When all these trade-offs are considered, we feel that climate change mitigation should receive emphasis over climate adaptation on federal land management (especially when adaptation efforts come with significant trade-offs). When climate change mitigation and adaptation may be in conflict, the agency needs to focus on reducing GHG emissions (or maintaining carbon stores). These mitigation actions are more important because (i) mitigation is shown to be more challenging (institutionally) and it is perennially under-achieved, (ii) mitigation has global benefits, and (iii) mitigation ultimately reduces the need for adaptation. An emphasis on mitigation is in accord with international law, e.g. the European Convention on Human Rights:

The court emphasises that the [State’s duty of care] first and foremost should concern mitigation measures, as adaptation measures will only allow the State to protect its citizens from the consequences of climate change to a limited level. If the current greenhouse gas emissions continue in the same manner, global warming will take such a form that the costs of adaptation will become disproportionately high. Adaptation measures will therefore not be sufficient to protect citizens against the aforementioned consequences in the long term. The only effective remedy against hazardous climate change is to reduce the emission of greenhouse gases.

*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>

“According to a recently published analysis, increasing carbon storage could lead to more favorable conditions for northern spotted owls, pileated woodpeckers, olive-sided flycatchers, Pacific marten and red tree voles. These species may benefit from management policies that favor less intensive logging and longer periods between tree harvests.” Nick Houtman 2016. Storing more carbon in western Cascades forests could benefit some wildlife species, not others. Phys.org News. November 17, 2016. <http://phys.org/news/2016-11-carbon-western-cascades-forests-benefit.html>, <http://onlinelibrary.wiley.com/doi/10.1002/eap.1358/abstract>

## The NWFP EIS analysis of carbon and climate change is outdated and inaccurate.

The agency cannot tier to the carbon and climate change analysis in the NWFP FSEIS analysis because it is outdated and inaccurate. The 1994 FSEIS includes many flawed assumptions and assertions such as

* The 1994 FSEIS says “… young, fast-growing trees store less carbon in total, they are expected to absorb more carbon from the atmosphere than older trees” (p 3&4-50) and “In mature and old-growth stands, release and absorption of carbon dioxide tend to be in balance.” (p 3&4-50) In fact, new science indicates that old forests continue to grow and add carbon. See 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/nature12914 <http://www.nature.com/nature/journal/vaop/ncurrent/full/nature12914.html> (“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’s total leaf area that outpace declines in productivity per unit of leaf area and, among other factors, age-related reductions in population density.”) Also, “Studies here [at the Wind River Canopy Crane] also proved it doesn't make sense from a global-warming perspective to cut older forests and replace them with seedlings, which grow faster and had been thought to absorb more carbon dioxide. Old forests are storehouses for such vast amounts of carbon that it would take many decades for new forests to catch up on the carbon balance sheet.” Sandi Doughton. Trees giving bizarre clues to climate change. Seattle Times. Nov 27, 2007. <http://seattletimes.nwsource.com/html/localnews/2004037053_trees27m.html>.
* The 1994 FSEIS says “Wildfires have effects similar to logging, but over a shorter period of time.” (p 3&4-50) In fact, wildfire tends to release much less carbon because logging removes the large wood where most of the carbon is stored, while fire tends to consume small fuels containing less carbon, leaving most of the large fuels (where most of the carbon is stored) unconsumed.

**Myth:** Forest fires release carbon stored in forests so forests are not good places to store carbon. Managing forests for carbon storage requires that we continue to practice aggressive fire suppression.

**Fact:** Forest fires do release CO2 to the atmosphere, but taking a long-term view, forest fires represent a temporary localized dip in the landscape carbon pool that should eventually return to high levels with proper management. When evaluating the carbon consequences of fire we must also account for the decades and sometimes centuries between fires when photosynthesis and carbon uptake dominate the system. Also, when fires burn, only a small fraction of the total forest biomass is converted to greenhouse gases and lost to the atmosphere. Due to the incomplete combustion of large wood, 70-80 percent of the carbon in tree stems may remain after forest fires, and globally, 23 times more carbon is captured by photosynthesis than is emitted by fires.[[1]](#footnote-1) Even after a forest fire, most of the carbon remains in the forest and contributes to carbon sequestration.[[2]](#footnote-2) So called "salvage logging" would tend to exacerbate the carbon released by the fire because it would (a) disturb soils and release soil carbon, (b) convert the largest, longest-lasting logs into short-lived wood products, and (c) reduce the piece-size of the remaining material resulting in higher rates of decomposition. Aggressive fire suppression is not wise because it will only make future fires more severe and exacerbate  future emissions of GHGs. The goal should be to reestablish natural and resilient disturbance regimes. In many areas this will mean large trees with thick bark and high canopies that store lots of carbon while remaining resistant to fire.

Oregon Wild 2011. The straight facts on forests, carbon, and global warming. <http://tinyurl.com/2n96m5>. See also this slide show clarifying many misconceptions about forests, logging, and carbon:

<http://www.slideshare.net/dougoh/forest-carbon-climate-myths-presentation/>

* The 1994 FSEIS says “The restoration silviculture permitted under Alternatives 3 and 9 … including prescribed underburning, may reduce forest susceptibility to large, stand-replacing fires. Thinning of small diameter trees in Late-Successional Reserves will accelerate the carbon dioxide absorption of the younger forest stands. Watershed/landscape-level emission trade-off analyses, as described in the following Air Quality Analysis, can determine an optimal level of fuel treatment to reduce carbon dioxide emissions. Thus, it is likely that Alternatives 3 and 9 would have the least impact on the global carbon dioxide balance in spite of having larger harvest levels than some of the other alternatives.” (3&4 – 51). New science indicates that logging for fuel reduction (or any other reason) is unlikely to provide carbon benefits. In almost all cases, the carbon that is removed by logging vastly exceeds the carbon gained by thinning or reducing fire effects. See 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:10.1890/110057 <http://scholarsarchive.library.oregonstate.edu/xmlui/bitstream/handle/1957/26174/CampbellJohn.Forestry.CanFuelReductionTreatments.pdf>. 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. 643–655. <http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_mitchell001.pdf>. 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) 1427–1435. 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; 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>; 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>.

Since there are significant trade-offs between logging and carbon storage, and since the 1994 FSEIS incorrectly analyzed the effects of logging, incorrectly assumed that logging would enhance carbon storage, and underestimated the importance of forests for carbon storage and climate change mitigation, the agency now has a duty to reconsider and rebalance the different uses of the forest and shift emphasis from logging toward carbon storage. This is especially important in this case, where the proposes to conduct logging that is likely to have a significant long-term impact on forest carbon storage, and this proposal is justified on the basis of following the forest plan which did not address carbon and climate issues. The agency needs to prepare an EIS to deal with this as a significant issue and it needs to address this issue on a programmatic level. The agencies’ timber sale program may require reconsideration in light of climate change and the critical need for additional carbon storage.

## Do not rely on the flawed boilerplate climate analyses

The PA refers to a “[Climate Change Report](https://www.fs.usda.gov/nfs/11558/www/nepa/105362_FSPLT3_4630795.pdf)” that is incomplete and misleading.

We are very dissatisfied with the Forest Service’s boilerplate NEPA analysis regarding carbon and climate. It 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 “deforestation.” 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. Do not use the boilerplate NEPA language from the regional office which is flawed in many ways:

* 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;
* Don’t try to say that this project is harmless because it’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.
* Thinning for forest health does not mean logging emissions are justified or mitigated. Logging does not increase the capacity for growing trees. To the contrary, logging harms soil and reduces site productivity.
* Do 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 NEPA alternatives over time, so please describe the carbon emissions and carbon storage in the forest over time *with 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 fire alone.
* Carbon storage in wood products is not 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.

## Cumulative Impacts of GHG Emissions Must not be Minimized

The carbon report associated with the PA says “A project of this magnitude makes an infinitesimal contribution to overall emissions. “ The NEPA analysis must avoid minimizing this project’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’t make a difference in the global scheme of the climate problem, but as Voltaire said, "No snowflake in an avalanche ever feels responsible.” 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*. “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.” H. Damon Matthews and Ken Caldeira. 2009. Stabilizing climate requires near-zero emissions. Nature Vol 455 | 18 September 2008 | doi:10.1038/nature07296.

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’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’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, … [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](http://web.archive.org/web/20080610172128/http:/www.supremecourtus.gov/opinions/06pdf/05-1120.pdf))

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’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 CO2 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’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’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 “cannot be expected to convert curies or mrems into such costs as cancer deaths,” the EIS’s readership cannot be expected to understand whether an individual project’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’n*, 685 F.2d 459, 487 n.149 (D.C. Cir. 1982) rev’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 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’ 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. § 1502.22(b)(4).

Any assertion that it is impossible to discuss the impact or significance of the Project’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’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 carbon report included with the PA says “The main activity in this sector associated with GHG emissions is deforestation, which is defined as removal of all trees for the conversion of forest into agricultural land or developed landscapes (IPCC 2000). ... This project does not fall within any of the main contributors of greenhouse gas emissions: forested land will not be converted to agriculture or be converted to other non-forest uses.” 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 “forest degradation” 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 “forest degradation” i.e., Reducing Emissions from Deforestation and Forest Degradation (REDD). This clearly refutes the agency’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.

“…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 … 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”

<http://www.climatesciencewatch.org/file-uploads/Copenhagen_Accord.pdf>. This likely requires reducing atmospheric CO2 concentrations below 350 ppm[[3]](#footnote-3) 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> (“Enormous amounts of carbon are released into the atmosphere when forests are cleared. “**Forest degradation” activities, such as selective logging, … are also significant emissions sources**.”)

**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’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’s the amount of carbon, the research calculated, that could reside in the world’s vegetation — so not in the atmosphere — 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’s potential vegetation — 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 “management.” With the latter, many trees and other types of vegetation are subtracted from forests — often the larger and older trees due to logging — but the forests as a whole don’t disappear. They’re just highly thinned out.  
“This effect is quite massive, more massive than we expected actually,” Erb said.  
...  
The research means that so-called degraded land — not fully deforested but not “natural” or whole, either — is a phenomenon to be reckoned with.  
“It suggests that the amount of carbon released to the atmosphere from land use is approximately equal to the amount still retained,” said Tom Lovejoy, an ecologist at George Mason University who was not involved in the work. “That means the restoration agenda is even more important than previously thought and highlights the enormous amount of degraded land in the world.”  
...  
“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,” Phil Duffy, president of the Woods Hole Research Center, said in an email.  
“This paper suggests that restoring vegetation around the world could in principle achieve that,” Duffy continued, noting that if all the potential vegetation were restored it would offset some 50 years of global carbon emissions. While “the full theoretical potential will never be realized in practice … this paper indicates that restoring vegetation could make an extremely important contribution to controlling global climate change.”

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](https://www.nature.com/articles/nature25138.epdf?referrer_access_token=AmG5brx_IASERhmJverWl9RgN0jAjWel9jnR3ZoTv0NirJkvwWx4SyxNfQ6HSmxzxqqZAANXNnLuatTe8oLumy8xaQxUd_1g_013OmtCbricjv4GoVo9VJ5ssO5K2RQhmSYii7rJeYoxF8Lkb5CIKhsm1yIsw9QNdNDCRtpvmHMCXVOH0UBHSE_DrTpHZiCWSTLd6ApZpSjkNsiY9ZHeqtaUmcdUx5Yu4LBybsurghysOsdm_vFJMfGB8cjKXGTIaRonXgp1tIGTaqA58oo3Cns4w6fxeIeJVX7bZEgSq6uhnaQeb9omahqkNN2K5IcqN-Kuk5Ag41jw6LsRh_8FOpKBxwXBUs8nniPkZbc4t0sij5tEnRwnL8wxHwM4rSK_h33VtNvWUjC_q3ZbJPZ0oA%3D%3D&tracking_referrer=www.washingtonpost.com)

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 benefitsof forest conservation.

… Dynamic global vegetation model simulations suggest that CO2 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 CO2 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. …

…

**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’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 — 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 realistically16,19–21 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. …

…

**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) — 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>

## Logging Does Not Increase Capacity for Growing Trees

The NEPA analysis suggests that logging will increase forest productivity, but there is no evidence that this is true. The carbon report included with the PA says “Projects like the proposed action that create forests or improve forest conditions and capacity to grow trees are positive factors in carbon sequestration.” This is false.

“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 “within a decade or two” 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 ).”

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 “capacity to grow trees” (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 “improve forest conditions” in way that justifies logging that increases carbon emissions at the expense of 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’s carbon balance: doubts, certainties and implications. Climatic Change (2013) 121:801–814. 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> (“A first-order model shows that biofuels are beneficial only to the extent that their production effectively enhances net ecosystem production.”).

## Risk reduction logging does not help store carbon.

The carbon report associated with the PA says “The release of carbon associated with this project is justified given the overall change in condition increases forest resistance to release of much greater quantities of carbon from wildfire, drought, insects/disease, or a combination of these disturbance types (Millar 2007)” This is inaccurate and misleading.

Logging proponents often claim that logging will increase carbon storage controlling 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 “base rate fallacy” or “neglecting priors” 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>

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’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 … 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 CO2 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 ‘negative emissions’ *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 …

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.

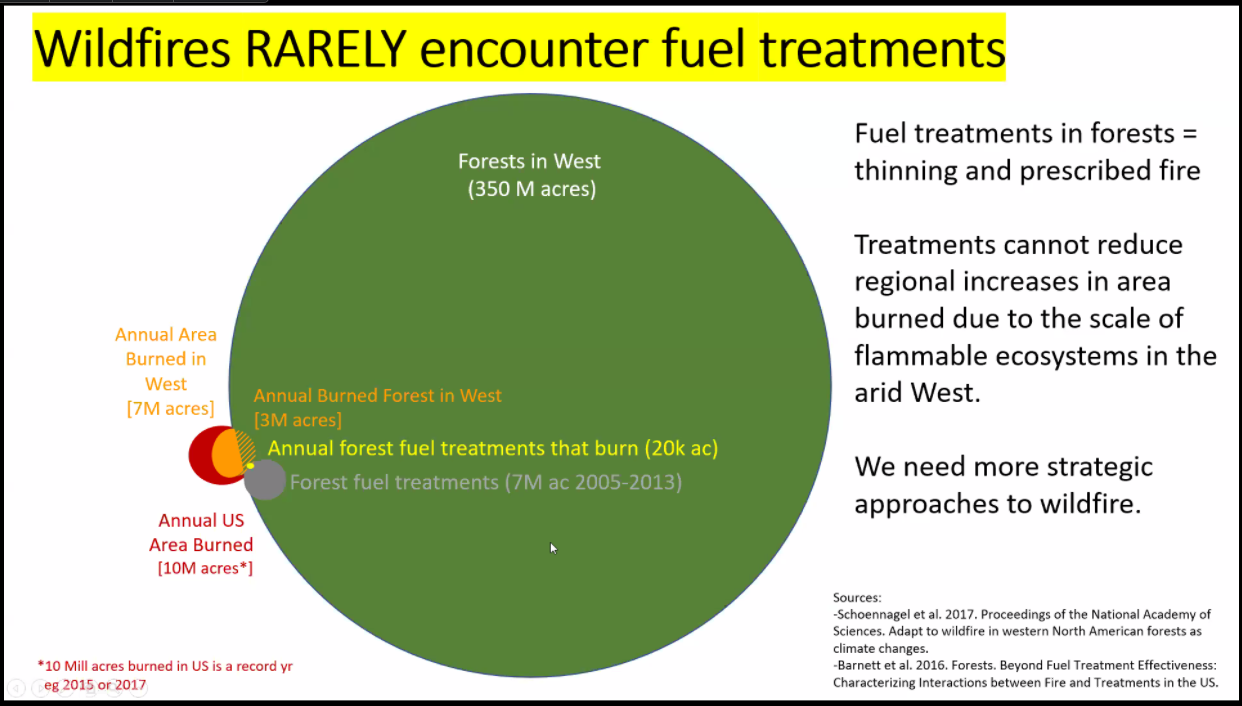
Law, B. & M.E. Harmon 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to mitigation and adaptation of forests to climate change. Carbon Management 2011 2(1). <https://content.sierraclub.org/ourwildamerica/sites/content.sierraclub.org.ourwildamerica/files/documents/Law%20and%20Harmon%202011.pdf>.

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

… 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, … 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:10.1890/110057 <http://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’Connell. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. 19(3), 2009, pp. 643–655. <http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_mitchell001.pdf>. (“…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…. We suggest that forest management plans aimed solely at ameliorating increases in atmospheric CO2 should forego fuel reduction treatments …”)
* 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) 1427–1435. <http://www.fs.fed.us/rm/pubs_other/rmrs_2010_reinhardt_e002.pdf> (“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. … Our results show generally long recovery times …”)
* 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> (“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.”)
* 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> (“… 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). … 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).)”
* 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: “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.”)
* 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> (“[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 … [T]reatment activities produce an immediate carbon emission while future wildfire emissions are uncertain … Depending on the intensity of treatment, the quantity of carbon removed may be substantial enough to negate gains from avoided wildfire emissions. … 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.”)
* 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>. (“’The take-home message is we could not find a greenhouse gas benefit from treating forests to reduce the risk of fire,’ 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.”)
* Rachel A. Loehman, Elizabeth Reinhardt, Karin L. Riley 2014. Wildland fire emissions, carbon, and climate: Seeing the forest and the trees – A cross-scale assessment of wildfire and carbon dynamics in fire-prone, forested ecosystems. Forest Ecology and Management 317 (2014) 9–19. <http://www.fs.fed.us/rm/pubs_other/rmrs_2014_loehman_r001.pdf> (“… 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).”)
* 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> (“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 … [A]ll treatment scenarios resulted in higher C emissions than the no-treatment scenarios.”)

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. 643–655 <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)

… 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. … 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) 1427–1435.

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:**

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

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

• Over multiple fire cycles, forests that burn less often store more C than forests that burn more often

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

…

**Conclusions**

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

…

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.

…

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:10.1890/110057 <http://forestpolicypub.com/wp-content/uploads/2011/12/campbell-2011.pdf> It is important to recognize that “the equilibrium between growth and mortality” 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:

“All studies agree unequivocally that untreated stands release more emissions to the atmosphere during wildfire than treated stands…. 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 2.0–4.2% 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 ‘‘best-case scenario’’ 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). … 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. … 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). … 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 – 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>.

**Disclose the Social Cost of Carbon Dioxide as a proxy for the impacts of GHG emissions**.

The PA (p 55) says “A quantitative carbon analysis was not conducted for this project because it would not likely lead to changes to the proposed action or to the creation of other alternatives that achieve the purpose and need.” This is improper. Carbon emissions associated with logging should be quantified. Consideration of carbon storage in the context of forest management absolutely DOES lead to different alternatives, such as less logging, more green tree retention. There are tools available such as “social cost of carbon” that can help the public and the decision-maker understand the climate consequences of carbon emissions of different levels of logging relative to other quantifiable economic values, such as the value of timber products or the number of jobs created. The FS chose to quantify jobs, but not the social cost of carbon dioxide emissions. This is arbitrary and capricious.

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 “the greatest good to the greatest number” 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 “climate misery index” related to the human impacts of greenhouse gas emissions. CEQ’s draft guidance on NEPA and Climate Change recognizes that the Social Cost of Carbon Dioxide (SCC) is a “harmonized, interagency metric that can provide decision-makers and the public with some context for meaningful NEPA review.” 79 Fed. Reg. 77802, 77827. “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. Ruth Greenspan and Dianne Callan, World Resources Institute, More than Meets the Eye: The Social Cost of Carbon in U.S Climate Policy, in Plain English (July 2011) at 1, <http://pdf.wri.org/more_than_meets_the_eye_social_cost_of_carbon.pdf>; Wentz, J. 2016. EPA’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’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 “paid for” 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—locally, nationally, and globally—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:

*• Outweigh the additional timber-related benefits by 2-to-1.*

*• Equal $91,000 per additional timber-related job.*

*• 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:

*• Outweigh the additional timber-related benefits by more than 30-to-1.*

*• Equal $1.6 million per additional timber-related job.*

*• 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 2015–2. <http://static1.1.sqspcdn.com/static/f/551504/26259333/1432605642583/SocialCostsOfCarbonOClandsNiemiMay2015.pdf?token=wDqoa5RkP8EoBLlsRWIPPRuahzg%3D>. Niemi (2015) explained that “Moore and Diaz (2015) found that accounting for the impacts of climate on economic growth increases the Interagency Working Group’s estimates of the social cost of carbon by a factor of six.” c*iting* Moore, F.C., and D.B. Diaz. 2015. “Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy.” Nature Climate Change. 12 January. <http://www.eenews.net/assets/2015/01/13/document_cw_01.pdf> (“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.”)

The Trump administration’s new estimate of the social cost of carbon dioxide emissions cannot be used in NEPA analyses because it includes only effects in the U.S., and excludes effects occurring in other countries. NEPA does not allow such as arbitrary distinction. CEQ requires that “Agencies must analyze indirect effects, which are caused by the action, are later in time or farther removed in distance, but are still reasonably foreseeable,.… CEQ has determined that agencies must include analysis of reasonably foreseeable transboundary effects of proposed actions in their analysis of proposed actions in the United States.” July 1, 1997 Memo from CEQ Chair Kathleen McGinty to the Heads of Agencies, RE: Transboundary Environmental Impacts. <http://ceq.hss.doe.gov/nepa/regs/transguide.html>

NEPA does not require agencies to monetize adverse impacts in all cases. See 40 C.F.R. § 1502.23. The statute does, however, require agencies to take a hard look at the “ecological …, aesthetic, historic, cultural, economic, social, [and] health,” effects of its actions, “whether direct, indirect, or cumulative.” 40 C.F.R. § 1508.8. Monetization of costs may be required where available “alternative mode[s] of [NEPA] evaluation [are] insufficiently detailed to aid the decision-makers in deciding whether to proceed, or to provide the information the public needs to evaluate the project effectively.” *Columbia Basin Land Prot. Ass’n v. Schlesinger*, 643 F.2d 585, 594 (9th Cir. 1981); see also *Ctr. for Biological Diversity v. Nat’l Highway Traffic Safety Admin*., 538 F.3d 1172, 1201 (9th Cir. 2008) (NHTSA violated NEPA where it failed to monetize the benefits of GHG emission reductions from more stringent fuel economy standards even while it monetized the adverse costs of such standards due to depressed automobile sales and employment). In another recent case concerning an energy infrastructure project, where the agency’s NEPA analysis quantified greenhouse gas emissions but claimed that it was impossible to discuss the effects thereof, the court ruled that the agency’s refusal to use the social cost of carbon to illustrate the impact of these emissions was arbitrary and capricious. *High Country Conservation Advocates v. United States Forest Serv.*, 52 F. Supp. 3d 1174, 1190-91 (D. Colo. 2014); see also *Montana Envt’l Info. Ctr. v. U.S. Office of Surface Mining*, 274 F. Supp. 3d 1074, 1097 (D. Mont. 2017), amended in part, adhered to in part sub nom. *Montana Envtl. Info. Ctr. v. United States Office of Surface Mining*, No. CV 15-106-MDWM, 2017 WL 5047901 (D. Mont. Nov. 3, 2017).

Although they likely underestimate the true costs of GHG emissions, the IWG’s social cost metrics remain the best estimates yet produced by the federal government for monetizing the impacts of GHG emissions and are “generally accepted in the scientific community,” 40 C.F.R. § 1502.22(b)(4). This is true notwithstanding Executive Order 13,783, which disbanded the Interagency Working Group and formally withdrew its technical support documents. Exec. Order. No. 13,783 § 5(b), 82 Fed. Reg. 16,093 (Mar. 28, 2017). Indeed, that Executive Order did not find fault with any component of the IWG’s analysis. To the contrary, it encourages agencies to “monetiz[e] the value of changes in greenhouse gas emissions” and instructs agencies to ensure such estimates are “consistent with the guidance contained in OMB Circular A-4.” *Id.* § 5(c). The IWG tool, however, illustrates how agencies can appropriately comply with the guidance provided in Circular A-4: OMB participated in the IWG and did not object to the group’s conclusions. As agencies follow the Circular’s standards for using the best available data and methodologies, they will necessarily choose similar data, methodologies, and estimates as the IWG, since the IWG’s work continues to represent the best estimates presently available. Richard L. Revesz et al., Best Cost Estimate of Greenhouse Gases, 357 SCIENCE 6352 (2017) (explaining that, even after Trump’s Executive Order, the social cost of greenhouse gas estimate of around $50 per ton of carbon dioxide is still the best estimate), <http://policyintegrity.org/files/publications/Science_SCC_Letter.pdf>. Thus, the IWG’s 2016 update to the estimates of the social costs of greenhouse gases remains the best available and generally accepted tool for assessing the impact of greenhouse gas emissions, notwithstanding the fact that this document has formally been withdrawn. U.S. Interagency Working Group on the Social Cost of Greenhouse Gases (IWG), “Technical support document: Technical update of the social cost of carbon for regulatory impact analysis under executive order 12866 & Addendum: Application of the methodology to estimate the social cost of methane and the social cost of nitrous oxide” (August 26, 2016), available at <https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf>. The estimates of social cost are based on reasonable forecasts of the actual physical effects 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’ pro rata contribution to these environmental problems. As explained above, 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. § 1502.22(b)(4). Uncertainty as to the most appropriate discount rate to use in calculating the SCC is a reason to provide social cost estimates using the range of plausible rates—which FERC and other agencies have done (See, e.g., FERC, Final EIS, Constitution Pipeline and Wright Interconnect Projects, CP13-499 (Oct. 2014), Accession No. 20141024-4001, at 4-256 to 4-257 (“For 2015, the first year of project operation, … the project’s social cost of carbon for 2015 would be $1,638,708 at a discount rate of 5 percent, $5,325,802 at 3 percent, and $8,330,100 at 2.5 percent.”))— but it is not a reason for ignoring the social cost of greenhouse gas emissions entirely. *Center for Biological Diversity* 538 F.3d at 1200 (disagreement over cost of carbon emissions does not allow agency to forgo estimating cost where, “while the record shows … a range of values, the value of carbon emissions reduction is certainly not zero.”).

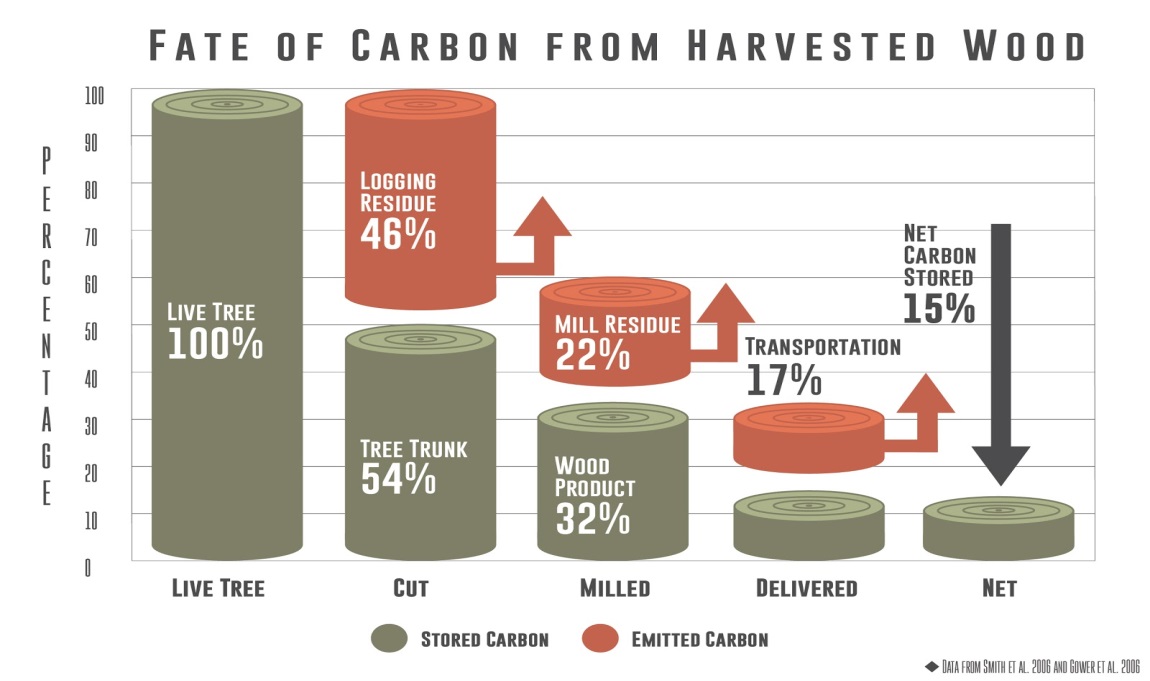
Any assertion that it is impossible to discuss the impact or significance of the Project’s greenhouse gas emissions is arbitrary. Agencies must use available generally accepted tools to address the impact of these emissions, 40 C.F.R. 1502.22, and employ reasonable forecasting in its analysis. The agency’s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

## The Carbon Value of Wood Products is Over-estimated.

The carbon report says “Utilizing trees to create long-lived wood products sequesters carbon (IPCC 2007) (FAO 2007) (Stavins 2005) (Upton 2007). Some have shown that using wood to build houses has a more favorable carbon balance when compared to other building materials such as steel, concrete or plastic (Wilson 2006).” This is inaccurate and misleading. Wood products represent net carbon emissions, NOT carbon sequestration, because only a small fraction of the carbon in a logged forest ends up in wood products. Logging causes the majority of forest carbon to be transferred to the atmosphere, not wood products.

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

*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.



*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 “throw-away” 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> (“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 (25–65%) 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 0.35–1.25% 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.”)

*Reliance on wood products prevents forests from reach their potential for carbon storage.* Shanks (2008) said “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.” 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>.

*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’s WOPR 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.

*A lot of wood products are “stored” in landfills where they emit methane which has a global warming effect much greater than CO2.* 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>. (“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. … 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.”)

*Living trees, even if they are “suppressed” 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 “maximize durability while minimizing … damage”. 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>

*The “substitution” value of wood products is vastly over-estimated.* The timber industry must not be allowed to continue business-as-usual and call it “climate friendly” 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 CO2during 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](http://www.corrim.org/reports/2005/swst/140.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’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 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’s efforts to show a “substitution” 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’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.

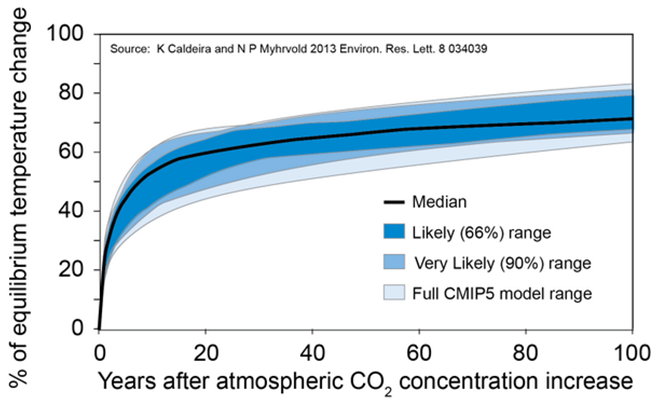
The benefits of wood product substitution are vastly over-stated:

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 “demand reduction.” 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/>

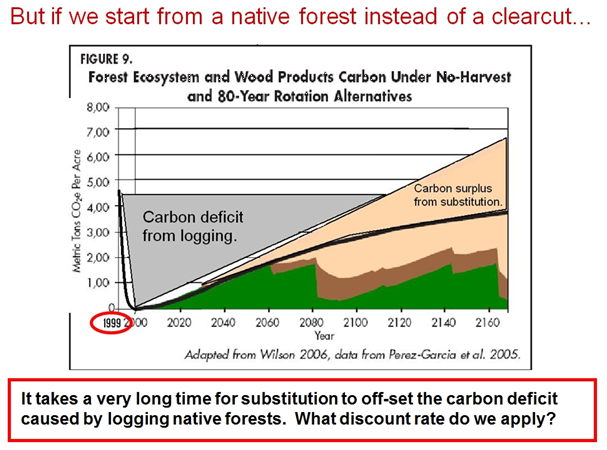
3) Substitution is speculative because the alleged benefits are in the distant future, and it takes more than a century to off-set the carbon emissions (carbon debt) caused by logging forests. Only a small fraction of the carbon in a logged forest ends up in long-term storage in wood products. Most of 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’Neill. 2018. The Paris Agreement zero-emissions goal is not always consistent with the 1.5 °C and 2 °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>.

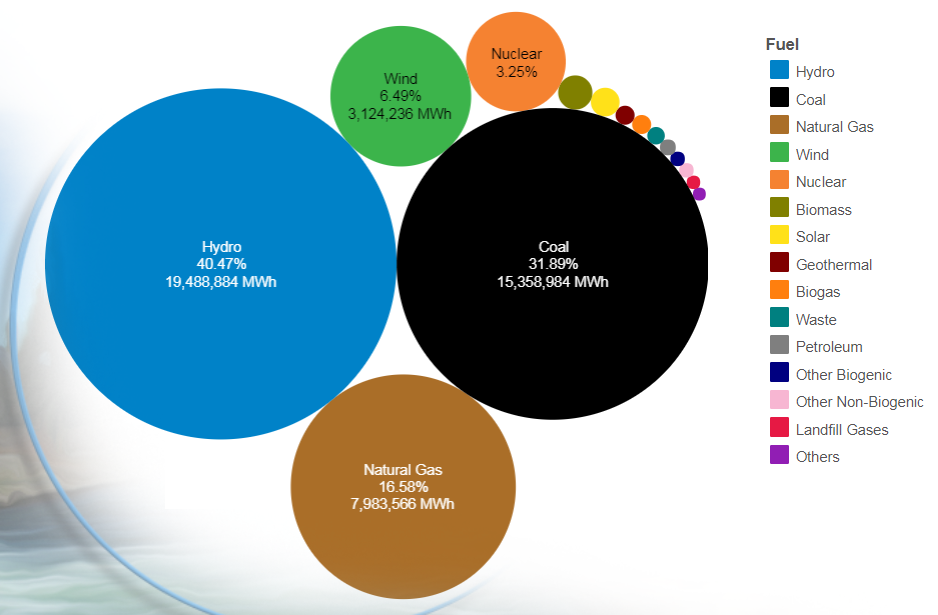
4) Many analyses of substitution fail to account for the carbon debt associated with logging. They do this by starting with "bare ground" instead of an existing forest, which biases the analysis by crediting wood products with growing the forest in the first place instead of debiting wood products for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



5) 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.

6) 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> (“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. “High-blend” 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 “carbon-cured” 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.”). 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>.

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 <http://www.pnas.org/content/pnas/early/2018/03/13/1720064115.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 “stores” 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’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/1999-4907/9/10/618> *citing* Franklin, J.; Johnson, N.; Johnson, D. Ecological Forest Management; Waveland Press: Long Grove, IL, USA, 2018.

… 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) 4–14. <http://terraweb.forestry.oregonstate.edu/pubs/law.fmec.2015.pdf>

​Law & Harmon conducted a literature review and concluded …

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:  
·  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 – they could be positive, neutral or negative;  
·   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;  
·  Dead wood and soil carbon stores are either not included or assumed to be constant;  
·  In one LCA, dead wood is not present in older forests, contrary to findings in the extensive ecological literature;  
·  The wood product pool is assumed to be an increasing carbon stock over time.

…

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 CO2 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 [9–11,31]; 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.

…

**Life cycle analysis (including substitution, proposed considerations)**

…

·       **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. DOl: 10.1007/510021-009-9256-2 ECOSYSTEMS. <https://www.fs.fed.us/pnw/pubs/journals/pnw_2009_harmon001.pdf>

Each substantive issue discussed in these comments should be (i) incorporated into the purpose and need for the project, (ii) incorporated into a NEPA alternative, (iii) carefully analyzed 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

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