



OREGON WILD

Formerly Oregon Natural Resources Council (ONRC)

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5 June 2019

TO: PNW Regional Forester, Objections Reviewing Officer
VIA: objections-pnw-regional-office@fs.fed.us

Subject: 36 CFR 218 objection of the Kew Vegetation Management Project

Dear Forest Service:

In accordance with 36 CFR 218, Oregon Wild hereby objects to the project described below.

DOCUMENT TITLE: Kew Vegetation Management and Forest Plan Amendments
Project DRAFT Decision Notice and Finding of No Significant Impact

PROJECT DESCRIPTION:

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Table 1 Summary of Alternative 2 activities

		Alternative 2
Total Footprint Acres		6,818
Overstory Tree Treatments (acres)	Commercial Thinning (HTH) (Thinning from below favoring largest and healthiest ponderosa pine)	2,395
	Selection Cut / Uneven-aged Management (HSL) (Removal of mostly lodgepole pine and white fir and thinning of ponderosa pine to release ponderosa pine; about 15% in openings to be planted to ponderosa pine)	2,365
	Shelterwood (HSH) (Release large old remnant ponderosa pine by removing white fir and lodgepole pine)	71
	Overstory Removal (HOR) (Final removal of overstory lodgepole pine to release established immature understory)	80
	Final Removal (HFR) (Even-aged regeneration in a previously established seed tree or shelterwood unit, understory may not yet be fully developed)	502
	Improvement Cut (HIM) (Manage stands along Cascade Lakes Highway for various scenic, safety and forest health objectives)	17
	Regeneration Cut (HCC) / (HCR) (Cut lodgepole pine to develop new understory. The incoming understory would be managed as a single aged stand)	202
	Skid & Deck (Larger-diameter ponderosa pine plantation thinning)	71
	Total	5,703
	Volume Recovered (MMBF)	15.3
Understory Tree Treatments (acres)	Precommercial Thinning (PCT)	2,434
	Ladder Fuel Reductions (LFR)	2,533
	Whip Felling	287
Fuel Treatments (acres)	Prescribed Fire Underburn	4,614
	Mastication / Mowing	2,044
Reforestation Activities (acres)	Tree Planting	385
	Herbicide Spot Application	121
Road Work (miles)	Temporary Roads	19
	Roads to be Closed	7.2
	Road Decommissioning	8
User Created Roads and Trails Rehab (miles)		25

*More than one treatment may occur on each unit, e.g. commercial thin followed by ladder fuel reduction and prescribed underburning. Appendix A lists the combination of treatments for each units.

<https://www.fs.usda.gov/project/?project=47326>

PROJECT LOCATION (Forest/District): Bend-Fort Rock Ranger District
Deschutes National Forest. Deschutes County, Oregon.

NAME AND TITLE OF RESPONSIBLE OFFICIAL: JOHN ALLEN,
Forest Supervisor, Deschutes National Forest

LEAD OBJECTOR: Oregon Wild

REQUEST FOR MEETING TO DISCUSS RESOLUTION: Oregon Wild hereby requests a meeting to discuss potential resolution of the issues raised in this objection.

NARRATIVE DESCRIPTION OF THOSE ASPECTS OF THE PROPOSED DECISION ADDRESSED BY THE OBJECTION:

Oregon Wild objects to:

- heavy thinning to less than 40% canopy cover in spotted owl dispersal habitat;
- failure to follow the LRMP requirements for key elk habitat;
- failure to analyze and mitigate long-term adverse effects on snag habitat recruitment;
- failure to analyze and mitigate excessive and unnecessary greenhouse gas emissions;
- failure to consider more alternatives that would mitigate significant trade-offs.

SUGGESTED REMEDIES THAT WOULD RESOLVE THE OBJECTION:

Oregon Wild respectfully requests that the Forest Service withdraw the recommended project and —

1. Issue a clear decision that follows LRMP requirement for key elk habitat, maintains >40% canopy cover in spotted owl dispersal habitat, avoids new road construction, retains more untreated skips and greater basal area retention in order to mitigate for adverse effects of commercial logging on snags and carbon. Our suggestions for avoiding adverse impacts and improving this project are set forth below; or
2. Prepare a new EIS to address new alternatives and the significant impacts and unresolved trade-offs and fully complies with the requirements of NEPA and the CEQ regulations and addresses the specific concerns expressed below.

DESCRIBE HOW THE OBJECTIONS RELATE TO PRIOR COMMENTS:

Oregon Wild raised concerns about the issues raised in this objection in our detailed comments submitted during scoping (12-21-2015) and during public comment on the EA (11-16-2018). We incorporate those comment by reference.

SPECIFIC ISSUES RELATED TO THE PROPOSED ACTION:

Failure to Consider Alternatives That Address Trade-offs

Oregon Wild's comments on the EA explained a range is significant trade-offs caused by large-scale logging and asked that the FS develop alternative to respond to those trade-offs.

Our scoping comments noted: "The map of proposed overstory treatments looks like wall-to-wall commercial logging, especially in the southern part of the project area. Commercial logging has significant trade-offs in terms of simplified forest structure and depletion of the recruitment pool for future snags and down wood. We are concerned about excessively aggressive treatment of the overstory. The FS needs to figure out some way to determine the optimal mix of treated and untreated areas."

The FS should develop a light touch alternative based on public comments and known trade-offs, e.g., logging impacts on snag habitat, owl habitat, big game cover, carbon storage.

...

Need Alternative to Address the Trade-off Between Logging and Snag Habitat

...

Need Alternative to Address the Trade-off Between Logging and Habitat for Wildlife that Thrive in Dense/Complex Forests.

...

Need Alternative to Address the Trade-off Between Logging and Carbon Storage and Climate Mitigation

...

Need Alternative to Address Trade-off Between Canopy Removal and Fire Hazard

Alternatives 3 and 4 don't go far enough. They modestly address a few of those issues, such as big game habitat, but those alternatives still conduct thousands of acres of logging (not dissimilar from Alt 2) and fail to mitigate several additional potentially significant effects of logging.

The Response to Comment says "The proposed actions were developed to take action in response to the purpose and need of the project as described in Chapter 1 of the EA. The removal of commercial size trees in combination with removal of noncommercial trees and other proposed vegetation management activities are needed to achieve restoration objectives including restoring composition, structure, and process as well as increasing resilience to insects fire." The agency is ignoring 40 CFR 1508.25 which says:

... To determine the scope of environmental impact statements, agencies shall consider ... 3 types of alternatives, They include:

...

(b) Alternatives, which include: (1) No action alternative. (2) Other reasonable courses of actions. (3) Mitigation measures (not in the proposed action).

And 40 CFR 1500.2 which says:

Federal agencies shall to the fullest extent possible: ... (e) Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.

The FS failed to consider mitigation alternatives and alternatives that will avoid or minimize adverse effects and address trade-offs identified during scoping.

As noted in our comments on the EA:

If the agency purpose and need includes a mix of restoration goals and timber production, the NEPA analysis needs to clearly disclose to what extent optimal restoration outcomes are being sacrificed in order to produce timber volume. It is often the case that optimal restoration calls for retention of more trees, especially commercial-sized trees, that serve a variety of ecosystem services. Retaining optimal levels of medium and large trees –

- Provides habitat for wildlife that depend on (i) relatively dense forests and/or (ii) abundant snags and dead wood;
- Stores carbon that helps moderate global climate change;
- Enhances recreational/scenic values;

- Suppresses the growth of hazardous ladder fuels and reduces future maintenance costs associated with removing non-commercial in-growth; and
- Provides cool/moist microclimate buffering that benefits wildlife, recreation, and moderates fire hazard;

Removing trees to meet timber objectives sacrifices all these values. The agency needs to carefully disclose the extent to which these public values are sacrificed in order to achieve timber volume objectives. Clearly disclosing such trade-offs helps the public provide informed comment, and helps achieve the informed decision-making requirements of NEPA. It also furthers the requirements of NEPA related to:

- “Study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.” 40 CFR §§1501.2(c), 1507.2(d), 42 USC § 4332(2)(E).
- “... the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity, ...” 40 CFR §1502.16, 42 USC § 4332(2)(C).

https://www.energy.gov/sites/prod/files/NEPA-40CFR1500_1508.pdf

NEPA requires disclosure of the trade-offs among competing uses.

Project-level planning and implementation pursues management activities in accordance with forest plans to enhance flows of particular ecosystem services—to improve a specific fish or wildlife population, for example, or reduce the likelihood that natural disturbance (e.g., wildfire) might adversely affect flows of ecosystem services. However, many ecosystem services and the associated landscape conditions from which they derive are interrelated in either conflicting or synergistic ways such that changes in one service necessarily involve changes in another service. In some cases, increased flows of one service may only be possible by accepting decreased flows of another service. Evaluating and communicating expected management outcomes necessarily must account for these interrelationships and the tradeoffs—the exchange of one level of service for another—made necessary when implementing a project that will affect multiple ecosystem service flows. Conceptually, tradeoffs among ecosystem services are best illustrated by using the economic concept of “production possibility frontiers” (e.g., Bowes and Krutilla 1989: 49, Stevens and Montgomery 2002). Production possibility frontiers show the combinations and levels of ecosystem services that can be produced on a landscape given that landscape’s capacity to produce those services (e.g., its size and biophysical features) and management inputs (e.g., labor) and capital improvements (e.g., roads, trails, culverts).

...

Understanding the production possibilities for a given landscape enables managers to identify and weigh the possible output combinations that might be expected on a given landscape, and may make it more feasible to avoid unnecessary tradeoffs.

...

Another important step in evaluating forest management tradeoffs is characterizing how valued ecosystem services are likely to change in response to management activities under consideration. ... Ideally, analysis of the likely outcomes of landscape management would be based on credible scientific information linking expected changes in ecosystem services to specific changes in landscape conditions and processes resulting from proposed plans and projects. The quantity and quality of scientific information available for evaluating management effects in this way can differ depending on how well particular ecosystem processes are understood and how well they can be described by ecologists and biophysical scientists as changes in ecosystem services.

... [M]any economists refer to a need for ecological production functions (e.g., Polasky 2008) that link the production of a given ecosystem service in space and time to landscape conditions and processes necessary to its production. ...

Whether dealing with empirical data and models or qualitative data and narratives, evaluating and communicating expected management outcomes calls for managers to (1) identify key landscape conditions that affect the quantity and quality of valued ecosystem services; (2) characterize key relations between those landscape conditions and the levels of ecosystem services produced; and (3) describe the degree of uncertainty in the data and models used to predict management outcomes. This process includes describing the spatial and temporal aspects of expected outcomes.

Kline, Jeffrey D.; Mazzotta, Marisa J. 2012. Evaluating trade-offs among ecosystem services in the management of public lands. Gen. Tech. Rep. PNW-GTR-865. Portland, R: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 48 p. http://www.fs.fed.us/pnw/pubs/pnw_gtr865.pdf.

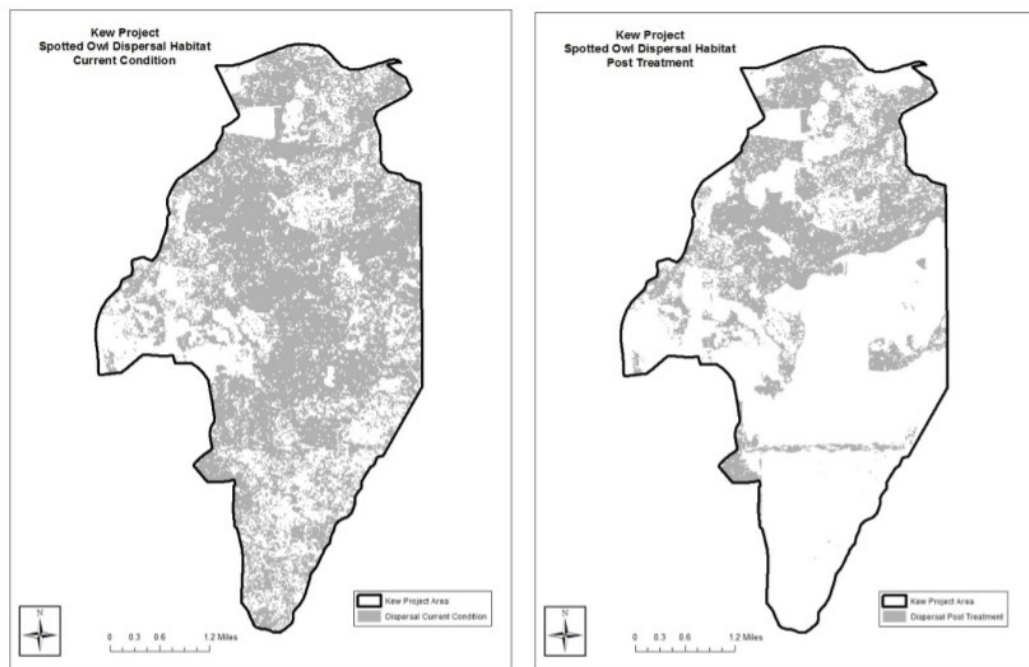
Failure to Maintain Even Minimal Spotted Owl Dispersal Habitat

One of the important functions of the Matrix is to provide for spotted owl dispersal habitat. New information indicates that spotted owl dispersal habitat should be managed for “at least 80%” canopy cover. See Stan G. Sovern, Eric D. Forsman, Katie M. Dugger, Margaret Taylor. 2015. Roosting Habitat Use and Selection By Northern Spotted Owls During Natal Dispersal. The Journal of Wildlife Management 79(2):254–262; 2015; DOI: 10.1002/jwmg.834. (“**Roost Site Selection.** In contrast to the assumption that stands with relatively open canopies provide suitable dispersal habitat for spotted owls, our results suggest that dispersing juveniles selected stands for roosting that had relatively high canopy closure ($x = 66 \pm 2\%$). ... Two hypotheses could explain why dispersing owls selected closed-canopy stands. First, several researchers (Barrows 1981, Forsman et al. 1984, Weathers et al. 2001) have shown that temperature and precipitation appear to influence selection for roost trees and attributes within a roost tree, such as perch height and percent overhead cover. ... Second, juvenile northern spotted owls may have selected for closed-canopy forest because their preferred prey were most abundant ... **Landscape Scale Selection.** ... [O]ur mean estimate of canopy closure from plots at roosts (66%),

which was likely an underestimate of canopy cover, was considerably higher than the minimum values recommended by Thomas et al. (1990) [i.e. 50-11-40]. ... **Management Implications.** ... Based on our study, we recommend that managers should pursue a strategy that exceeds the canopy cover guidelines recommended by Thomas et al. (1990) when managing dispersal habitat for spotted owls. Based on our estimate of mean canopy closure (66%), and our estimate of mean canopy cover from overlaying a dot grid on the same areas (approx. 14% larger), we recommend that the target for canopy cover in stands managed for dispersing spotted owls should be at least 80%.")

The FS failed to meaningfully respond to our comments on the Kew EA which noted: Most of the project area is Owl CHU. As shown in EA Figure 72, this project will have a significant adverse effect on spotted owl's ability to move through this landscape, as well as a significant adverse effect on the ability to grow NRF habitat within this critical habitat unit.

Figure 72 Kew Project Area Dispersal Habitat Current and Post Treatment



This adverse effect on habitat for an ESA listed species could be easily mitigated by retaining 40% canopy cover instead of 30%. Such a mitigation strategy would also provide more options for growing some patches of NRF habitat as these stands develop. This mitigation is quite appropriate, since this project is located in critical habitat. This would have minimal impact on goals related to stand resilience, species composition, etc.

Spotted owl dispersal habitat should also offer foraging opportunities. Understory treatments should therefore leave a meaningful level of untreated skips to maintain complex habitat for owl prey species.

We are concerned that the EA analysis is diluting the impacts on dispersal habitat by combining this project area with adjacent watersheds for analysis, so the loss of

dispersal habitat in this project appears to be a smaller impact when viewed in the context of that larger area that is not being treated (by this project).

There is a significant corridor of more intact functional owl habitat in the project area that spans a swath of the project area going generally east to west. Protecting and enhancing connectivity between these habitats should be a goal of this project. Lots of road/trail disturbance goes right through the core of the owl corridor. Given that these impacts are likely not going away, the FS should minimize impacts from other activities like logging.

Critical Habitat is supposed to emphasize recovery of the owl, not just avoiding jeopardy. Regen harvest, moderate-to-heavy thinning, and logging trees over 20" dbh is likely to do far more harm than good with respect to owl recovery. See Heiken, D. 2010. Log it to save it? The search for an ecological rationale for fuel reduction logging in Spotted Owl habitat. Oregon Wild. V 1.0. May 2010. https://www.dropbox.com/s/pil5rap4nvwxhtt/Heiken_Log_it_to_save_it_v.1.0.pdf?dl=0

The Response to Comment says "Dispersal habitat amounts would be reduced but the functionality of the dispersal habitat within the project area would be maintained by providing a dispersal habitat corridor ..." This is misleading. Spotted owl disperse more-or-less randomly, not following corridors established by forest managers. The EA analysis therefore over-estimates the dispersal value of a corridor compared to maintain dispersal habitat across the landscape. The analysis also ignores the fact that the FS can achieve most of their purposes for this project while maintaining a minimum 40% canopy closure. The EA fails to weigh and disclose that the agency is sacrificing a significant degree of owl dispersal function for a small gain in other goals.

Flawed Analysis of Carbon Emissions from Logging

The FS failed to respond to our comments on the Kew EA:

Avoiding the worst effects of global climate change requires that we retain and hold carbon in ecosystems like forests. Since these forests are already publicly owned, and ostensibly managed in the public interest, its relatively easy to make a decision to retain and restore carbon in these forests. Logging as proposed in this project will kill trees, stop photosynthesis, initiate decay and combustion processes, and accelerate the transfer of carbon from the forest to the atmosphere. Logging related carbon emissions are directly contrary to climate goals and represent a significant trade-off caused by logging. This trade-off should be mitigated by considering and adopting alternatives that retain more carbon in the forest, such as retaining greater green-tree basal area and unlogged "skips" where trees are allowed to live and grow and sequester more carbon for decades to come.

Avoiding GHG emissions during the next few decades is critical because that is the period that we must decarbonize our economy. The FS should avoid misguided carbon strategies that cause GHG emissions in the short-term with an

expectation of climate benefits decades in the future (after we have presumably already decarbonized the economy).

The EA includes a number of misleading and inaccurate statements regarding carbon storage and the impact of logging.

First, the analysis attempts to minimize the impacts of this individual project, even though the problem of greenhouse gas emission is caused by cumulative effects. The problem cannot be solved by fixing one sector of the economy. All GHG emissions are adverse, and every sector that emits GHG must be part of the solution. 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).

Second, the analysis tries to segregate forest related emissions into two categories: emissions from deforestation (which the EA says is bad), and emissions from forest management (which the EA implies are not bad because they are not deforestation). In truth, the climate is impacted exactly the same from each molecule of CO₂ regardless of the source. The agency must account for all forest carbon losses, not just from deforestation, but also forest 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/>. See 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> (“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.

Third, the EA adopts without evidence a discredited notion that logging to reduce fire emissions will result in net carbon storage and climate benefits. The EA (p 402) 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...” This is refuted by numerous scientific studies. 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>

Fourth, the EA suggests that logging will increase forest productivity, but there is no evidence that this is true. The EA (p 402) says “Projects like the proposed action that create forests or improve forest conditions and capacity to grow trees are positive factors in carbon sequestration.” 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 FS 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-](http://download.springer.com/static/pdf/522/art%253A10.1007%252Fs10584-013-0927-9.pdf?auth66=1398528430_ad123a71083ade45750f8bec9a091a43&ext=.pdf)

[9.pdf?auth66=1398528430_ad123a71083ade45750f8bec9a091a43&ext=.pdf](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.”).

I am attaching additional analysis showing that the Forest Service boilerplate NEPA language addressing carbon and climate change is deeply flawed.

Flawed Analysis of Impacts to Snag Habitat

The Kew EA fills many pages with analysis about snag associated wildlife but does not disclose the extent to which logging will reduce snag habitat over time. This is a potentially significant effect of logging that was simply glossed over. The snag analysis in the EA described the silvicultural prescriptions more than the effects of logging on snag recruitment over time. The EA failed to use stand simulation to show the effects of logging. The EA failed to account for the fact that LRMP standards for snag habitat are outdated. The FS has not followed NEPA or NFMA procedures to adopt new standards for snag habitat. New information indicates that wildlife need more snags for a wider variety of life functions and the FS needs to retain more green trees to ensure recruitment of adequate snag habitat throughout the life of the stand. The EA failed to disclose effects of logging on snag habitat relative to the tolerance levels in DecAID. The EA ignored the scoping comments asking for greater attention to these issues.

As an example, the Kew EA repeatedly says “The proposed treatments could cause short-term reductions in small snag (>10” diameter) numbers, but would allow for the longterm development in large snag structure (>20” diameter).” There is no stand simulation provided to show whether these assertions are likely to be true. Effects on small snags are likely to be significant and long-term, not short term. The assertion that logging would “allow” development of large snags is highly misleading. It sounds like effects would be minimal or even positive, when in reality, quantitative analysis would show negative effects of logging on large snag recruitment would be significant and long-term.

Notably, the 2001 Survey and Manage ROD requires site-specific analysis using stand simulation to consider snag recruitment over time and address cavity species habitat needs, particularly white-headed woodpecker, black-backed woodpecker, pygmy nuthatch, and flammulated owl. “Site-specific analysis, and application of a snag recruitment model (specifically, the Forest Service’s Snag Recruitment Simulator) taking into account tree species, diameters, falling rates, and decay rates, will be required to determine appropriate tree and snag species mixes and densities. If snag requirements cannot be met, then harvest must not take place. ... More information is needed on habitat use, seasonal occurrence, and use of forest age classes and burns, for the black-backed woodpecker.” 2001 S&M ROD pp 33-34. This does not appear to have been done for the Kew Project.

Oregon Wild's comments on the Kew EA said:

Managing for tree vigor causes trade-offs that conflict with Forest Health goals. The objective of increased tree vigor is one-dimensional. It ignores that natural forests both grow and die. Healthy forests need a balance of vigorous growing trees and dead and dying trees. Wildlife need both processes to flourish. Foresters seem to have a bias against tree mortality (unless mortality is caused by chainsaws) and this bias has adverse consequences for a wide variety of wildlife that thrive in forests with abundant dead wood. Logging results in significant trade-offs when it emphasizes tree vigor at the expense of valuable and important ecological features of a natural forest landscape (such as mortality and snags which provide essential habitat values and play a critical role in shaping forest development). The FS should consider and adopt an alternative that addresses this trade-between tree vigor and snag habitat by retaining greater basal area and more and larger unlogged "skips." The FS should recognize the new information (not yet reflected in the LMRP or the NWFP) indicating that wildlife need more snags and more green trees to recruit those snags.

...

Many wildlife and a wide variety of ecosystem services are supported by abundant snags and dead wood. As a result of past logging, desired conditions for these wildlife and ecosystem services are not being met. Commercial logging captures and exports mortality and depletes the pool from which future large trees and snags are recruited for decades to come. This effect is cumulative. This area has experienced a significant amount of past harvest that targeted large trees. These stands were already extensively clearcut and high-graded by private logging companies before they became part of the Deschutes National Forest. All this past logging significantly depleted the snag population and the snag recruitment pool. More logging now will exacerbate this cumulative effect and represents a significant trade-off caused by commercial logging that should be mitigated by considering and adopting alternatives that retain greater basal area in treated areas and retain more and larger unlogged "skips."

It is important to manage for dead wood in this area because it is designated as critical habitat for the northern spotted owl. The NEPA analysis needs to carefully consider the long-term effects of captured mortality and its degradation of habitat for small mammals and spotted owls.

Several small mammals, such as the northern flying squirrel form the prey base for the Endangered Species Act (ESA) listed spotted owl and are among the species associated with abundant large dead standing and down wood. This presumably, is why spotted owls prefer to forage in stands with abundant standing and fallen dead wood (Table 2, North et al. 1999). The fruiting bodies of hypogeous fungi are a food source of northern flying squirrels and are also associated with down logs, suggesting that there are complex, indirect paths through which dead wood supports spotted owls (Amaranthus et al. 1994, Carey 2000).

Thomas Spies, Michael Pollock, Gordon Reeves, and Tim Beechie 2013. Effects of Riparian Thinning on Wood Recruitment: A Scientific Synthesis - Science Review Team Wood Recruitment Subgroup. Jan 28, 2013, p 36.

<http://www.mediate.com/DSConsulting/docs/FINAL%20wood%20recruitment%20document.pdf>

North et al. (1999) noted in a study of foraging habitat selection by northern spotted owls, “In our study area, stands with high use by owls typically included many ‘legacies’ (large trees and snags) that survived a fire or windstorm that destroyed much of the previous stand. They found that “stands with 142 m³/ha of intact snags and a high diversity of tree heights had medium or high foraging use by spotted owls. In these old-growth stands, biological legacies (e.g., large trees and snags) produced by past disturbance provide important forest structures associated with spotted owl foraging.” North, Franklin, Carey, Forsman, Hamer. 1999. Forest Stand Structure of the Northern Spotted Owl’s Foraging Habitat. For. Sci. 45(4):520-527.

The EA shows that existing large snag habitat is in short supply compared to reference conditions.

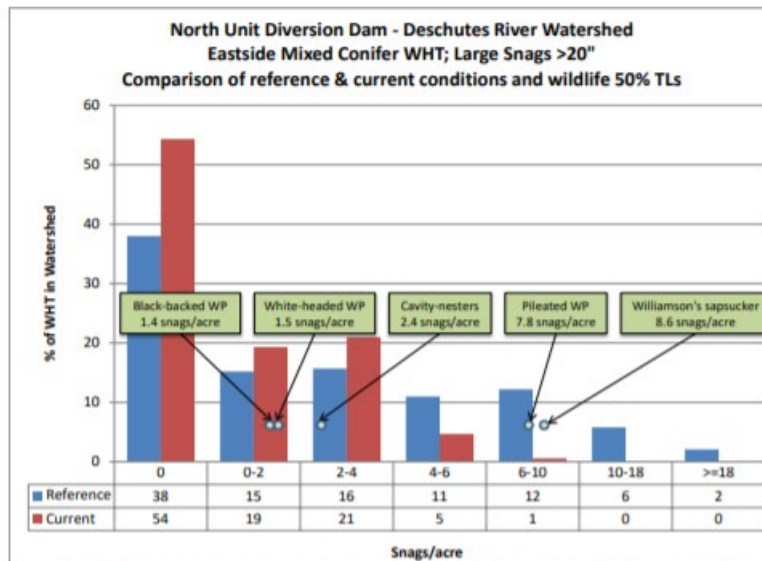


Figure 80: North Unit Watershed: Eastside Mixed Conifer WHT: Large snags >20"

This chart really need a third bar showing the projected level of snags after logging for each class of snag density.

The EA analysis fails to accurately describe the trade-off between snag size and snag numbers. The EA (p 308) says “Thinning is expected to reduce down wood and small snag recruitment in the short-term; however in the long-term it is anticipated that there would be more large trees that can be recruited into large snags and large down wood.” The EA fails to illuminate an important trade-off. The EA fails to say that thinning may result in a very slight acceleration in creation of a few large snags, at the expense of a very large reduction in recruitment of slightly smaller snags.

When the EA does try to describe the trade-off between logging and snags, it does so inaccurately, and draws conclusions lacking quantitative analysis to back it up. EA (p 310) says

“The proposed action would result in a small negative impact locally with limited effect across the analysis area and Forest-wide. This action would mostly reduce small snags and small downed wood within treatment units in favor of future large snags and large downed wood and closer to reference conditions.”

First, the impact of logging on snag habitat is not small. It is significant and long-lasting, but the FS did not conduct a quantitative analysis to address this trade-off. See sample analysis from another thinning project below. Second, the adverse effect of logging is not limited to small snags, it also includes large snags. This is undeniable, because (i) many of the trees that the FS is removing are already large (>20" dbh). Lidar shows a lot of 20-30" dbh trees in the project area, and since this project is not under the 21" dbh limits of the Eastside Screens, many of these large trees will be cut and removed, so they cannot serve as snag habitat; and (ii) many more trees that the FS is removing may be less than 20" dbh today, and if they were to be retained they would continue growing beyond 20" dbh and would eventually be recruited as large snags, but the FS did not conduct a quantitative analysis to show this.

The following graph from the Curran Junetta Thin EA shows that heavy thinning delays by more than 60 years the attainment of habitat objectives for large snags (i.e. mid-point of the gray band representing 30-80% tolerance level).

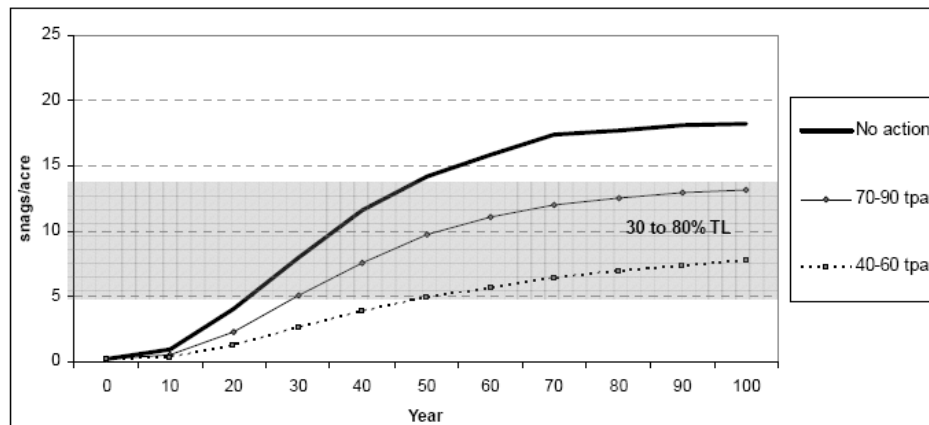
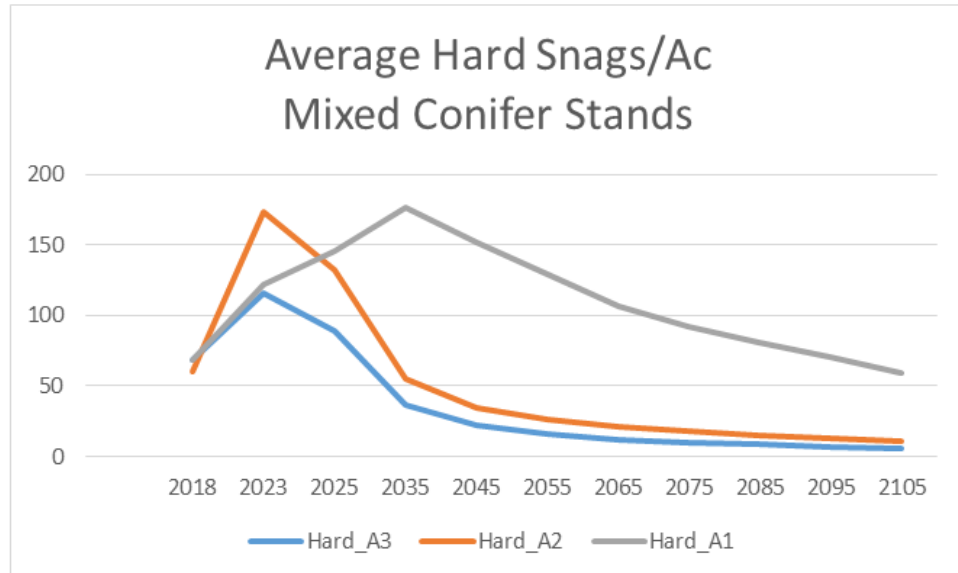


Figure 15. Short and long-term changes to ≥20" dbh snags.

http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/32805_FSPLT2_053506.pdf.

The following graph from the East Hills Project on the Fremont-Winema NF, shows a very long-lasting adverse impacts to snag habitat from typical eastside thinning. (Note: this graph does not distinguish between large and small snags.)



The snag habitat analysis also fails to note that current LRMP standards for snag retention and recruitment are scientifically discredited. We need new standards to account for significant new information indicating that wildlife need more snags (and more green recruitment trees) to meet a wider range of life needs. This means that the trade-off between logging and snag habitat is even more significant than acknowledged by the LRMP and the EA.

The Response to Comment is inadequate:

Increasing tree vigor does not intend to eliminate natural mortality of trees on the landscape.

Logging may not eliminate mortality but it is designed to suppress it significantly.

The Response to Comment says:

Restoration would work towards keeping the mortality close to historic levels. (EA at 68).

This is inaccurate and misleading. The EA fails to understand the profound differences between natural and managed forests. In a natural forest, virtually 100% of the trees and virtually 100% of forest productivity ends up as snags and/or dead wood habitat IN the forest. Past, proposed and future commercial logging will not allow that natural process to unfold. Logging will export the a very large fraction of the trees off-site so they cannot fulfill the natural process as snags and dead wood. Logging will NOT restore natural levels of mortality. It will significantly reduce it over a very long time period.

Logging will also increase stand vigor, so there will be fewer trees succumbing to mortality processes. This effect will last for decades. The analysis in the EA explicitly says that logging is designed to modify natural disturbance processes to favor live trees and disfavor mortality processes including competitive exclusion, fire, and insects. Foresters are trained to manage stand density at a level that will minimize mortality. This is contrary to ecological principles.

The EA analysis ignores the fact that natural disturbance recruits large amounts of dead wood that provide valuable habitat for diverse wildlife. Of the many wildlife species that use early seral forest, 85% use dead wood at some life stage. Friesen, C.A. 2007. Early Seral Forest: A conservation Conundrum.

<http://www.ecoshare.info/uploads/ccamp/Early-Seral-Forest-Friesen.ppt> Unfortunately, regen harvest removes virtually all of the most valuable large wood depriving wildlife of the rich structural complexity they would normally enjoy after a natural disturbance.

The presence of coarse woody debris is critical for biodiversity conservation. ... In general, post-fire forest ecosystems include the presence of large numbers of snags and downed woody debris. This dead material provides important habitat elements for many species of plants and animals, while also storing a great deal of carbon (MacDonald 1993; Fleming and Freedman 1998; Freedman et al. 1996). Clearcut harvesting of natural forests results in the removal of most of the aboveground woody biomass from the site because trees are the commodity being harvested. ... Because clearcut harvesting concentrates on the removal of biomass, it fails to produce large-dimension snags and coarse-woody debris in intensively managed forests, ... Although both harvesting and wildfire kills trees, only fire leaves them as dead standing biomass. ... The fire-killed snags and woody debris cast partial shade, which ameliorates the surface microclimate and may enhance the survival of pine seedlings (Fraser and Farrar 1953; Cayford and McRae 1983; Carleton and MacLellan 1994). ... Some studies have suggested that the cover and richness of the understory vegetation of a natural forest may never fully recover from clearcutting. ... Wildfires reduce the presence of some hosts that assist the spread of pests and pathogens while clearcutting may promote them. ... [E]xclusion of fire from such ecosystems, along with forestry practices that leaves young infected trees in the residual stand, leads to increased abundance of this parasite. In contrast, fire eliminates Dwarf mistletoe. ... Numerous studies have determined the potential removals of nutrients with conventional and whole-tree clearcuts ... The data show that clearcutting removes large amounts of biomass and nutrients from the site, and that these are equivalent to a substantial fraction of the site capital of these materials. ... During a wildfire, biomass capital of the stand is lost by combustion, as is that of nitrogen through the oxidation of organic compounds and the release of gaseous NO and NH₃. In intense wildfires these losses of biomass and nitrogen can be comparable in magnitude to what would be removed by the clearcutting of comparable stands. Unlike wildfire, however, clearcutting also removes large amounts of phosphorus, potassium, calcium, and magnesium contained in the tree biomass; these materials are mostly conserved *in situ* during a wildfire. ... Clearcut harvesting with heavy equipment can cause severe soil compaction along skidding lanes and it can also disrupt soil profiles by churning ... Permanent roads are not generally associated with wildfire management or suppression (although temporary access routes may be constructed while fighting some wildfires). An extensive road network is, however, necessary for timber

harvesting and subsequent stand management. Roads affect biodiversity in many ways. Roads directly remove natural habitat, alter drainage and stream dynamics, cause erosion, introduce edge effects, fragment contiguous ecosystems, alter species movements, and act as corridors for the introduction of non-native species Road density is a useful indicator of ecological threat ... [I]t is erroneous to assume that forest harvesting plays the same ecological role as wildfire.

D.J. McRae, L.C. Duchesne, B. Freedman, T.J. Lynham, and S. Woodley, 2001. Comparisons between wildfire and forest harvesting and their implications in forest management. *Environ. Rev.* 9. 223-260 (2001); DOI: 10.1139/er-9-4-223

Modelling by Harris (2000) suggests that 12 or more green trees need to be retained during regen harvest for every snag we want to recruit at any given time during the rotation. Harris, R.B. 2000. Estimating large snag recruitment needs in regeneration timber harvests. *Western Journal of Applied Forestry*. 15: 140-146.
http://www.cas.umt.edu/facultydatabase/FILES_Faculty/1152/Harris%202000%20Large%20SnagRecruitment%20Western%20J.%20Appl.%20For.pdf. This paper also highlights the concern that without numerical guides, managers could erroneously assume that they are maintaining adequate numbers of snags across the landscape even though they are retaining too few green trees to achieve that goal.

Disturbance and biomass change (live, snag, down)

- All disturbances are not created equal:
 - Harvest results in net biomass loss (live and snag)
 - Natural disturbances result in flux between live and dead pools

Ohmann, JL, MJ Gregory, HM Roberts, RE Kennedy, Z Yang, J Braaten, SL Powell, WB Cohen, V Kane, J Lutz. 2012. Mapping change in live and dead forest biomass with Landsat time-series, remeasured plots, and nearest-neighbor imputation. *ForestSat 2012*: Corvallis, OR; September 2012.

http://lemma.forestry.oregonstate.edu/export/presentations/ohmann_etal_2012_forestsat.pps

Although many existing silvicultural systems have been designed to mimic stand-scale natural disturbances, McRae et al. (2001) and Palik et al. (2002) remind us that natural disturbances are inherently different from those of silviculture. One difference, of course, relates to the amount of carbon removed from the site when harvesting a forest. Removals tend to be much greater with harvesting than for fire, for example. Fire tends to create a complex mosaic of forest types and ages on the landscape. Forest harvesting, as commonly practiced, tends to simplify forest composition and structure.

Crow, T.R. and A.J. Perera. 2004. Emulating natural landscape disturbance in forest management – an introduction. *Landscape Ecology* 19: 231-233.

http://www.firescience.gov/projects/01-1-3-43/project/01-1-3-43_01_1_3_43_Deliverable_02.pdf

The agency should avoid reducing stand density lower than is appropriate to meet the full suite of ecological objectives, including wildlife cover, perpetuating mortality processes that create and sustain valuable habitat features, etc.

We are concerned that the agencies' stocking guides were created and intended to be used as a tool to avoid mortality which is clearly inconsistent with ecosystem management. ("To preclude serious tree mortality from mountain pine beetle, western dwarf mistletoe and perhaps western pine beetle, stand densities should be maintained below the upper limit of the management zone" Powell 1999,

https://fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev7_016034.pdf) Healthy forests require dead trees, sometimes in abundance, in order to meet the needs of diverse wildlife and provide full suite of ecosystem functions. Rose, C.L., Marcot, B.G., Mellen, T.K., Ohmann, J.L., Waddell, K.L., Lindely, D.L., and B. Schrieber. 2001. Decaying Wood in Pacific Northwest Forests: Concepts and Tools for Habitat Management, Chapter 24 in *Wildlife-Habitat Relationships in Oregon and Washington* (Johnson, D. H. and T. A. O'Neil. OSU Press. 2001)

<http://web.archive.org/web/20060708035905/http://www.nwhi.org/inc/data/GISdata/docs/chapter24.pdf>

A comprehensive restoration approach requires focusing not just on live trees, but also on the full suite of ecological processes including density dependent mortality processes that create and recruit snags and dead trees as a valuable feature of eastside forests. We urge the agency not to manage for tree vigor and minimum stocking levels because it will not provide enough green trees for recruitment of snags through time. This is a critical issue given that the current standards for snag habitat are outdated and fail to provide adequate levels of snags and dead wood, and adequate levels of green trees needed to recruit those snags through time.

As the FS knows, the snag habitat standards are outdated and have not been updated to ensure population viability or provision of the other important ecological functions provided by dead wood.

The authors of DecAID describe some of the limitations of the old methods of managing snag habitat (used in the LRMP and no longer scientifically accepted).

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

Models of relationships between wildlife species and snags in the Pacific Northwest typically are based on calculating potential densities of bird species and expected number of snags used per pair. This approach was first used by Thomas et al. (1979). Marcot expanded this approach in Neitro et al. (1985) and in the Snag Recruitment Simulator (Marcot 1992) by using published estimates of bird population densities

instead of calculating population densities from pair home range sizes. This approach has been criticized because the numbers of snags suggested by the models seem far lower than are now being observed in field studies (Lundquist and Mariani 1991, Bull et al. 1997). In addition, the models provided only deterministic point values of snag sizes or densities and of population response ("population potential") instead of probabilistic estimates that are more amenable to a risk analysis and risk management framework.

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

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

Bruce G. Marcot , Janet L. Ohmann, Kim L. Mellen-McLean, and Karen L. Waddell. Synthesis of Regional Wildlife and Vegetation Field Studies to Guide Management of Standing and Down Dead Trees. Forest Science 56(4) 2010.
http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_marcot002.pdf. See also, Rose, C.L., Marcot, B.G., Mellen, T.K., Ohmann, J.L., Waddell, K.L., Lindely, D.L., and B. Schrieber. 2001. Decaying Wood in Pacific Northwest Forests: Concepts and Tools for Habitat Management, Chapter 24 in Wildlife-Habitat Relationships in Oregon and Washington (Johnson, D. H. and T. A. O'Neil. OSU Press. 2001)
<http://web.archive.org/web/20060708035905/http://www.nwhi.org/inc/data/GISdata/docs/chapter24.pdf>.

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

We feel that forest managers may well be asking a misleading question. "Snags per acre" requirements implicitly assume an equilibrium condition and reflect only one ecological requirement for a given cavity-nesting species. ... [C]onsideration of foraging habitat and other ecological requirements must be part of the "snags per acre" management considerations. This is an important, but somewhat daunting proposition, as potential cavity-nesting species are diverse,

and each species likely has very different foraging ecologies, as well as other differences in habitat requirements. ... [C]avity nesters at BMEF used larger snags on average ... [T]he loss of large trees due to logging in eastside pine and other forests, over the past century has major implications for cavity-nesting birds. ... [F]orest managers must have a sense of snag recruitment in relationship to snag fall, and the patterns and processes that underlie them, when addressing wildlife needs. ... We view the understanding of these complexities to be of primary importance in forest management for wildlife.

Steve Zack, T. Luke George, and William F. Laudenslayer, Jr. 2002. Are There Snags in the System? Comparing Cavity Use among Nesting Birds in “Snag-rich” and “Snag-poor” Eastside Pine Forests. USDA Forest Service Gen. Tech. Rep. PSW-GTR-181.

http://www.fs.fed.us/psw/publications/documents/gtr-181/017_Zack.pdf.

Failure to Follow Elk Habitat Guidelines

Alt 2 will amend the LRMP to allow logging and removal of 1,200 acres of hiding cover in key elk habitat area. This is a potentially significant impact requiring an EIS.

The EA fails to take a hard look at the trade-offs caused by amending the LRMP requirements for key elk habitat to allow large-scale logging in key elk habitat.

The EA says that “Alternatives 3 and 4 reduces total of understory fuels treatments based on preservation of hiding cover associated with key elk habitat.” But significantly, the EA does not put this modest reduction in treatment acres in the context of the very low probability that treatments will interact with wildfire during the brief period before fuel regrow.

“A recent study conducted by researchers at the University of Montana found that only about 7 percent of fuel-reduction treatment areas in the entire United States were subsequently hit by wildfires since 1999. ... If someone had the magical ability to predict, within the past decade, that a major fire was going to strike that particular portion of the 240,000-acre Scapegoat Wilderness, then thinning and logging theoretically could have helped. But it doesn’t work that way, and fires are sparked in random places by lightning and humans, and they are pushed by erratic winds and weather. ... According to Tania Schoennagel, a forest landscape ecologist and fire researcher at the University of Colorado, ... ‘it’s little bit of a crapshoot probability game whether the treatment you put in is going to encounter wildfire in the 10 to 15 years it remains effective in reducing fire severity. Simply because forests in the West are so vast, the chance of burning in a place we’ve pre-treated is so low. It’s not a very effective lever. We don’t know where fires are going to happen.’” David Erickson (2017). Experts: More logging and thinning to battle wildfires might just burn taxpayer dollars. CREDIT: MISSOULIAN.COM. Oct 1, 2017. <http://www.america.easybranches.com/montana/Experts--More-logging-and-thinning-to-battle-wildfires-might-just-burn-taxpayer-dollars-152776> citing Kevin Barnett, Sean A. Parks, Carol Miller, and Helen T. Naughton. 2016. Beyond Fuel Treatment Effectiveness: Characterizing Interactions between Fire and Treatments in the US. Forests [open access] 2016, 7, 237; doi:10.3390/f7100237. <http://www.mdpi.com/1999-4907/7/10/237>. See

also, William L. Baker, Jonathan J. Rhodes. 2008. Fire Probability, Fuel Treatment Effectiveness and Ecological Tradeoffs in Western U.S. Public Forests. pp.1-7 (7). The Open Forest Science Journal, Volume 1. 2008.
http://api.ning.com/files/1kp0vDW*F1cqOeO4-GdXE1AHOATghmIAN2x9qLpH3aA_/FireandFuelTreatments.pdf; “According to a recent analysis, annually less than one percent of U.S. Forest Service fuel reduction treatments in forested areas subsequently burned, on average. From 2000 to 2015, almost 17 million acres of federal land were treated for fuels reduction, equating to approximately four percent of U.S. Forest Service and Bureau of Land Management lands. During the same time period, more than 93 million acres burned. The odds of putting fuel treatments in the wrong place are extremely high.” Pohl, Kelly 2019. “For communities, land use planning is more effective than logging on federal lands to reduce future wildfire disasters.” <https://headwaterseconomics.org/wildfire/solutions/land-use-planning-is-more-effective/>. In, other words, the FS failed to consider that elk habitat is being sacrificed for a very low probability of fire modification.

The EA analysis of Alt 3 shows that the goals of this project can be substantially met while following the key elk habitat requirements. The EA does not provide a compelling rationale why logging is more important than following elk habitat requirements. This shows that the FS has not justified why the plan amendment is necessary.

Additionally, wildlife, including both elk and spotted owls, are adversely affected by roads. The EA does not adequately disclose the effects of excessive road density and road use *during* the project implementation – while roads remain extensively used during logging operations and before road closures have been implemented. Implementation is expected to take many years and there is also lots of logging activity in nearby planning areas, so cumulative effects during this period may be significant.

Failure to Prepare an EIS for Impacts That May be Significant

This is a large project, with more than 5,000 acres of overstory logging. There are numerous trade-offs involved in logging at this scale that may cause significant direct, indirect, and cumulative effects, such as:

- Logging to less than 40% canopy closure across thousands of acres will degrade dispersal habitat for threatened northern spotted owls;
- Delayed and reduced recruitment of ecologically valuable snags and dead wood;
- Adding to the cumulative emissions of greenhouse gases that are causing a global climate crisis;
- Amending the LRMP to allow large-scale logging in key elk habitat;
- Extensive ground-based logging and road construction will cause significant adverse soil and water quality impacts;

Many of these effects are cumulative and amplified by similar large-scale logging projects in adjacent areas of the Deschutes National Forest (e.g., Lex, West Bend, Junction).

Sincerely,

A handwritten signature in black ink that reads "Doug Heiken". The script is cursive and fluid, with the first name "Doug" and last name "Heiken" clearly legible.

Doug Heiken

Supplemental Analysis

Cumulative Impacts of GHG Emissions Must not be Minimized

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 be 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>)

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 agency often says "This project does not fall within any of these main contributors of greenhouse gas emissions. ... The main activity in this [forestry] sector associated with GHG emissions is deforestation, which is defined as removal of all trees, most notably the conversion of forest and grassland into agricultural land or developed landscapes (IPCC 2000)." 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.climate-science-watch.org/file-uploads/Copenhagen_Accord.pdf. This likely requires reducing atmospheric CO₂ concentrations below 350 ppm¹ 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 losses, 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

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

<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>

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

... 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 realistically^{16,19–21} 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 agency often says “Projects like the proposed action that create forests or improve forest conditions and capacity to grow trees are positive factors in carbon sequestration.”

“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 than 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 GHG emissions at the expense of maintaining forest carbon storage.

Also, this project will cause far more tree mortality by logging than would be avoided via natural mortality. See discussion in DeCicco J.M. 2013. Biofuel’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.”).

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

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

Risk reduction logging does not help store carbon.

Forest Service NEPA analyses often include the following assertion - “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 negative 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_voll.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.

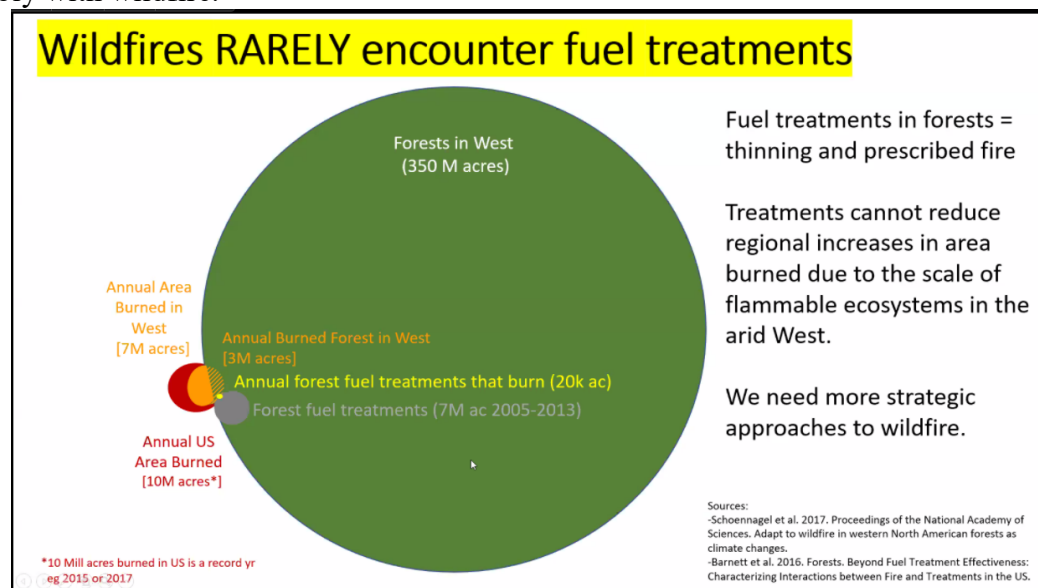
... we attempt to remove some of the confusion surrounding this subject by performing a sensitivity analysis wherein long-term, landscape-wide carbon stocks are simulated under a wide range of treatment efficacy, treatment lifespan, fire impacts, forest recovery rates, forest decay rates, and the longevity 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.”)