CENTER for BIOLOGICAL DIVERSITY

July 28, 2009

SENT VIA EMAIL

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Re: Comments on the Fairfax DEIR

Dear CAL FIRE:

The Center for Biological Diversity ("Center") submits the following comments for the Fairfax Draft Environmental Impact Statement ("Fairfax DEIR"). The Center is a non-profit, public interest, conservation organization dedicated to the protection of native species and their habitats through applying sound science, policy and environmental law. The Center has over 40,000 members, many of whom reside in California.

The California Environmental Quality Act ("CEQA") mandates that the environmental impacts of a project be considered and analyzed, and that agencies "mitigate or avoid the significant effects on the environment of projects that it carries out or approves whenever it is feasible to do so." Pub. Res. Code § 21002.1(b); *see also* Pub. Res. Code § 21002 ("[It is the] policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures which will avoid or substantially lessen the significant environmental effects of such projects."). Mitigation of a project's significant impacts is one of the "most important" functions of CEQA. *Sierra Club v. Gilroy City Council*, 222 Cal.App.3d 30, 41 (1990).

As the lead agency, it is CAL FIRE's duty to ensure that the Fairfax EIR conforms with applicable law. With regard to GHG emissions analysis under CEQA, the Attorney General's Office has recently stated that:

> Lead agencies should make a good-faith effort, based on available information, to calculate, model, or estimate the amount of CO2 and other GHG emissions from a project, including the emissions associated with vehicular traffic, energy consumption, water usage and construction activities.
>
> The question for the lead agency is whether the GHG emissions from the project . . . are considerable when viewed in connection with the GHG emissions from past projects, other current projects, and probable future projects.

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> Unlike more localized, ambient air pollutants which dissipate or break down over a relatively short period of time (hours, days or weeks), GHGs accumulate in the atmosphere, persisting for decades and in some cases millennia. The overwhelming scientific consensus is that in order to avoid disruptive and potentially catastrophic climate change, then it's not enough simply to stabilize our annual GHG emissions. *The science tells us that we must immediately and substantially reduce these emissions*.
>
> The decisions that we make today do matter. Putting off the problem will only increase the costs of any solution. Moreover, delay may put a solution out of reach at any price. *The experts tell us that the later we put off taking real action to reduce our GHG emissions, the less likely we will be able to stabilize atmospheric concentrations at a level that will avoid dangerous climate change*.[1]
>
> [Agencies should] evaluate *at least one alternative* that would ensure that the [agency] contributes to a lower-carbon future.

See Climate Change, the California Environmental Quality Act, and General Plan Updates: Straightforward Answers to Some Frequently Asked Questions California Attorney General's Office [Rev. 3/06/09] (emphasis added).

The California Resources Agency has also addressed the issue of GHG emissions and has pointed out that the following must be considered when assessing GHG emissions associated with logging:

- Type of Forest Management (Clear Cutting or other types of logging management)[2]
- Age of forest at issue, tree type[3]
- Store of Carbon in Bio Mass, Soil[4], and Old Growth
- Rate new growth sequesters carbon
- Changes to system overall
- Reduction of carbon stores v. rate of carbon uptake
- Increases and Decreases in Carbon to Environmental Setting
- Cumulative Impacts

[1] This goes to the heart of the problem. Forest conversion immediately disrupts the ongoing process of C sequestration by a forest, causes immediate and ongoing emissions, and any sequestration by vineyards will not make up for the losses and foregone sequestration.

[2] A forest conversion is essentially a clear-cut but without any tree replanting.

[3] Absent from the DEIR is an accurate accounting of the fact that "young-growth timber (redwood and Douglas-fir)" will be cut. DEIR 1-2.

[4] The DEIR almost completely ignores the issue of soil carbon and does not calculate the emissions associated with loss of soil carbon stores.

See Powerpoint Presentation of Resource Agency (presented at February, 2009, Board of Forestry meeting).

The above statements from the Attorney General and Resources Agency make clear that agencies must give careful attention to the greenhouse gas ("GHG") emissions associated with the projects they approve and must calculate, model, or estimate all of the GHG emissions associated with a particular project. After fully quantifying a project's emissions, an EIR must determine the cumulative significance of the project's greenhouse gas pollution. An impact is considered significant where its "effects are individually limited but cumulatively considerable." CEQA Guidelines § 15065(a)(3). Climate change is the classic example of a cumulative effects problem; emissions from numerous sources are combining to create the most pressing environmental and societal problem of our time. *See Center for Biological Diversity v. Diversity v. NHTSA*, 508 F.3d 508, 550 (9th Cir. 2007), ("the impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."); *Kings County Farm Bureau v. City of Hanford*, 221 Cal. App. 3d 692, 720 (1990) ("Perhaps the best example [of a cumulative impact] is air pollution, where thousands of relatively small sources of pollution cause a serious environmental health problem."). While a particular project's greenhouse gas emissions may represent only a tiny fraction of total emissions, courts have rejected the notion that the incremental impact of a project is not cumulatively considerable when it is so small that it would make only a *de minimis* contribution to the problem as a whole. *Communities for a Better Env't v. California Resources Agency*. 103 Cal.App.4th 98, 117 (2002) ("The relevant issue was not the relative amount of traffic noise resulting from the project when compared to existing traffic noise, but whether any additional amount of traffic noise should be considered significant given the nature of the existing traffic noise problem. From *Kings County* and *Los Angeles Unified*, the guiding criterion on the subject of cumulative impact is whether any additional effect caused by the proposed project should be considered significant given the existing cumulative effect.").

This Project, unfortunately, is particularly problematic from a GHG perspective because it "would convert forests and grasslands to vineyards, a reservoir, corporation yard, and roads." DEIR at 4-13. As explained below, forests are one of this planet's greatest attributes in terms of sequestering carbon, and, consequently, any loss of forest is cause for serious concern. In this particular instance, 171 acres of forest would be clear-cut and lost (DEIR at 4-13), and therefore, alternatives and/or mitigation must be presented in the DEIR to address this significant environmental impact. Indeed, the lead agency for this DEIR, CAL FIRE, has already stated that forest conversions such as this one are a significant GHG threat that require mitigation: "One of the activities recognized as having adverse impacts to C02 sequestration potential of California's forests is deforestation through conversion . . . [L]oss to conversions are recognized as potential threats to the Forest Sector in relation to achieving [AB 32 GHG] goals . . . [C]onversions will require GHG accounting to analyze and mitigate the direct and indirect impacts associated with these types of projects. . . . Even before carbon sequestration was in the national spotlight it was acknowledged that the most significant threat to resource values associated with forest lands is when those forestlands are converted to non-timberland uses . . . [C]onversion of forests to other non-forest uses [] has been shown in many studies to reduce the potential for carbon sequestration and elevate carbon release on a long-term basis . . . ." CAL FIRE Official Response for THP 04-08-024-AMA.

I. THE DEIR MUST ENSURE INFORMED DECISION-MAKING

CEQA demands, among other things, that enough information be provided regarding a project to ensure informed decision-making. Moreover, CEQA requires that the information "be presented in a manner calculated to adequately inform the public and decision makers, who may not be previously familiar with the details of the project." *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova,* 40 Cal. 4th 412, 442 (2007). The statement in the DEIR regarding greenhouse gas emissions falls well short of those standards and is therefore deficient from an informational standpoint. As stated by the California Supreme Court:

> The preparation and circulation of an EIR is more than a set of technical hurdles for agencies and developers to overcome. The EIR's function is to ensure that government officials who decide to build or approve a project do so with a full understanding of the environmental consequences, and, equally important, that the public is assured those consequences have been taken into account.

Id. at 449-50, s*ee also East Peninsula Ed. Council, Inc. v. Palose Verdes Peninsula Unified School Dist.*, 210 Cal.App.3d 155, 174 (1989) ("Where failure to comply with the law results in a subversion of the purposes of CEQA by omitting information from the environmental review process, the err is prejudicial"); *Laurel Heights Improvement Assn. v. Regents of University of California,* 47 Cal. 3d 376, 402 (1988) ("CEQA's fundamental goal of … informed decision making").

The DEIR fails to discuss the importance of the fact that 171 acres of trees will no longer be sequestering carbon. This is a big deal, especially when considered in light of the many other conversions that have occurred or are occurring just in Sonoma County alone. As explained in *Forests: Opportunities for Greenhouse Gas Emission Reduction in Sonoma County*, Michelle Passero, December 2007, p. 3:

> Over the past several years, Sonoma County has witnessed an increasing threat of forestland conversion to non-forest uses, vineyards in particular. Between 1990 and 1997, at least 1,630 acres of dense oak woodlands were converted to vineyards[5] and from 1989 to 2004, 851 acres of timberland were approved for conversion, primarily to vineyards. More recently, an application to convert approximately 1,700 acres of forestland to vineyards has been submitted to the County, which is still pending. According to Sonoma County's Permit and Resource Management Department, once the time and money has been invested to convert timberland to croplands, these lands are almost never restored to forests.
>
> The climate impacts of this forestland conversion are twofold. First, the conversion of these forestlands results in direct emissions of CO_2 to the atmosphere. Second, the future capacity of the forest to remove additional CO_2 from the atmosphere is significantly diminished because there is very little chance that these lands will be restored to forests

[5] Merenlender, Adina and Brooks, Colin. GIS in Rangeland Management, Vineyard Expansion in Sonoma County: Mapping, Monitoring, and Changing Policies

> based on the history of conversions in Sonoma County. The potential net difference between the overall carbon stored in a vineyard and forestland could be anywhere from 15 tons of carbon per acre to over a thousand tons per acre, depending on several factors, including forest type, age, site class and maturity and management of the vineyard. Such a reduction in overall carbon stocks means net emissions of CO_2 to the atmosphere upon conversion of the forestland to vineyards.

While the DEIR does show in its calculations that carbon sequestration will be severely diminished as a result of the Project's conversion of forest to vineyard (*see* Table 4-3), the DEIR essentially ignores those calculations – there is no discussion of their meaning from a GHG perspective. Instead, the DEIR concludes, without justification, that the diminished sequestration is inconsequential. As discussed above, however, courts have made clear that even tiny impacts can be cumulatively significant and that this is especially so when dealing with GHG emissions. Moreover, time and again, the lead agency (CAL FIRE), has explicitly stated that it believes a) conversion can be a significant GHG problem, and b) that young forests such as the one being logged here, are important sequesterers of carbon due to their sequestration rates. *See, e.g.,* CAL FIRE's Official Response for THP 04-08-024-AMA. Put another way, this Project would result in the complete loss of 171 acres of what the lead agency itself believes is one of our best weapons against climate change. Therefore, the DEIR's conclusion that this Project does not have a significant GHG impact makes no sense, and the failure to discuss the importance of lost sequestration prevents an informed decision.

The DEIR similarly fails to adequately address the emissions that will be associated with the following logging impacts that will occur when the 171 acres are cut : a) loss of young redwood and Douglas fir trees, b) severe soil disturbance, c) loss of understory, d) site preparation/prevention of development of understory, e) burning or decay of leftover slash material, and e) emissions associated with the actual cutting, movement and development of the trees (*e.g.*, gray emissions). For instance, the removal of the forest canopy by clear-cutting exposes the soil to direct sunlight, which tends to increase soil respiration; soil preparation (such as discing) also increases soil respiration; and soil erosion associated with clear-cutting and soil preparation can cause significant losses of soil carbon. All of these factors are substantial additions to the greenhouse gas emissions, and therefore are impacts of the Project, and must be addressed.

It is also important to note that GHG emissions are now more than ever understood to be at a tipping point. In addressing the impacts of the GHG emissions from this Project, it is important to take into account the impacts of ecological tipping points, irreversible changes in the climate expected to occur when atmospheric concentrations of greenhouse gases reach a certain level. [6]

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[6] It is well-accepted that there will be tipping points. (Meehl et al. at 775, 2007). Reaching any single tipping point can bring severe economic and ecologic consequences. But perhaps more worrisome is the linkage between tipping points such that reaching one tipping point may in turn trigger a second. An example is the connection between Arctic sea ice and permafrost melt rates; recent evidence indicates that the loss of Arctic sea ice, one tipping point, accelerates permafrost thaw, a second tipping point. (Lawrence et al. 2008). Permafrost refers to permanently frozen land; this surface stores large amounts of carbon. As permafrost thaws due to global warming, it releases carbon, often as methane. (Christensen et al. 2004). Methane has a global warming potential that is approximately

The issue of tipping points adds to the need for this Project to fully disclose its greenhouse gas emissions. The greenhouse gases emitted from conversion/clear-cutting are indubitably adding to the overall atmospheric concentration of greenhouse gases at a time that the global climate is potentially approaching critical tipping points. In addition, these emissions in the short term would contradict the efforts throughout the state (including in the forest sector) to reduce greenhouse gas emissions to 1990 levels by 2020.

The best available scientific evidence now indicates that a warming of 2°C is not "safe" and would not prevent dangerous interference with the climate system. In order to avoid dangerous anthropogenic interference (DAI) with the climate system, sound climate analysis must minimize the risk of severe and irreversible outcomes. Stabilizing greenhouse gas emissions at 350 ppm CO2eq, would reduce the mean probability of overshooting a 2°C temperature rise to 7 percent. A 350 ppm CO2eq stabilization level is also consistent with that proposed by leading climatologists, who have concluded that in order "to preserve a planet for future generations similar to that in which civilization developed and to which life on Earth is adapted . . . CO2 will need to be reduced from its current 385 ppm to at most 350 ppm."[7] While current CO2 levels exceed 350 ppm, a pathway toward 350 ppm is possible though the rapid phase-out of coal emissions, improved agricultural and forestry practices, and possible future capture of CO2 from biomass power plants. *Id*. In short, time is of the essence when addressing GHG emissions, and therefore, timing must be properly considered and accounted for when determining and addressing the emissions associated with the loss of 171 acres of forest. Carbon sequestration foregone, especially in the short term, and carbon emitted, especially in the short term, is significant. And the DEIR makes no effort to address that fact.

In sum, the DEIR is not a credible CEQA document from an informational standpoint. The public and decision-makers are not provided any discussion of the meaning of the DEIR's numbers despite the vast differences between a redwood forest and a vineyard in terms of carbon storage and carbon sequestration and despite the fact that even the lead agency, CAL FIRE, has found that forest conversions "will require GHG accounting to analyze and mitigate the direct and indirect impacts associated with these types of projects." CAL FIRE Official Response for THP 04-08-024-AMA. Moreover, the DEIR fails to discuss the temporal aspects of GHG emissions, especially the fact that short term emissions are extremely problematic because they contribute to an already existing problem at a time when GHG reductions are necessary. Until the informational deficiencies are corrected, the DEIR is illegal.

II. THE DEIR MUST ADEQUATELY IDENTIFY AND QUANTIFY ALL GREENHOUSE GAS EMISSIONS ASSOCIATED WITH THE PROJECT

The removal of a tree in the name of conversion results in the direct removal of that tree's carbon as well as a loss of future carbon sequestration by that tree. In addition, there is also loss of

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25 times greater than that of carbon dioxide over 100 years. The multiplicative effect of reaching several tipping points on a similar time scale would drastically increase the costs associated with climate change.

[7] Hansen, J. et al., *Target Atmospheric CO2: Where Should Humanity Aim?* Open Atmospheric Sci. J. 217, 226 (2008).

carbon from a) soil disturbance, b) loss of understory, c) burning or decay of leftover slash material, and d) other emissions associated with the conversion/logging such as trucking and cutting tools (*e.g.*, gray emissions). All of these impacts must be quantified in order to do an accurate assessment of the carbon implications of the loss of 171 acres of forest.

In its recent white paper, CEQA & Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act (Jan. 2008), the California Air Pollution Control Officers Association (CAPCOA) set forth methodologies for analyzing greenhouse gas pollution (CAPCOA 2008). The CAPCOA information should be helpful for addressing emissions from a) logging machinery, b) the transportation of logs and any other byproducts, c) the construction and maintenance of roads, and d) the creation of vineyards. Moreover, the OPR paper on CEQA And Climate Change discusses various models such as the EMFAC model (page 17), which can be used to "calculate emission rates from all motor vehicles in California. The emission factors are combined with data on vehicle activity (miles traveled and average speeds) to assess emission impacts."

While the Fairfax DEIR provides calculations for potential emissions it does so in only a general way and is only a partial accounting. For instance, no accounting is made for the type of forest being cut (here, redwood/Douglas fir). This is especially problematic given that redwood trees

> are famous for their enormous stocks of standing biomass and represent perhaps the most massive forests, per unit area, on earth. Measurements of old-growth (>200 years) redwood stands have yielded standing carbon stocks ranging from 1,650 to 1,784 t C equivalent per ha (Hallin, 1934, Westman and Whittaker, 1975, and Fujimori, 1977). Equally impressive is the rate at which carbon is sequestered in growing redwood stands. A 100 year old redwood stand measured by Olson et al (1990) yielded 3,600 cubic meters per ha, equivalent to 648 t C per ha (at specific gravity 0.36 g oven dry biomass/cm^3 for second-growth redwood (Markwardt and Wilson, 1935)), or a mean annual carbon increment of 6.48 t C per ha per year.[8]

In short, conversion of redwood forest means losing one of the most important forest systems on Earth when it comes to carbon sequestration/storage, and the DEIR ignores that fact entirely. *See also* Figures 34, 40, 41and Tables 24, 25, 29 (inserted on the following pages) in Christensen, Glenn A.; Campbell, Sally J.; Fried, Jeremy S., tech. eds. 2008. California's forest resources, 2001–2005: five-year Forest Inventory and Analysis report. Gen. Tech. Rep. PNW-GTR-763. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 183 p., accessed at http://www.fs.fed.us/pnw/publications/gtr763/ on July 25, 2009.

The DEIR also admits that it "does not account for tractor emissions, small engine emissions (e.g., weedeaters), or the initial emissions associated with logging and conversion of the site." DEIR at 4-15. This means no carbon accounting was made for soil and understory impacts or for the many

[8] Winrock International. *Measuring and Monitoring Plans for Baseline Development and Estimation of Carbon Benefits for Change in Forest Management in Two Regions, March 2004.* Accessed at http://www.energy.ca.gov/reports/CEC-500-2004-070/CEC-500-2004-070F.PDF on July 25, 2009.

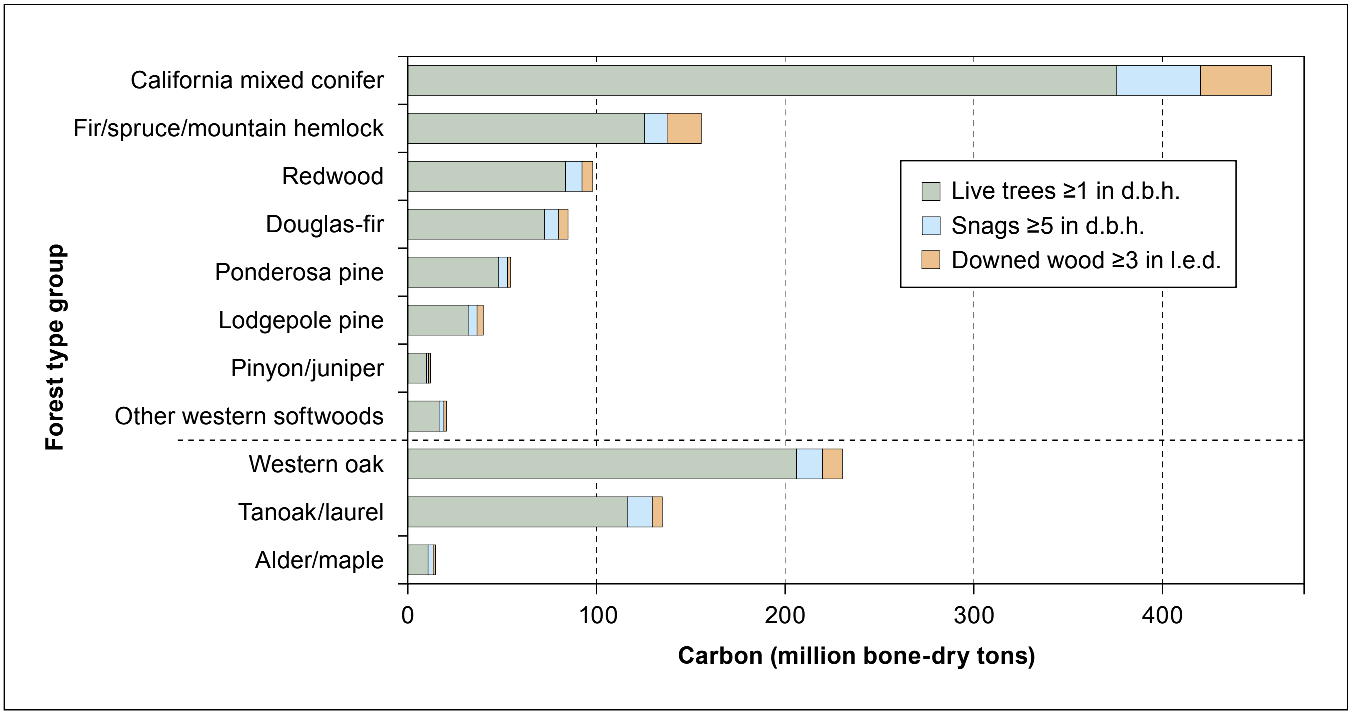

Figure 33—Carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in California, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

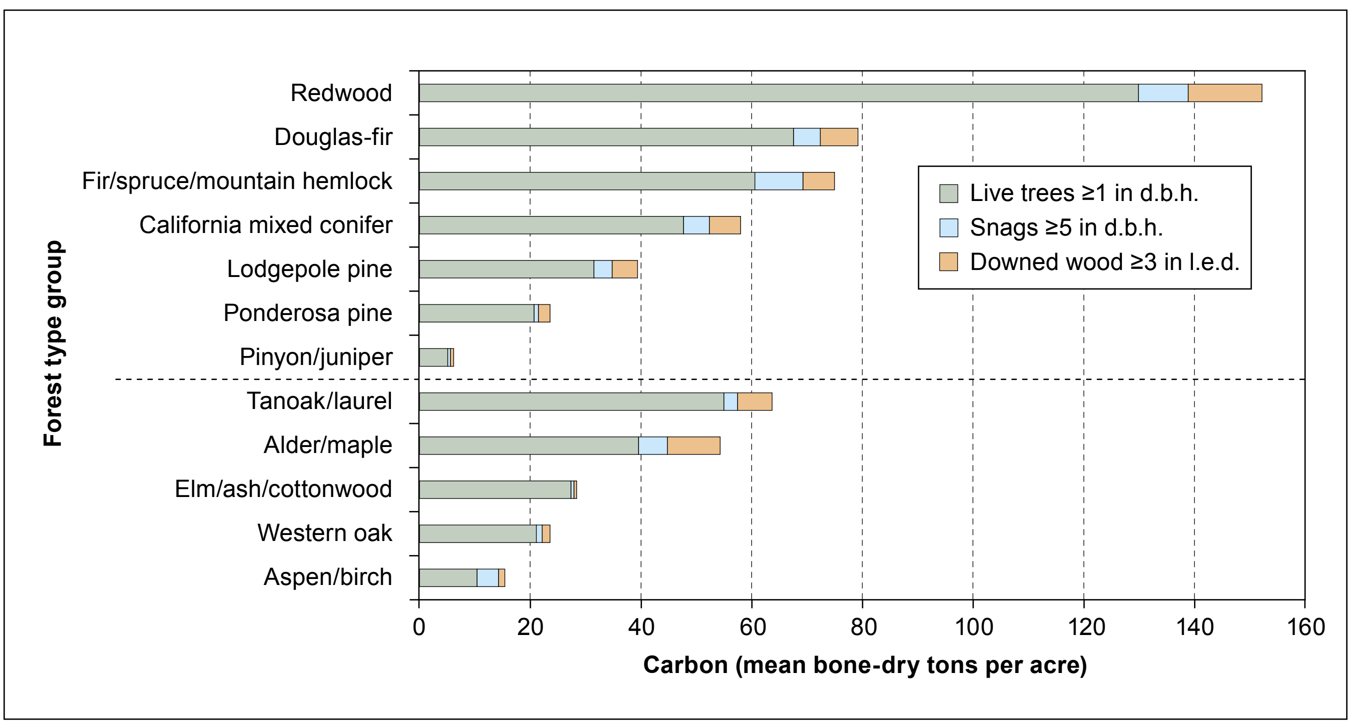

Figure 34—Mean carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in California, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

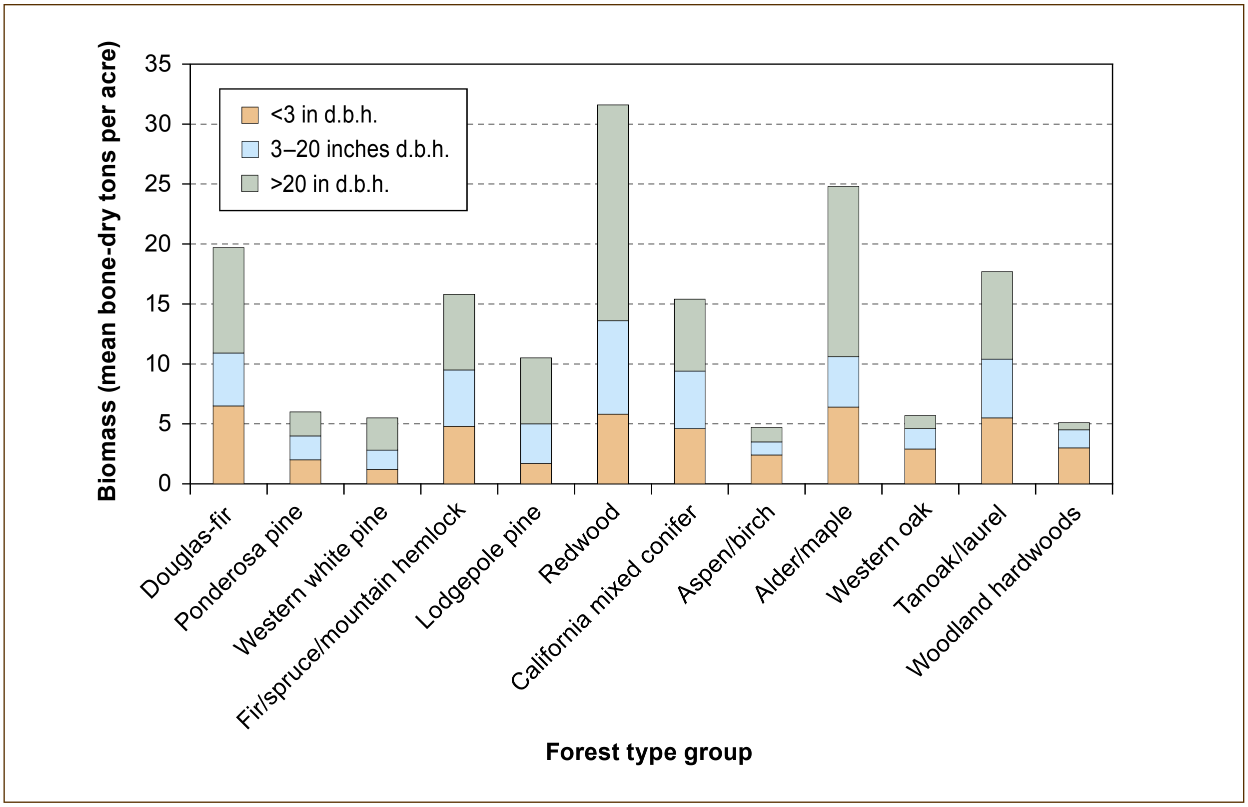

Figure 40—Mean biomass of down wood by forest type and diameter class on forest land in California, 2001–2005.

alder/maple forest types, over 50 percent was contained in large-diameter logs (≥20 inches). Although large logs contain the greatest mean volume and biomass per acre statewide, they are significantly fewer in number than small logs (3 to 19 inches in diameter). We estimated an average of 7 large logs per acre and 144 small logs per acre.

Snags had a mean biomass of 6 tons per acre and a mean density of 13 snags per acre across the state. Almost 88 percent of the snag density was in snags <20 inches d.b.h., with just 0.2 snags per acre in the very large class (>40 inches d.b.h.). Softwood forest types had the most biomass and the largest proportion of large-diameter (>20 inches d.b.h.) snags (fig. 41).

Although the total amount of dead wood present in a forest fluctuates over time, the mean density of large-diameter (≥ 20 inches) snags and down logs generally increases with stand age (fig. 42), as shown below:

	Snags		Down wood	
	Diameter classes			
Stand age in years	5 to 19 in	≥ 20 in	3 to 19 in	≥ 20 in
	Mean trees/acre		*Mean logs/acre*	
1 to 50	10.4	0.9	155.0	8.0
51 to 100	11.5	1.2	148.1	5.1
101 to 150	13.4	2.4	164.7	8.0
151 to 200	13	3.6	170.6	11.6
201 to 250	6.5	3.4	121.0	9.7
251 to 300	7.4	2.9	152.8	11.4
300 plus	10.7	4.4	119.8	11.8
Total	11.4	1.7	143.0	6.4

Large snags ranged from a mean of 0.9 per acre in young stands to 4.4 per acre in stands older than 300 years. In contrast, young stands appear to start out with a higher level of large down wood, most likely remnants from a stand-initiating event such as a fire or harvest. Density of down wood differed by age class, rising and falling slightly over time and reaching a high of 11.8 logs per acre in very old stands.

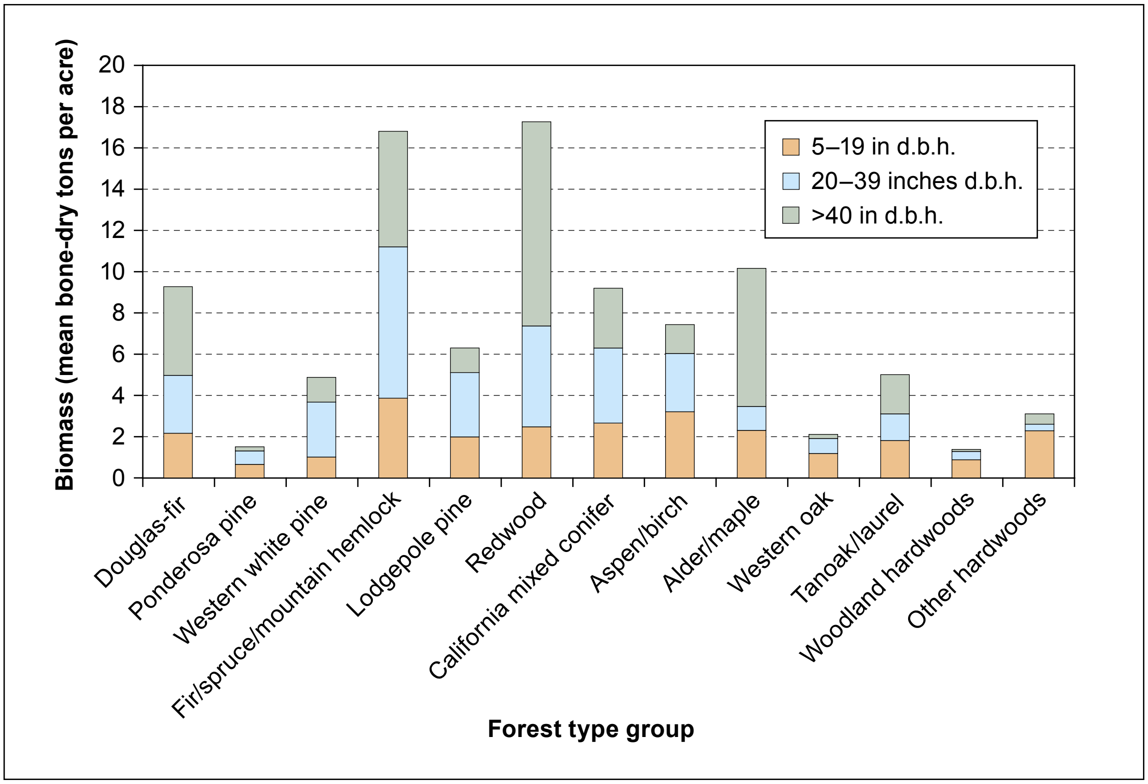

Figure 41—Mean biomass of snags by forest type and diameter class on forest land in California, 2001–2005.

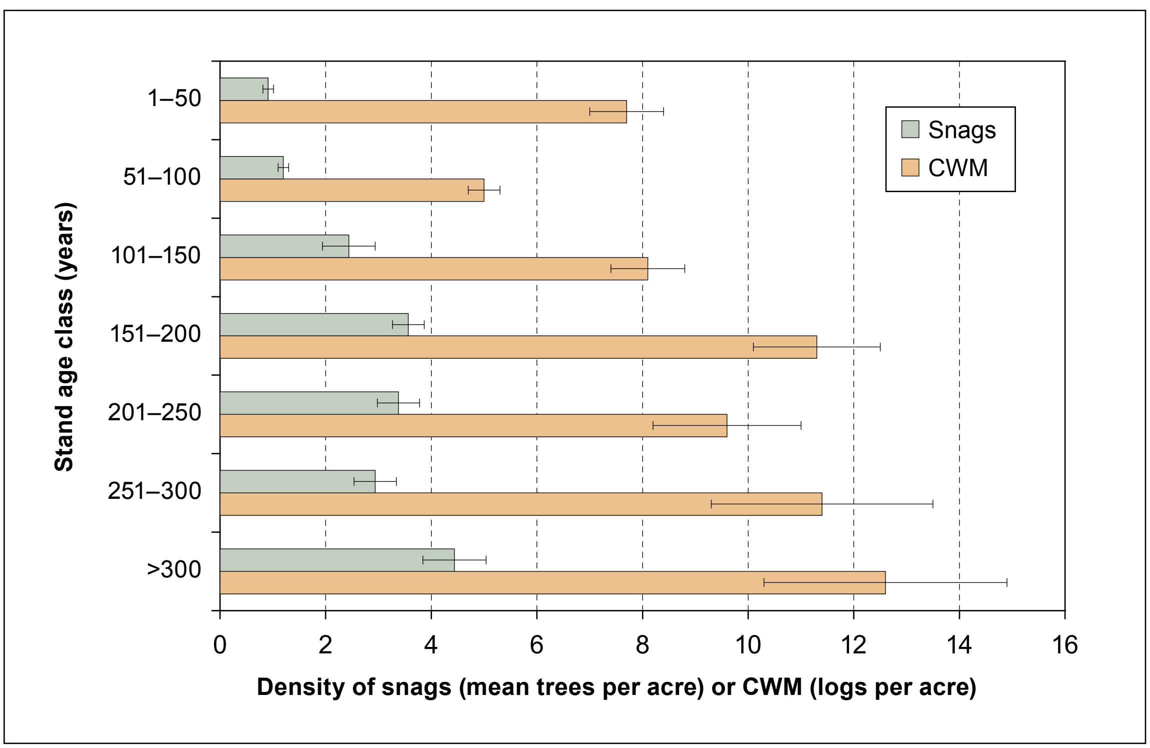

Figure 42—Mean density of down wood and snags by stand age class for large-diameter (> 20 inches) logs or snags on forest land in California, 2001–2005; CWM = coarse woody material.

Table 24—Estimated average biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, California, 2001–2005

	Biomass							Carbon						
	Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)			Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)		
Forest type group	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**TOTAL**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**TOTAL**
	Bone-dry tons per acre													
Softwoods:														
California mixed conifer	91.9	2.0	9.2	0.5	10.5	0.4	111.6	47.7	1.0	4.7	0.2	5.4	0.2	57.8
Douglas-fir	130.9	8.6	9.3	1.3	13.2	1.7	153.4	67.6	4.5	4.8	0.7	6.8	0.9	79.2
Fir/spruce/mountain hemlock	116.4	5.2	16.8	1.4	11.0	0.8	144.2	60.6	2.7	8.7	0.7	5.7	0.4	75.0
Lodgepole pine	60.5	4.0	6.3	0.9	8.8	1.0	75.6	31.5	2.1	3.3	0.5	4.6	0.5	39.4
Other western softwoods	15.7	1.1	1.2	0.2	2.4	0.3	19.3	8.2	0.6	0.6	0.1	1.3	0.2	10.1
Pinyon/juniper	9.9	0.7	0.9	0.2	1.2	0.2	12.0	5.1	0.4	0.5	0.1	0.6	0.1	6.2
Ponderosa pine	39.9	1.9	1.5	0.2	4.0	0.3	45.4	20.7	1.0	0.8	0.1	2.1	0.2	23.6
Redwood	250.3	33.1	17.3	3.7	25.7	5.4	293.3	129.9	17.2	9.0	1.9	13.3	2.8	152.2
Western hemlock/Sitka spruce[b]	198.4	25.7	87.5	17.1	16.5	4.2	302.4	102.7	13.5	45.5	8.9	8.6	2.2	156.8
Western white pine	33.8	6.5	4.9	1.4	4.2	1.1	42.9	17.6	3.4	2.5	0.7	2.2	0.5	22.3
Total	77.4	1.9	7.5	0.3	8.5	0.3	93.4	40.2	1.0	3.9	0.2	4.4	0.2	48.5
Hardwoods:														
Alder/maple	78.1	10.6	10.1	2.8	18.4	4.2	106.6	39.6	5.4	5.2	1.5	9.5	2.2	54.3
Aspen/birch	20.7	6.8	7.5	6.0	2.3	1.4	30.5	10.4	3.4	3.9	3.1	1.1	0.7	15.4
Elm/ash/cottonwood	55.8	16.1	1.0	0.7	1.1	0.4	57.9	27.4	7.9	0.5	0.3	0.5	0.2	28.4
Exotic hardwoods[b]	82.0	19.1	—	—	2.7	0.1	84.7	40.3	9.4	—	—	1.3	0.1	41.6
Other hardwoods	45.6	6.8	3.1	0.8	3.5	0.7	52.2	22.8	3.4	1.6	0.4	1.8	0.3	26.2
Tanoak/laurel	109.3	5.4	5.0	0.6	12.2	1.1	126.5	55.0	2.7	2.5	0.3	6.2	0.5	63.7
Western oak	42.4	1.2	2.1	0.2	2.8	0.2	47.3	21.1	0.6	1.1	0.1	1.4	0.1	23.6
Woodland hardwoods	11.4	1.2	1.4	0.3	2.1	0.4	14.9	5.8	0.6	0.7	0.2	1.1	0.2	7.6
Total	52.6	1.5	2.8	0.2	4.6	0.3	60.0	26.3	0.7	1.4	0.1	2.3	0.1	30.0
Nonstocked	1.8	0.3	8.3	2.5	2.6	0.5	12.7	0.9	0.2	4.3	1.3	1.4	0.3	6.6
All forest types	65.7	1.2	5.6	0.2	6.8	0.2	78.1	33.7	0.6	2.9	0.1	3.5	0.1	40.1

Note: Means are calculated using a ratio of means formula across plots within forest type groups; data subject to sampling error; SE = standard error; — = less than 0.05 bone-dry tons per acre were estimated; d.b.h. = diameter at breast height; l.e.d. = large-end diameter of the log.

[a] Down wood in this table includes coarse woody material only.

[b] These forest type groups are represented by <5 plots.

Table 25—Estimated average biomass, volume, and density of down wood on forest land, by forest type group and diameter class, California, 2001–2005

	Biomass								Volume								Density[b]					
	Diameter class (inches)[a]								Diameter class (inches)[a]								Diameter class (inches)					
	FWM		CWM						FWM		CWM						CWM					
	< 3 in		3 to 19 in		≥20 in		Total		< 3 in		3 to 19 in		≥20 in		Total		3 to 19 in		≥20 in		Total	
Forest type group	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Bone-dry tons per acre								*Cubic feet per acre*								*Logs per acre*					
-																						
Softwoods:																						
California mixed conifer	4.9	0.3	4.6	0.2	5.9	0.3	15.4	0.8	391.9	19.5	548.4	21.8	786.6	41.0	1,726.9	81.4	225.5	7.0	9.5	0.5	235.0	7.2
Douglas-fir	6.6	0.7	4.4	0.4	8.8	1.6	19.8	2.0	478.0	56.0	526.1	41.6	1,164.2	229.0	2,168.3	265.9	191.8	13.9	16.5	2.8	208.3	14.7
Fir/spruce/mountain hemlock	5.0	0.3	4.7	0.3	6.3	0.7	16.0	0.9	434.4	22.6	600.8	34.8	872.3	91.0	1,907.5	115.2	224.6	12.5	11.5	1.1	236.1	12.7
Lodgepole pine	1.8	0.2	3.3	0.5	5.5	0.7	10.6	1.1	150.5	16.8	420.3	57.3	740.3	90.6	1,311.1	142.4	109.8	12.1	9.1	1.2	118.9	12.6
Other western softwoods	1.2	0.1	1.1	0.1	1.3	0.2	3.6	0.4	83.3	7.8	123.4	14.5	179.0	35.1	385.7	56.7	49.1	4.8	3.0	0.6	52.1	5.0
Pinyon/juniper	1.3	0.1	0.9	0.1	0.3	0.1	2.5	0.2	101.4	8.7	101.1	12.4	28.7	8.6	231.2	21.1	55.0	6.3	0.7	0.2	55.7	6.4
Ponderosa pine	2.1	0.1	2.0	0.1	2.0	0.2	6.1	0.8	178.2	12.0	236.9	15.3	286.4	33.1	701.5	94.5	121.8	7.4	4.4	0.6	126.2	7.6
Redwood	6.2	1.0	7.8	0.8	18.0	5.2	32.0	5.3	63.0	87.1	952.9	93.6	2,466.9	696.3	3,482.8	703.5	307.1	35.3	27.1	4.3	334.2	35.6
Western hemlock/Sitka spruce	5.2	1.7	4.5	1.0	12.0	3.1	21.7	3.0	5.3	147.4	706.7	158.6	1,746.9	458.9	2,458.9	498.4	226.8	25.3	36.8	9.7	263.6	27.6
Western white pine	1.3	0.2	1.6	0.4	2.7	0.9	5.6	1.0	8.3	19.8	199.0	51.2	307.1	100.5	514.4	117.8	96.6	17.0	5.8	2.7	102.4	17.7
Total	4.0	0.1	3.5	0.1	5.0	0.3	12.5	0.4	326.6	10.1	429.3	12.3	667.3	35.5	1,423.2	50.6	170.8	4.1	8.5	0.4	179.3	4.2
Hardwoods:																						
Alder/maple	6.5	1.0	4.2	0.6	14.2	3.8	24.9	4.2	509.8	74.8	569.6	82.1	1,865.5	514.7	2,944.9	573.8	183.2	23.6	23.7	5.5	206.9	27.0
Aspen/birch	2.4	0.6	1.1	0.4	1.2	1.1	4.7	1.4	196.1	45.9	153.5	58.7	197.5	190.3	547.1	236.3	106.4	32.0	1.5	1.5	107.9	32.7
Elm/ash/cottonwood	4.5	0.8	1.1	0.4	––	––	5.6	0.5	330.1	32.9	156.6	53.7	––	––	486.7	81.4	78.9	27.9	––	––	78.9	27.9
Other hardwoods	4.9	1.0	2.5	0.5	1.1	0.4	8.5	1.3	314.4	71.6	188.5	36.7	128.7	40.8	631.6	112.7	95.8	23.2	2.6	1.1	98.4	23.4
Tanoak/laurel	6.1	0.4	4.9	0.3	7.3	1.0	18.3	1.3	395.3	26.3	531.1	32.0	840.1	102.8	1,766.5	124.2	202.4	12.2	12.2	1.4	214.6	12.5
Western oak	3.1	0.1	1.7	0.1	1.1	0.2	5.9	0.3	169.3	6.0	167.9	8.2	128.9	24.3	466.1	28.7	83.9	3.5	1.6	0.2	85.5	3.6
Woodland hardwoods	3.1	0.5	1.5	0.3	0.6	0.2	5.2	0.7	197.6	26.2	134.2	29.9	74.0	31.0	405.8	53.4	89.3	18.3	1.7	1.0	91.0	18.2
Total	3.7	0.1	2.3	0.1	2.3	0.2	8.3	0.3	220.2	7.8	235.2	9.0	273.7	28.1	729.1	35.1	107.2	3.7	3.8	0.3	111.0	3.8
Nonstocked	1.7	0.2	2.1	0.4	0.5	0.2	4.3	0.7	133.7	16.1	247.2	52.4	62.1	19.8	443.0	72.7	76.4	13.7	1.1	0.4	77.5	13.8
All forest types	3.8	0.1	3.0	0.1	3.8	0.2	10.6	0.3	276.5	6.6	347.0	8.1	495.2	23.5	1,118.7	32.6	143.0	2.8	6.4	0.2	149.4	2.9

Note: Means are calculated using a ratio of means formula across plots within forest type groups; data subject to sampling error; SE = standard error; –– = less than 0.05 bone-dry tons per acre, 0.05 cubic feet per acre, and 0.05 logs per acre were estimated; CWM = coarse woody material; FWM = fine woody material.

[a] The diameter at the large end is used to classify CWM with decay classes of 1–4; diameter at the point of intersection with the transect is used for heavily decomposed CWM (decay class 5) and for all FWM.

[b] An estimate of pieces per acre is not possible for FWM.

Table 29—Mean cover of understory vegetation on forest land, by forest type group and life form, California, 2001–2005

Forest type group	Seedlings and saplings		Shrubs		Forbs		Graminoids		All understory plants		Bare soil	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Percent											
Softwoods:												
California mixed conifer	6.3	0.2	17.6	0.6	5.2	0.2	3.6	0.2	31.0	0.7	4.7	0.2
Douglas-fir	7.7	0.8	24.4	2.0	8.9	1.1	4.8	0.9	43.4	2.4	3.5	0.6
Fir/spruce/mountain hemlock	3.5	0.3	17.2	1.3	5.8	0.5	2.9	0.3	28.0	1.4	5.6	0.5
Lodgepole pine	3.7	0.5	10.9	1.3	8.9	0.9	11.0	1.4	31.6	2.1	5.9	0.8
Other western softwoods	1.7	0.2	14.9	1.0	7.6	0.6	14.1	0.9	35.9	1.4	14.1	0.9
Pinyon/juniper	1.0	0.2	17.6	0.9	4.9	0.4	6.9	0.6	29.4	1.3	16.5	1.2
Ponderosa pine	3.0	0.3	23.3	1.2	6.0	0.4	8.5	0.7	39.0	1.3	6.0	0.5
Redwood	7.9	0.9	21.7	2.4	12.5	1.7	3.5	0.7	43.3	2.8	3.4	0.8
Western hemlock/Sitka spruce	0.7	0.3	24.6	16.5	23.4	7.4	2.5	2.8	44.0	14.3	0.2	0.1
Western white pine	10.0	3.8	18.0	4.4	8.9	2.2	5.4	1.1	39.1	6.0	12.5	3.7
Total	4.6	0.1	18.1	0.4	6.3	0.2	6.0	0.2	33.2	0.5	7.2	0.2
Hardwoods:												
Alder/maple	7.5	1.7	35.4	4.6	18.1	2.8	3.6	1.2	58.7	4.4	1.8	0.8
Aspen/birch	14.9	3.1	26.6	5.6	12.6	3.3	8.7	1.7	57.1	6.7	5.1	2.2
Elm/ash/cottonwood	2.2	1.6	51.5	8.7	2.7	1.2	25.7	10.8	69.5	9.8	1.4	0.7
Exotic hardwoods	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
Other western hardwoods	5.5	0.8	20.7	1.8	7.8	0.8	15.8	2.0	47.3	2.5	9.0	1.5
Tanoak/laurel	12.1	0.8	16.7	1.3	7.2	0.7	4.0	0.8	38.2	1.7	3.0	0.4
Western oak	4.0	0.2	18.2	0.7	11.7	0.5	28.7	0.9	57.5	0.9	4.0	0.2
Total	5.5	0.2	18.7	0.6	10.8	0.4	23.1	0.8	53.7	0.8	4.2	0.2
Nonstocked	1.6	0.6	28.9	2.8	10.7	1.4	16.0	2.3	53.9	2.9	16.0	2.1
All forest types	4.9	0.1	18.6	0.3	8.2	0.2	13.1	0.3	41.9	0.4	6.2	0.2
Chaparral on national forest	0.7	0.2	61.5	1.3	5.9	0.5	6.0	0.5	72.0	1.1	9.0	0.5

Note: Data subject to sampling error; SE = standard error.

gray emissions associated with cutting the 171 acres. Therefore, until the above issues are addressed, the DEIR fails to adequately identify, and consequently, fails to calculate, the GHG emissions associated with this Project. Moreover, the numbers that have been provided (*i.e.*, Tables 4-3 and 4-4), while deficient, nonetheless demonstrate that GHG impacts will be much greater than zero, and hence, are cumulatively significant.

III. THE DEIR MUST ANALYZE AND ADOPT ALL FEASIBLE MITIGATION MEASURES AND ALTERNATIVES TO REDUCE ITS CARBON IMPACT

In order to comply with CEQA, CAL FIRE "must determine whether any of the possible significant environmental impacts of the project will, in fact, be significant." *Protect the Historic Amador Waterways v. Amador Water Agency*, 116 Cal. App. 4th 1099, 1109 (2004). A major deficiency of the DEIR is its failure to properly acknowledge and discuss a) what will be foregone as a result of the loss of 171 acres of redwood forest, and b) what will be emitted as a result of the loss of 171 acres of redwood forest. While the DEIR does provide numbers which show that carbon sequestration will be diminished, and that there will be serious emissions as a result of the Project, the DEIR then fails to take the next logical step of avoiding and/or mitigating for this significant impact. Instead, with almost no explanation, the DEIR asserts that its GHG impacts are insignificant. As explained below, this conclusion is without merit, and therefore, the DEIR is deficient in its failure to address its significant GHG impacts.

Even by its own numbers, the DEIR shows that the Project would result in significant GHG emissions. First of all, the DEIR's numbers demonstrate that foregone sequestration will be substantial – if left alone, the forest area being proposed for conversion would sequester between 188 and 1316 *more* metric tons of carbon per year than would occur if the Project goes forward. *See* Table 4-3. Second, the DEIR notes that at least 231 metric tons of carbon would be emitted from vehicles as a result of the Project. *See* Table 4-4. Third, as the DEIR admits, the vehicle emissions figure "does not account for tractor emissions, small engine emissions (e.g., weedeaters), or the initial emissions associated with logging and conversion of the site." DEIR at 4-15. Together, this means that by the DEIR's own findings, this Project would result in substantial metric tons of carbon emissions per year. Of course, as already pointed out, the DEIR fails to account for all emissions, and fails to account for the loss of redwood forest, so the DEIR's numbers are *minimums*. Indeed, just the emissions associated with "logging and conversion of the site" would themselves be significant and yet are unaccounted for by the DEIR.

Inexplicably, though, after laying out the above numbers (and admitting that much was left out of those numbers), the DEIR asserts that "in the context of statewide, nationwide, or global emissions, and considering the carbon sequestration that would continue to occur once the vineyards are planted, the proposed project's incremental contribution … would not be cumulatively considerable. Therefore, the proposed project would have a ***less-than-significant*** impact on climate change." DEIR at 4-17 (emphasis in original). This makes no sense given that the Project will indeed lead to substantially diminished sequestration as well as greater GHG emissions than would occur absent the Project. Again, with GHG emissions, even tiny impacts are significant from a cumulative perspective, especially in light of the very serious nature of the issue – numerous sources are combining to create the problem, and while some are small and some are large, all are significant because they each further intensify the problem.

The DEIR exacerbates its GHG shortomings by failing to explain how it determined the significance of it GHG impacts. Indeed, there is no discussion whatsoever in the DEIR of a GHG significance threshold other than the following statement:

> Currently, thresholds of significance for GHGs have not been identified by either the ARB, or the NSCAPCD. Early actions proposed by the ARB are not strictly applicable to the proposed project, and the proposed project would be subject to any applicable State regulations as they are developed.

DEIR at 4-16 – 4-17. CEQA requires agencies to explain the significance of a Project's emissions with or without established significance thresholds and this is true regardless of whether the Project would be subject to other regulations. As noted in the CAPCOA white paper on CEQA and Climate Change, "[t]he absence of a threshold does not in any way relieve agencies of their obligations to address GHG emissions from projects under CEQA." CAPCOA 2008 at 23. *See also* OPR Technical Advisory document, p. 4 ("Even in the absence of clearly defined thresholds [of significance] for GHG emissions, the law requires that such emissions from CEQA projects must be disclosed and mitigated to the extent feasible whenever the lead agency determines that the project contributes to a significant, cumulative climate change impact."). Moreover, as already discussed, projects cannot, as this DEIR attempts to do, hide behind the fact that their GHG emissions are individually small when examined "in the context of statewide, nationwide, or global emissions." On the contrary, a cumulative impacts analysis under CEQA demands that even very small impacts be considered significant, and hence, mitigated, if they are further contributing to an already serious problem as is the situation with GHGs. Again, climate change is likely *the* most pressing cumulative impacts problem of our time – if each small source was allowed to hide behind claims of "de minimis" impacts, the problem would go unsolved. This is why courts have consistently rejected the notion that the incremental impact of a project is not cumulatively significant when it is so small that it would make only a *de minimis* contribution to the problem as a whole. *See, e.g., Communities for a Better Env't v. California Resources Agency*, 103 Cal.App.4th at 117.

The California Global Warming Solutions Act of 2006 (AB 32) recognized that "global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California" and required that existing levels of greenhouse gases be reduced to 1990 levels by 2020. Health & Safety Code §§ 38501(a), 38550. AB 32 establishes that existing greenhouse gas levels are unacceptable and must be substantially reduced within a fixed timeframe. Put another way, any additional emissions that contribute to existing levels will frustrate California's ability to meet its ambitious and critical emissions reduction mandate. Consequently, only thresholds that are highly effective at reducing emissions from new projects will ensure that new projects do not have significant cumulative effects on global warming. Thus, in order to account for the fact that any additional emissions are problematic, CAL FIRE should adopt a zero significance threshold for any Project's greenhouse gas emissions. As stated in *CEQA and Climate Change: Addressing Climate Change Through California Environmental Quality Act Review*, from the Governor's Office of Planning and Research:

> When assessing whether a Project's effects on climate change are cumulatively considerable, even though its GHG contribution may be individually limited, the lead

> agency must consider the impact of the project when viewed in connection with the effects of past, current, and probable future projects . . . . Lead agencies should not dismiss a proposed project's direct and/or indirect climate change impacts without careful consideration, supported by substantial evidence. Documentation of available information and analysis should be provided for any project that may significantly contribute new GHG emissions, either individually or cumulatively, directly or indirectly (e.g., transportation impacts).

See also Communities for Better Env't v. California Resources Agency, 103 Cal. App. 4th at 120 ("the greater the existing environmental problems are, the lower the threshold for treating a project's contribution to cumulative impacts as significant."). Regardless of whether a zero threshold is adopted, the fact remains that even by its own numbers, this Project's impacts (emissions and foregone sequestration) are well above zero, and hence, while they may be small "in the context of statewide, nationwide, or global emissions," they are still cumulatively significant.[9]

The failure to recognize the cumulatively significant GHG impacts from this Project directly leads to the failure to consider feasible alternatives and mitigation measures to reduce this cumulatively significant impact. CEQA requires that agencies "mitigate or avoid the significant effects on the environment of projects that it carries out or approves whenever it is feasible to do so." Pub. Res. Code § 21002.1(b). A rigorous analysis of reasonable alternatives to the project must be analyzed to comply with this strict mandate. "Without meaningful analysis of alternatives in the EIR, neither courts nor the public can fulfill their proper roles in the CEQA process." *Laurel Heights Improvement Ass'n v. Regents of University of California*, 47 Cal.3d at 404. Moreover, "[a] potential alternative should not be excluded from consideration merely because it would impede to some degree the attainment of the project objectives, or would be more costly." *Save Round Valley Alliance v. County of Inyo*, 157 Cal. App. 4th 1437, 1456-57 (2007) (quotations omitted). An analysis of alternatives should also quantify the estimated greenhouse gas emissions resulting from each proposed alternative.

Here, the DEIR neglects to discuss even "one alternative that would ensure that the [agency] contributes to a lower-carbon future." Potential alternatives include one that would not result in

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[9] At page 4-15, the DEIR asserts that "except for the low carbon sequestration estimate, the project site would continue to sequester more carbon dioxide than vineyard activities would emit. Under the worst-case scenario the project would result in net emissions of 83.6 metric tons of carbon dioxide equivalents. In comparison, California emits approximately 492 million metric tons of carbon dioxide equivalents." This assertion misses the mark entirely. First, it ignores the biggest problem associated with forest conversion – the loss of forest sequestration capacity. As explained in these comments, when diminished sequestration is properly acknowledged (especially the fact that this Project would result in the loss of redwood forest sequestration), this Project's GHG impacts are plainly significant. Second, comparing this Project's emissions to state-wide emissions tells us very little and is irrelevant. *Communities for a Better Env't v. California Resources Agency*. 103 Cal.App.4th at 117 ("The relevant issue was not the relative amount of traffic noise resulting from the project when compared to existing traffic noise, but whether any additional amount of traffic noise should be considered significant given the nature of the existing traffic noise problem."). The question here is whether the Project's GHG impacts are cumulatively significant, and as already explained, there is no question that that is the case – together, the lost sequestration and the emissions associated with clear-cutting/preparing the area for vineyard operations are well above zero.

conversion of existing forest or would result in much less conversion.[10] A recent court decision also makes clear that just because a project proponent wishes to proceed under a certain scenario does not mean the CEQA analysis must accommodate that desire. Rather, feasible alternatives must be considered regardless of the project proponent's position on the alternatives. For example, in *Preservation Action Council v City of San Jose*, 141 Cal .App. 4th 1355 (2006), the defendant relied heavily on the real parties' project objectives in order to reject an alternative. The court found that "the project objectives in the DEIR appear unnecessarily restrictive and inflexible." *Id*. at 1360. "[T]he willingness of the applicant to accept a feasible alternative . . . is no more relevant than the financial ability of the applicant to complete the alternative. To define feasible [in such fashion] would render CEQA meaningless." *Uphold Our Heritage v. Town of Woodside*, 147 Cal. App. 4th 587, 601 (2007). This same principle was reiterated in *Save Round Valley Alliance v. County of Inyo*, 157 Cal. App. 4th at 1460, where the court found that "the willingness or unwillingness of a project proponent to accept an otherwise feasible alternative is not a relevant consideration." This was so despite the project proponent's explicit unwillingness to accept a proposed alternative. *Id.* The Court found that the alternative should have been analyzed regardless, and noted that an "applicant's feeling about an alternative cannot substitute for the required facts and independent reasoning." *Id.* at 1458, quoting *Preservation Action Council*, 141Cal. App. 4th at 1356. Thus, CAL FIRE has an obligation to assess a lower carbon alternative. This is also necessary in order to allow for informed decision-making. Consequently, thus far, the DEIR's analysis of alternatives is deficient.

In addition to thoroughly evaluating project alternatives, "the EIR must propose and describe mitigation measures that will minimize the significant environmental effects that the EIR has identified." *Napa Citizens for Honest Gov't v. Napa County Bd. of Supervisors*, 91 Cal.App.4th 342, 360 (2001). Mitigation of a project's significant impacts is one of the "most important" functions of CEQA. *Sierra Club v. Gilroy City Council*, 222 Cal.App.3d at 41. Importantly, mitigation measures must be "fully enforceable through permit conditions, agreements, or other measures" so "that feasible mitigation measures will actually be implemented as a condition of development." *Federation of Hillside & Canyon Ass'ns v. City of Los Angeles*, 83 Cal.App.4th 1252, 1261 (2000).

In sum, there is simply no escaping the need for immediate GHG reductions, and the DEIR offers no alternatives or mitigation for its substantial GHG impacts. Instead, in conclusory fashion, the DEIR simply asserts that its impacts are insignificant. A vineyard, however, as even the DEIR admits in its calculations, is far different than a forest in regard to sequestration capacity and therefore it is obvious that this Project will not only lead to significant emissions in terms of carbon lost from the cut, but will also lead to a significant loss of sequestration capacity. Therefore, until the DEIR acknowledges the significance of its GHG impacts and appropriately avoids or mitigates them, this Project will be in violation of CEQA.

[10] The DEIR does include an alternative that would result in less conversion than the proposed Project. However, there is no discussion whatsoever of how this alternative would avoid or mitigate GHG impacts. Until such a discussion is included, the DEIR's alternatives are inadequate from a GHG perspective.

IV. THE DEIR MUST ADDRESS THE IMPACT GLOBAL WARMING WILL HAVE ON THE PROJECT

Climate change poses enormous risks to California. Scientific literature on the impact of greenhouse gas emissions on California is well developed.[11] The California Climate Change Center ("CCCC") has evaluated the present and future impacts of climate change to California and the project area in research sponsored by the California Energy Commission and the California Environmental Protection Agency (Cayan et al. 2007). The severity of the impacts facing California is directly tied to atmospheric concentrations of greenhouse gases (Cayan et al. 2007; Hayhoe et al. 2004). According to the CCCC, aggressive action to cut greenhouse gas emissions today can limit impacts, such as loss of the Sierra snow pack to 30%, while a business-as-usual approach could result in as much as a 90% loss of the snowpack by the end of the century. As aptly noted in a report commissioned by the California EPA:

> Because most global warming emissions remain in the atmosphere for decades or centuries, the choices we make today will greatly influence the climate our children and grandchildren inherit. The quality of life they experience will depend on if and how rapidly California and the rest of the world reduce greenhouse gas emissions (Cayan et al. 2007).

Some of the types of impacts to California and estimated ranges of severity – in large part dependent on the extent to which emissions are reduced – are summarized as follows:

- A 30 to 90 percent reduction of the Sierra snowpack during the next 100 years, including earlier melting and runoff.
- An increase in water temperatures at least commensurate with the increase in air temperatures.
- A 6 to 30 inch rise in sea level, before increased melt rates from the dynamical properties of ice-sheet melting are taken into account.
- An increase in the intensity of storms, the amount of precipitation and the proportion of precipitation as rain versus snow.
- Profound impacts to ecosystem and species, including changes in the timing of life events, shifts in range, and community abundance shifts. Depending on the timing and interaction of these impacts, they can be catastrophic.
- A 200 to 400 percent increase in the number of heat wave days in major urban centers.
- An increase in the number of days meteorologically conducive to ozone (O_3) formation.
- A 55 percent increase in the expected risk of wildfires (Cayan et al. 2007).

Given that California's temperatures are expected to rise "dramatically" over the course of this century (Cayan 2007), affecting snowpack and precipitation levels, and because California's

[11] Additional reports issued by California agencies are available at http://www.climatechange.ca.gov, and IPCC reports available at http://www.ipcc.ch/.

ecosystems depend upon relatively constant precipitation levels, and water resources are already under strain (Cayan 2007), California will face significant impacts. These impacts will affect the planned Project, as well as exacerbate its own environmental impacts. Thus, when analyzing the Project, the DEIR must take into account global warming. To ignore the impact of global warming on would significantly understate the situation. *See, e.g., Laurel Heights Improvement Ass'n v. Regents of Univ. of Cal.*, 47 Cal.3d at 392 (EIR is intended "to demonstrate to an apprehensive citizenry that the agency has, in fact, analyzed and considered the ecological implications of its action.").

<u>The following information provides background regarding forest carbon, explains why retaining existing forest is extremely important from a GHG perspective, and demonstrates that there are significant differences in carbon sequestration between a forest and a vineyard.</u>

A. Carbon Forest Basics

Forests play an important role in reducing the amount of carbon dioxide in the atmosphere. During photosynthesis, trees "breathe in" carbon dioxide and "breathe out" pure oxygen. Through this process, forests remove massive amounts of carbon dioxide from the atmosphere each year.

Forest ecosystems also serve as banks that store carbon for finite periods of time; thus, in a natural state, and/or if managed well, they are carbon sinks and not sources (Tans et al. 1990). Carbon is added to the bank regularly through photosynthesis, which removes carbon dioxide from the atmosphere and stores the carbon contained therein in the organic matter of the forest.

Forest ecosystems are complex, and include not only living and dead trees but understory vegetation, and soil. Each of these elements contains carbon. For example, Turner et al. (1995) estimated that forests in the coterminous United States contain 36.7 Pg [12] of carbon with half of that in the soil, one-third in trees, 10% in woody debris, 6% in the forest floor, and 1% in the understory. The location of forest carbon is important because it helps determine how much carbon remains in storage or is lost after disturbances like logging.

B. U.S. Forests Store and Remove Carbon from the Atmosphere

Changes in land use and forestry practices can emit carbon dioxide (*e.g.*, through conversion of forest land to non-timberland use, or through logging) or can act as a sink for carbon dioxide (*e.g.*, through net additions to forest biomass). Regardless of the exact number, it is clear that if forests are protected and allowed to flourish they have the potential to store and sequester a significant amount of carbon. Evidence abounds on this topic. For example:

[12] Pg [petagram]=one billion metric tonnes=1000 x one billion kg

- It is estimated that from 1952-1993, carbon storage in American forests increased by 38% (Birdsey et al. 1993). The authors hypothesize that this may be due to biomass accumulation in temperate forests over the time period.

- Birdsey and Heath (1995) estimated that in 1995 the United States contained 298 million hectares of forests, which stored 54.6 billion metric tons of organic carbon above and below the ground. This amounted to five percent of all the carbon stored in the world's forests.

- Pacala et al. (2001) estimated that the coterminous United States was an annual carbon sink of between 0.3 and 0.58 Pg of carbon annually, with half of the storage occurring in forest ecosystems.

- Land use, land-use change, and forestry activities in 2006, resulted in a net carbon sequestration of 883.7 Tg CO_2 e, with 745 Tg of this coming from forest land that was allowed to remain as forest land. Forests (including vegetation, soils, and harvested wood) accounted for approximately 84 percent of total 2006 net CO_2 flux (EPA 2008). Overall in 2006, these activities represent an offset of approximately 14.8 percent of total U.S. CO_2 emissions, or 12.5 percent of total greenhouse gas emissions in 2006 (EPA 2008).

- Between 1990 and 2006, total land use, land-use change, and forestry net carbon flux resulted in a 20 percent increase in CO_2 sequestration, primarily due to an increase in the rate of net carbon accumulation in forest carbon stocks, particularly in aboveground and belowground tree biomass (EPA 2008). The net forest sequestration is a result of net forest growth and increasing forest area, as well as a net accumulation of carbon stocks in harvested wood pools.

- Peters et al. (2007) concluded that North American ecosystems remove 0.65 Pg C/year, offsetting one-third of the 1.85 Pg carbon emissions. Forests account for the majority of this uptake.

C. Forest Conversion Releases Carbon Stores

Certain forest management actions, and conversion in particular, allow stored carbon to be released into the atmosphere. Thus, in addition to affecting habitat, conversion causes a withdrawal from the forest carbon bank: carbon is removed from long-term storage and released to the atmosphere, exacerbating global warming and climate change.

Evidence shows that the carbon dioxide releases from conversion can be substantial. In a letter to the California Air Resources Board regarding California Climate Action Registry Forest Protocols, Harmon (2007) wrote:

> Timber harvest, clear cutting in particular, removes more carbon from the forest than any other disturbance (including fire). The result is that harvesting forests generally reduces carbon stores and results in a net release of carbon to the atmosphere.

Turner et al. (1995) suggest that in light of climate change and further disturbance, we need to pay close attention to forest loss due to the fact that:

> A general intensification of forest management, resulting in lower carbon storage per unit area (Cooper 1983, Dewer 1991), and a gradual increase in the harvest level (Haynes 1990), are also expected. These factors will tend to mitigate against a stable or increasing carbon sink (Turner et al. 1993). Increasing temperatures, atmospheric CO2, and nitrogen deposition could promote higher growth rates (McGuire et al. 1993), but projected climate change is also likely to produce a transient release of forest carbon because carbon sources associated with increasing disturbance rates would be greater than carbon sinks associated with land recovering from disturbance (King and Neilson 1992).

Furthermore, over half of the carbon stored in United States forests is in the forest floor and soils (Turner et al. 1995). The carbon stored in forest soils includes two pools: mineral soils and soil organic matter (Jandl et al. 2007). Much of the carbon stored in mineral soils is considered to be quite stable, and does not generally change dramatically in response to land management activities such as logging (Kimmins 1997; Johnson 1992; Heath and Smith 2000). However, the carbon contained in soil organic matter (which supports vegetation growth) does change in response to land management and is often reduced through logging (Jandl et al 2007; Birdsey and Heath 1995; Harmon et. al. 1990). This is because harvesting removes biomass, disturbs the soil and changes the microclimate all at the same time. It is possible that post-harvest soil carbon losses may exceed carbon gains in the aboveground biomass.

For example, Birdsey and Heath (1995) created a representative model for all forest land classes in all 50 states. They highlight the relative contribution of forest floor and soil carbon to the estimated annual increases in carbon storage and state that:

> Nationally about 2/3 of the historical and projected positive flux is carbon buildup in the soil and forest floor . . . . A search of the literature indicated that a major forest disturbance such as a clearcut harvest, can increase coarse litter and oxidation of soil organic matter. The balance of these 2 processes can result in a net loss of 20% of the initial carbon over a 10-15 year period following harvest (Pastor and Post 1986, Woddwell et al. 1984).

Citing literature from geographic regions throughout the U.S. and the world, and considering many different types of tree species and communities, Jandl et al. (2007) explored the way in which forest management can affect soil carbon sequestration. The authors summarize the science showing the impact that logging can have on soil carbon:

- Other researchers report large soil C losses after harvesting. Measurement of net ecosystem C exchange showed that for at least 14 years after logging, regenerating forests remained net sources of CO2 owing to increased rates of soil respiration (Olsson et al., 1996; Schulze et al., 1999; Yanai et al., 2003). Reductions in soil C stocks over 20 years following clear cuts can range between 5 and 20 t C/ha and are therefore significant compared to the gain of C in biomass of the maturing forest (Pennock and van Kessel, 1997).

- In their research to develop a model to quantify carbon in various types of U.S. forests, Smith and Heath (2002) found that by reducing litter input and increasing decomposition, clear-cut logging reduces forest floor carbon considerably. Decreases of 50% of forest floor mass have been shown for the first 15 years after logging in northern hardwoods (Covington 1981). Covington (1981) states that the initial decrease in forest floor mass is due to "lower leaf and wood litter fall and to more rapid decay resulting from higher temperature, moisture content, and nutrient levels and to early successional litter being more easily decomposed."

- Because the debris left behind after logging – branches, tops, and brush – continues to decay for many years after the disturbance, recently logged sites, even those that are replanted, continue to release carbon dioxide into the atmosphere for decades (Buchmann and Schulze 1999; Bergeron et al. 2007).

- Avoiding soil disturbances is important for the formation of stable organomineral complexes which in turn are crucial elements in the process of C soil sequestration.

Studies also show that logging can remove ninety-five percent of the non-soil carbon stored in a forest ecosystem and half of this is lost to the atmosphere in the first year (Janisch and Harmon 2002). Skog and Nicholson (2000) reconstructed the fate of forest carbon in the United States from 1910 to 2000. They found that 71 % of the carbon harvested during that period was released into the atmosphere while only 17% was stored in wood products and the remaining 12% was added to landfills. As pointed out in Turner et al. (1995b):

> After a human disturbance such as a clear cut harvest, ecosystems are a source of carbon to the atmosphere because of the decomposition of large woody debris and other forms of detritus. Later in stand development, as tree bole volume rapidly accumulates, forest ecosystems are strong carbon sinks.

Mackey et al (2008) note:

> The remaining intact natural forests constitute a significant standing stock of carbon that should be protected from carbon-emitting land-use activities. There is substantial potential for carbon sequestration in forest areas that have been logged commercially, if allowed to re-grow undisturbed by further intensive human land-use activities.

Unfortunately, specific examples of the climate costs associated with clear-cutting are plentiful. Using a model that took into account the prevalence of clear-cutting practices from 1972-1991, researchers found that forests in the Pacific Northwest released 11.8×10^{12} g C/year (Cohen et al. 1996). From this finding they calculated that even though forests in this region represented only 0.25% of the 4.1 billion hectares of forest on Earth, they were the source of 1.31% of the total land-use related carbon release in the world (Cohen et al. 1996; Dixon et al. 1994). They state:

> Although replacing older forests with more vigorous young forest can increase sequestration by live carbon pools, decomposition of the large detrital pools after harvest greatly offsets gains in biomass by living pools for an extended period of time (Cohen et al. 1996).

Moreover, a recent literature review (The Wilderness Society 2009[13]) found that only approximately 18% of original live tree volume is actually incorporated into long-lived wood products.[14] The remaining 82% waste would potentially result in emissions, as well as any portion of the wood products that are subsequently converted to emissions.

Finally, as pointed out in Noss (2001):

> Simplistic carbon accounting … ignores the tremendous releases of carbon that occur when forests are disturbed by logging and related activities such as site preparation and vegetation management (Perry 1994; Schulze et al. 2000). It ignores the fate of woody debris and soil organic carbon during forest conversion (Cooper 1983; German Advisory Council on Global Change 1998). Typically, respiration from the decomposition of dead biomass in logged forests exceeds net primary production of the regrowth (Schulze et al. 2000).

Noss (2001) also notes that clear-cutting causes significant habitat fragmentation, which has climate impacts of its own:

> Fragmentation may threaten biodiversity during climate change through several mechanisms, most notably edge effects and isolation of habitat patches. Intact forests maintain a microclimate that is often appreciably different from that in large openings. When a forest is fragmented by logging or other disturbance, sunlight and wind penetrate from forest edges and create strong microclimatic gradients up to several hundred meters wide, although they may vary in severity and depth among regions and forest types

[13] Ingerson, A. Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis? *The Wilderness Society*, April 2009

[14] From The Wilderness Society. 2009: "The U.S. Forest Service (2008) estimates logging residue at 30% of roundwood volume for the United States as a whole. State-level percentages range from 3% to 84% (U.S. Forest Service 2007).7 These percentages fail to capture the total carbon losses during logging, as reported logging residue volumes exclude roots, stumps, and small limbs.8 Including stumps and small limbs would increase logging residue volumes by an average of 14% for softwoods and 24% for hardwoods (McKeever and Falk 2004), which would increase overall national average residue to about 36%* of roundwood volume. Large roots range from 5% to 51% of total tree biomass, with a mean of 19%, in cold temperate and boreal forests in the United States (Li et al. 2003). Taking all these factors together, approximately 40%* of the original tree volume, with a range from 22%* to 59%* for individual states, might be left behind at harvest, and its stored carbon lost… "With about 36% of original standing tree volume available for processing into long-lived products, primary mill losses amount to about 4%* to 22%* (average of 13%) of the standing tree volume, leaving about 23% of the original volume to be incorporated into long-lived wood products such as lumber or panels… "Assuming that 76%* of wood volume in long-lived products is construction lumber, with the remaining 24% in furniture, cabinetry, and other products, total secondary processing and construction losses might be about 5%* of original standing tree volume. If 23% of the tree remains after primary processing, this leaves about 18% of original live tree volume actually incorporated into long-lived products."

(Ranney et al. 1981; Franklin & Forman 1987; Chen & Franklin 1990; Laurance 1991, 2000; Chen et al. 1992; Baker & Dillon 2000). With progressive fragmentation of a landscape, the ratio of edge to interior habitat increases, until the inertia characteristic of mature forests is broken. Fragmented forests will likely demonstrate less resistance and resilience to climate change than intact forests. Another potentially serious impact of fragmentation is its likely effect on species migration. By increasing the isolation of habitats, fragmentation is expected to interfere with the ability of species to track shifting climatic conditions over space and time. Weedy species, including many exotics, with high dispersal capacities may prosper under such conditions, whereas species with poor mobility or sensitive to dispersal barriers will fare poorly.

Clearly, land management, and specifically forest management, plays a major role in the global carbon balance. How California chooses to manage its forests has a significant effect on how much carbon dioxide is released and stored. If we are to maintain public and private forests as carbon sinks, which is now more important than ever, continued cumulative disturbance from conversion must be prevented or at least reduced.

D. Conversion Eliminates a Forest's Ability To Sequester Carbon

As discussed earlier, forests are carbon "banks," storing large amounts of carbon for long periods of time. Old growth forests have an especially vast amount of live vegetation including huge trees, large downed logs, a healthy understory and a rich ground layer. Each of these elements stores considerable amounts of carbon and so it follows that ancient forests are the "banks" holding the most carbon. A report from the IPCC has echoed this sentiment pointing out that the best way to preserve the carbon stored in a forest is to preserve the forest itself: "The theoretical maximum carbon storage (saturation) in a forested landscape is attained when all stands are in old-growth state (Nabuurs et al. 2007)."

Some industry advocates like to argue that old-growth forests are "carbon neutral" – that is, they no longer remove carbon from the atmosphere at significant rates.[15] The DEIR claims that "[c]arbon accumulation in forests and soils eventually reaches a saturation point, beyond which additional sequestration is no longer possible. This happens, for example, when trees reach maturity, or when the organic matter in soils builds up to saturation levels." Such claims are not only factually wrong – older forests continue to remove carbon from the atmosphere at considerable rates – they are also misleading in that they disregard the amount of carbon already stored in the forest ecosystem. As noted in Luyssaert et al (2008): "old-growth forests can continue to accumulate carbon, contrary to the long-standing view that they are carbon neutral." Numerous other studies have likewise shown that old-growth forests continue to sequester carbon from the atmosphere (Desai et al. 2005; Law et al. 2003; Chen et al. 2004[16]; Field and

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[15] See, for example "Modern Forestry and Climate Change" by the California Forest Products Commission, available at http://www.foresthealth.org/ (last accessed June 5, 2008).

[16] Chen et al. (2005) showed old-growth Douglas fir forests as a minor source of carbon during an exceptionally dry summer, and a more substantial sink during a year of average rainfall. Thus this study likely underestimates the level of carbon removal from this forest.

Kaduk 2004; Paw U et al. 2004; Harmon et al. 2004; Grier and Logan 1977; Knohl et al. 2003). Old-growth Douglas fir forests, for example, "show remarkable sequestration of carbon, comparable to many younger forests (Paw U et al. 2004)." As discussed in Hudiburg et al (2009):[17]

> Decrease in NPP with age was not general across ecoregions, with no marked decline in old stands (200 years old) in some ecoregions. In the absence of stand-replacing disturbance, total landscape carbon stocks could theoretically increase from 3.2 +- 0.34 Pg C to 5.9 +- 1.34 Pg C (a 46% increase) if forests were managed for maximum carbon storage.
>
> Trends in NPP with age vary among ecoregions, which suggests caution in generalizing that NPP declines in late succession. Contrary to commonly accepted patterns of biomass stabilization or decline, biomass was still increasing in stands over 300 years old in the Coast Range, the Sierra Nevada and the West Cascades, and in stands over 600 years old in the Klamath Mountains. If forests were managed for maximum carbon sequestration total carbon stocks could theoretically double in the Coast Range, West Cascades, Sierra Nevada, and East Cascades and triple in the Klamath Mountains (Fig. 8).

This is why logging, especially logging that converts forest to a non-forest use, is problematic; it prevents vast amounts of trees from getting older, and from reaching an old growth stage which science shows is best in terms of its implications for carbon uptake and climate change, not to mention overall ecological benefits.

But it is not only older trees that hold large amounts of carbon; forest floors in older forests contain significantly more carbon than forest floors of cutover forests (Lecomte et al. 2006; Fredeen et al. 2005; Harmon et al. 1990). Old forests also increase the amount of carbon that is placed into long-term storage in stable forest soils; this carbon is lost through the soil disturbance associated with logging. (Harmon et al. 1990). This can have serious implications for sequestration capabilities as we see from conclusions made by Jandl et al. (2007):

> What is beyond dispute is that the formation of a stable soil [carbon] pool requires time. Avoiding soil disturbances is important for the formation of … crucial elements in the process of [carbon] soil sequestration.

Luyssaert et al (2008) reported similar findings:

> In our model we find that old-growth forests accumulate 0.4 ±0.1 tC ha^{-1} yr^{-1} in their stem biomass and 0.7±0.2 tC ha^{-1} yr^{-1} in coarse woody debris, which implies that about 1.3 ±0.8 tC ha^{-1} yr^{-1} of the sequestered carbon is contained in roots and soil organic matter.

[17] Hudiburg, T. Beverly Law, David P. Turner, John Campbell, Dan Donato, and Maureen Duane. 2009. Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. *Ecological Applications* 19(1):163–180.

The fact that substantial carbon is found in roots and organic soil is significant given that logging, specifically clear-cutting, results in the loss of large amounts of soil and therefore, forest floor carbon. This loss is not only due to the direct impacts of logging, but also as a result of the continued erosion and soil degradation that often comes with logging. In short, conversion not only prevents trees from continuing with their carbon sequestration, it prevents the entire forest system from doing so.

E. The Rate Of Carbon Uptake By Vineyards Does Not Offset Forest Conversion

As stated in *Winrock International. Measuring and Monitoring Plans for Baseline Development and Estimation of Carbon Benefits for Change in Forest Management in Two Regions, March 2004*,[18]

> Mature redwood stands are famous for their enormous stocks of standing biomass and represent perhaps the most massive forests, per unit area, on earth. Measurements of old-growth (>200 years) redwood stands have yielded standing carbon stocks ranging from 1,650 to 1,784 t C equivalent per ha (Hallin, 1934, Westman and Whittaker, 1975, and Fujimori, 1977). Equally impressive is the rate at which carbon is sequestered in growing redwood stands. A 100 year old redwood stand measured by Olson et al (1990) yielded 3,600 cubic meters per ha, equivalent to 648 t C per ha (at specific gravity 0.36 g oven dry biomass/cm3 for second-growth redwood (Markwardt and Wilson, 1935)), or a mean annual carbon increment of 6.48 t C per ha per year.

While this Project will be cutting young redwood forest, not old growth, the fact remains that the Project will prevent forest from growing older and attaining old growth status. Moreover, as noted above, and in the excerpts from *California's forest resources, 2001–2005: five-year Forest Inventory and Analysis report*,[19] redwoods are extremely efficient carbon sequesters, and therefore, loss of young redwood trees is problematic because it will prevent these trees from any further sequestration. Vineyards, of course, which even the numbers in the DEIR recognize, offer profoundly less carbon sequestration.[20] DEIR at 4-14. Moreover, as noted in the document cited by the DEIR, *Sources: Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture; 2005*, "conservation tillage often also involves increasing inputs, such as chemical fertilizers and pesticides, which could offset some of the environmental gains from conservation tillage." Fertilizers and pesticides have their own carbon costs which are unaccounted for in the DEIR. Thus, the numbers provided in the DEIR are very much minimums because they a) fail to address the fact that the Project is cutting highly productive redwood and Douglas fir forest, and b) fail to account for the carbon costs associated with vineyards such as pesticides and fertilizers.

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[18] Accessed at http://www.energy.ca.gov/reports/CEC-500-2004-070/CEC-500-2004-070F.PDF

[19] Christensen, Glenn A.; Campbell, Sally J.; Fried, Jeremy S., tech. eds. 2008. California's forest resources, 2001–2005: five-year Forest Inventory and Analysis report. Gen. Tech. Rep. PNW-GTR-763. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 183 p.

[20] The DEIR uses conservation tillage numbers as a surrogate for vineyards, which show just 0 to 1.1 metric tons per acre per year; also, if the DEIR had properly accounted for the fact that redwoods and Douglas firs are being cut, the disparity between forest and vineyard sequestration would have been much greater.

In sum, conversion has significant negative impacts on carbon stores. It eliminates the existing trees and the carbon stored in the rest of the forest system, and prevents the development of more forest carbon stores. These issues must be appropriately and adequately addressed if the DEIR is to meet its CEQA obligations.

CONCLUSION

The Fairfax DEIR must be revised in light of its deficiencies. Until all issues discussed above are adequately addressed and the DEIR re-circulated for comments, the proposed Project is unlawful.

Thank you for your consideration of these comments. Please contact us if you have any questions.

Sincerely,

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Literature Cited[21]

Bergeron, O., H. Margolis, T. Black, C. Coursolle, A. Dunnz, A. Barr, and S. Wofsyz. 2007. Comparison of carbon dioxide fluxes over three boreal black spruce forests in Canada. *Global Change Biology* 13, 89–107.

Birdsey, R. A., and L. S. Heath. 1995. Carbon Changes in U. S. forests. In *Productivity of America's Forests and Climate Change GTR-RM-271*, edited by L. A. Joyce: USDA Forest Service, Rocky Mountain Research Station.

Birdsey, R.A., Plantinga, A.J. and Heath, L.S., 1993. Past and prospective carbon storage in United States forests. *Forest Ecology and Management* 58: 33-40.

Buchmann, N. and Ernst-Detlef Schulze. 1999. Net CO_2 and H_2O fluxes of terrestrial ecosystems. *Global Biogeochemical Cycles* 13 (3):751-760.

California Air Pollution Control Officers Association (CAPCOA), *CEQA & Climate Change, Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act*, Jan. 2008.

California State Board of Forestry & Fire Protection. 2005. Climate change and carbon sequestration *In Draft environmental impact report for the draft Jackson Demonstrations State Forest management plan*. SCH# 2004022025. Prepared for The California State Board of Forestry & Fire Protection. Page VII 16-1-16-5.

Cayan, et al. 2007. Our Changing Climate: Assessing the Risks to California. California Climate Change Center.

Chen, Jiquan, Kyaw Tha Paw U, Susan L. Ustin, Thomas H. Suchanek, Barbara J. Bond, Kimberley D. Brosofske, Matthias Falk. 2004. Net Ecosystem Exchanges of Carbon, Water, and Energy in Young and Old-Growth Douglas- Fir Forests. *Ecosystems* 7 (5): 534-544.

Cohen, W.B., M.E. Harmon, D.O. Wallin, and M. Fiorella. 1996. Two decades of carbon flux from forests of the Pacific Northwest. *BioScience* 46(11):836-844.

Covington, W.W. 1981. Changes in Forest Floor Organic Matter and Nutrient Content Following Clear Cutting in Northern Hardwoods. *Ecology* 62 (1): 41-48.

Desai, Ankur R., Paul V. Bolstad, Bruce D. Cook, Kenneth J. Davis, and Eileen V. Carey. 2005. Comparing net ecosystem exchange of carbon dioxide between an old-growth and mature forest in the upper Midwest, USA. *Agricultural and Forest Meteorology* 128:33–55.

[21] Much of this Literature has already been submitted with previous comments and is therefore already in CAL FIRE's files.

Dixon, K., S. Brown, R. A. Houghton, A. M. Solomon, M. C. Trexler and J. Wisniewski. Carbon Pools and Flux of Global Forest Ecosystems. *Science* 263 (4144) : 185-190

EPA (U.S. Environmental Protection Agency). 2008. Inventory of U.S. Greenhouse gas emissions and sinks: 1990-2006. EPA 430-R-08-005. Washington, DC.

Field, Christopher B. and Jorg Kaduk. 2004. The Carbon Balance of an Old-Growth Forest: Building across Approaches. *Ecosystems* 7 (5): 525-533.

Fredeen, Arthur L., Claudette H. Bois, Darren T. Janzen, and Paul T. Sanborn. 2005. Comparison of coniferous forest carbon stocks between old-growth and young second-growth forests on two soil types in central British Columbia, Canada. *Canadian Journal of Forest Research* 35:1411–1421.

Grier, C.C., and R.S. Logan. 1977. Old-growth *Pseudotsuga menziesii* communities of a western Oregon watershed: biomass distribution and production budgets. *Ecological Monographs* 47: 373-400.

Governor's Office of Planning and Research, Technical Advisory, *CEQA And Climate Change: Addressing Climate Change Through California Environmental Quality Act* (*CEQA) Review*, 2008.

Hansen, J. Makiko Sato, Pushker Kharecha, David Beerling, Robert Berner, Valerie Masson-Delmotte, Mark Pagani, Maureen Raymo, Dana L. Royer and James C. Zachos, Target Atmospheric CO2: Where Should Humanity Aim? *The Open Atmospheric Science Journal*, 2008, 2, 217-231

Harmon, Mark. 2007. Letter to California Air Resources Board. *Comment on Forest Protocols. Online at:* http://www.arb.ca.gov/lispub/comm/bccomdisp.php?listname= forestghg07&comment_num=22&virt_num=22.

Harmon, Mark E., Ken Bible, Michael G. Ryan, David C. Shaw, H. Chen, Jeffrey Klopatek, and Xia Li. 2004. Production, Respiration, and Overall Carbon Balance in an Old-growth Pseudotsuga-Tsuga Forest Ecosystem. *Ecosystems* 7:498–512.

Harmon, Mark E., William K. Ferrell, and Jerry F. Franklin. 1990. Effects on Carbon Storage of Conversion of Old-Growth Forests to Young Forests. *Science* 247:699-702.

Hayhoe, K., Daniel Cayan, Christopher B. Field, Peter C. Frumhoff, Edwin P. Maurer, Norman L. Miller, Susanne C. Moser, Stephen H. Schneider, Kimberly Nicholas Cahill, Elsa E. Cleland, Larry Dale, Ray Drapek, R. Michael Hanemann, Laurence S. Kalkstein, James Lenihan, Claire K. Lunch, Ronald P. Neilson, Scott C. Sheridan, and Julia H. Verville. 2004. Emissions pathways, climate change, and impacts on California. *Proceedings of the National Academy of Sciences* 101(34):12422-12427

Heath, L.S. and J.E. Smith. 2000. Soil carbon accounting and assumptions for forestry and forest-related land use change. P. 89-101. *In: Joyce L.A. and R. Birdsey, eds. The Impact of Climate Change on America's Forest*, USDA Forest Service, General Technical Report RMRS-GTR-59. 134p.

Hudiburg, T. Beverly Law, David P. Turner, John Campbell, Dan Donato, and Maureen Duane. 2009. Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. *Ecological Applications* 19(1):163–180.

Ingerson, A. Wood Products and Carbon Storage: Can Increased Production Help Solve the Climate Crisis? *The Wilderness Society*, April 2009

Jandl, R., M. Lindner, L. Vesterdal, B. Bauwens, R. Baritz, F. Hagedorn, D. W. Johnson, K. Minkkinen, and K. A. Byrne. 2007. How strongly can forest management influence soil carbon sequestration? *Geoderma* 137 (3-4):253-268.

Janisch, J. E., and M. E. Harmon. 2002. Successional changes in live and dead wood carbon stores: implications for net ecosystem productivity. *Tree Physiology* 22 (2-3):77-89.

Johnson, D.W. 1992. Effects of forest management on soil carbon storage. *Water Air and Soil Pollution* 64 (1-2):83-120.

Kimmins, J.P. 1997. Forest ecology. 2nd ed. Prentice Hall, Upper Saddle River, NJ. 596 pp.

Knohl, A., Ernst-Detlef Schulze, Olaf Kolle, and Nina Buchmann. 2003. Large carbon uptake by an unmanaged 250-year-old deciduous forest in Central Germany. *Agricultural and Forest Meteorology* 118:151-167.

Law, B. E., O. J. Sun, J. Campbell, S. Van Tuyl, and P. E. Thornton. 2003. Changes in carbon storage and fluxes in a chronosequence of ponderosa pine. *Global Change Biology* 9:510-524.

Lecomte, Nicolas, Martin Simard, Nicole Fenton, and Yves Bergeron. 2006. Fire Severity and Long-term Ecosystem Biomass Dynamics in Coniferous Boreal Forests of Eastern Canada. *Ecosystems* 9: 1215–1230.

Luyssaert, S., E. -Detlef Schulze, Annett Borner, Alexander Knohl, Dominik Hessenmoller, Beverly E. Law, Philippe Ciais and John Grace. 2008. Old-growth forests as global carbon sinks. *Nature* 455: 213-215.

Mackey, Brendan G, 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 forest, and policy implications. The Fenner School of Environment & Society, The Australian National University. 48 pp.

Mackey, Brendan G, David B. Lindenmayer, Malcolm Gill, Michael McCarthy and Janette Lindesay. 2002. Wildfire, Fire and Future Climate. CSIRO Publishing, Australia. 196pp.

Meehl G.A. et al., Global Climate Projections, in Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC (S. Solomon et al. eds., Cambridge University Press 2007).

Merenlender, Adina and Brooks, Colin. GIS in Rangeland Management, Vineyard Expansion in Sonoma County: Mapping, Monitoring, and Changing Policies

Mitchell, S, Mark E. Harmon, and Kari E. B. O'connell. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. *Ecological Applications* 19(3): 643–655

Nabuurs, Gert Jan, O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanz Sanchez, and X. Zhang. 2007. IPCC Fourth Assessment Report, Working Group III, Chapter 9 (final draft). In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by B. Metz, O. R. Davidson, P. R. Bosch, R. Dave and L. A. Meyer. Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press.

Noss, Reed F.. 2001. Beyond Kyoto: Forest Management in a Time of Rapid Climate Change. *Conservation Biology*, Volume 15, No. 3, 578-590.

Pacala, S.W., G.C. Hurtt, D. Baker, P. Peylin, R.A. Houghton, R.A. Birdsey, L.S. heath, E.T. Sundquist, R.F. Stallard, P. Ciais, P. Moorcroft, J.P. Caspersen, E. Shevilakova, B.Moore, G. Kohmaier, E. Holland M.Gloor, M.E. Harmon, S-M. Fan, J.L. Sarmiento, C.L. Goodale, D. Schmiel, and C.B. Field. 2001. Consistent Land and Atmosphere Based U.S. Carbon Sink Estimates. *Science* 292: 2316-2320.

Paw U, K. T., M. Falk, T. H. Suchanek, S. L. Ustin, J. Q. Chen, Y. S. Park, W. E. Winner, S. C. Thomas, T. C. Hsiao, R. H. Shaw, T. S. King, R. D. Pyles, M. Schroeder, and A. A. Matista. 2004. Carbon dioxide exchange between an old-growth forest and the atmosphere. *Ecosystems* 7 (5):513-524.

Peters, W., Andrew R. Jacobson, Colm Sweeney, Arlyn E. Andrews, Thomas J. Conway, Kenneth Masarie, John B. Miller, Lori M. P. Bruhwiler, Gabrielle Petron, Adam I. Hirsch, Douglas E. J. Worthy, Guido R. van der Werf, James T. Randerson, Paul O. Wennberg, Maarten C. Krol, and Pieter P. Tans. 2007. An atmospheric perspective on North American carbon dioxide exchange: CarbonTracker. *PNAS* 104 (48): 18925–18930.

Schulze, E. D., C. Wirth, and M. Heimann. 2000. Climate change - managing forests after Kyoto. *Science* 289:2058-2059.

Skog, K.E and G. Nicholson. 2000.Carbon Sequestration in Wood and Paper Products. Gen. Tech. Rep. RMRS-GTR-59. U.S. Department of Agriculture, Forest Service, 10 p.

Smith, J.E. and L.S. Heath. 2002. A model of forest floor carbon mass for United States forest types. Res. Pap. NE-722. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 37 p.

Tans PP, Y. Fungl and T. Takahashi. 1990. Observational constraints on the global atmospheric CO_2 budget. *Science* 247: 1431-1438.

Turner, D.P, Koerper, G.J., Harmon, M.E. and Lee, J.J. 1995. A carbon budget for forests of the conterminous United States. *Ecological Applications* 5: 421-436.

Turner, D.P., Koerper, G.J, Harmon, M.E and Lee, J.J. 1995b. Carbon sequestration by forests of the United States. Current Status and projections to the year 2040. *Tellus* 47B: 232-239.