April 8, 2016

Submitted to the Forest Carbon Action Team (FCAT)
via email at *fcat.calfire@fire.ca.gov*.

Re: Comments on the California Forest Carbon Plan Concept Paper

To the Forest Carbon Action Team:

These comments are submitted on behalf of the Center for Biological Diversity in response to the "California Forest Carbon Action Plan Concept Paper: Managing our Forest Landscapes in a Changing Climate" ("concept paper"), authored by the Forest Climate Action Team ("FCAT") on March 9, 2016. It is our understanding that the FCAT is soliciting public comment on all portions of the concept paper and the strategies of the Forest Carbon Plan. We also understand that the Air Resources Board intends to include this input in its development of goals for forest carbon sequestration and for reduction of greenhouse gas and black carbon emissions in the 2016 Scoping Plan Update. This comment letter is intended to offer comments relevant to both processes, while referencing specific passages in the concept paper.

I. Summary comments on the structure of the concept paper.

The concept paper identifies many appropriate goals for forest management, including the development of resilient forests and the protection of ecological values (although the latter are referred to almost exclusively in terms of "services"). However, the concept paper often fails to define key terms, provide robust scientific review of central concepts, or connect the proposed management goals to ecological objectives. In addition, the concept paper offers a sometimes unsupported and contradictory version of historical conditions and management of California's forests, placing much emphasis on thinning as a method for achieving ecological objectives, without acknowledging that logging in many cases can have (and many times has had) precisely the opposite results.

The concept paper also includes as a central assumption that “active management” (this term in the concept paper is often indistinguishable from commercial logging) as will lead inexorably to greater carbon storage. Although the paper acknowledges that mechanical thinning and other management will cause short-term reductions in carbon (a significant portion of which will likely be transferred to the atmosphere via combustion for bioenergy), it does not recognize the limitations on this assumption reflected in the scientific literature. For example, Campbell et al. (2011) and other studies (discussed in Part VII of these comments below) call this assumption into serious question. Even the studies cited in the concept paper in support of this assumption (at page 10) contain important qualifications and limitations; Hurteau and North (2010), for example, found substantial and continuing carbon losses from treatments that removed larger trees. Although the concept paper references this limitation obliquely, it is not fully reflected in

the paper's management proposals. Thinning operations in California routinely involve removal of large trees. (See Pub. Res. Code § 4584(j)(8), (11)(B) [authorizing removal of trees up to 18 inches in diameter, and in some cases up to 24 inches in diameter, in the course of thinning operations to reduce vertical continuity of fuels].) The concept paper fails to recognize that a great deal of current "active management" may be at cross purposes with the FCAT's goals.

We strongly urge the FCAT to perform a robust review of the most recent and best available science and provide the public with clear operational definitions of the key ecological and management concepts at the core of the policies proposed in the concept paper. Ecosystem resilience, fragmentation, conversion, environmental services, sustainability, and active management are some key terms in need of clarification. Similarly, it is necessary to provide some clarity regarding what the FCAT understands the term "active management" to mean. Forest thinning and harvesting comes in a wide range of operations with results that can vary widely. Without clarity and specificity on which management activities are being proposed for which results in which circumstances, policy proposals that foster "active management" are meaningless at best and at worst risk to undermine the ecological objectives.

Furthermore, we strongly urge the FCAT to develop their understanding of and position on the role of fire as a management objective and as a management tool. Similarly, the concept paper and the resulting policy objectives would benefit greatly from a review of current fire management policies in the context of moving away from fire suppression policies and attitudes that have contributed to the development of the current forest structure and continue to influence policy decisions today.

II. Restoring ecological structure and function at necessary scales.

Ecosystem resilience is a term that is highlighted as a primary objective and is mentioned repeatedly in the concept paper. However, the concept paper is often unclear in its use of the term in a way that allows for misunderstanding of the ecological concept. Page 12 of the concept paper defines resilience in this way: "Forests are able to regenerate after disturbance and adapt to changes in climate and precipitation regimes." To be clear, forest resilience, like many ecological attributes, must be considered at the appropriate scale. For processes like forest fire and climate change that work at large geographic scales, forest resilience also must be assessed at the large geographic scale. High resilience means that the forest at the landscape scale is able to maintain component species, structural diversity, and stable levels of ecosystem functions at the landscape scale; it does not mean that any individual forest stand or burned area is necessarily expected to return to its previous condition quickly after disturbance. Some disturbances such as fire can result in stand-scale changes over the course of decades, in the meantime contributing to necessary structural diversity at the landscape scale. Indeed, the concept paper, in the forest resilience section on page 12, points to the importance of such openings in reducing susceptibility to fires and environmental stressors such as drought, insects and disease. However, it is unclear from that passage whether the FCAT recognizes the role of natural disturbance processes in creating structural diversity, or whether the FCAT believes that diversity is best achieved through "active management." Elsewhere, on page 5, the concept paper discusses the benefits of managing for "larger and more fire resilient trees." Ecosystem resilience has little or no meaning at the level of an individual tree. Instead, what the FCAT

refers to here is "fire resistance." Growing fire-resistant trees is actually a very different objective from promoting an ecologically resilient forest; the latter is much more realistic and is associated much more strongly with positive ecological values.

Although the concept paper identifies early on the value of natural disturbances such as fire, there are statements throughout the concept paper that appear to overlook those values. Page 12 of the concept paper defines economic and ecological sustainability in this way: "Healthy forests are able to support ecosystem functions and processes while meeting current and future needs of people for aesthetics, recreation, health, products, and other ecosystem services." It would be very helpful to clarify that the FCAT understands that disturbance in general, and fire in particular, is among the ecosystem processes that must be supported. Indeed, we strongly urge the FCAT to substantially develop the discussion of landscape-level fire use as a management tool for promoting and maintaining forest health and resilience.

The concept paper must develop a clear review of the best available and most recent science on the use of fire as an ecosystem function and management tool. This is often dramatically understated or ignored in the concept paper. For example, in a reference to a Forest Service management document cited on page 6 of the concept paper: "The Forest Service estimates that 9 million acres of National Forest Lands in the state are in need of restoration in California." This statement is offered in a paragraph focusing on the need to reduce tree density, following a paragraph that equivocates on the ecological function of fire. The actual statement in the Forest Service document is that it is the Forest Service's intention to "Increase forest resilience through treatments (<u>including prescribed fire</u> and thinning) <u>and wildfire</u>, resulting in resource benefits to approximately 9 million acres on national forest system lands." Ecological Restoration Plan, Chapter 1: Region 5 Ecological Restoration Leadership Intent[1]; emphasis added. The strong reliance on fire, including wildfire, is completely missing in this paragraph of the concept paper and is repeatedly overlooked throughout the concept paper.

Furthermore, the concept paper acknowledges the ecological damage caused by decades of fire suppression as in this passage from page 6: "In addition, past fire suppression activities and lack of fuels management have left California forests particularly vulnerable and weakened." However, the concept paper offers no indication of moving away from the policy of continued fire suppression as in this passage on page 2: "It is our intent that the Forest Carbon Plan...Be consistent with state and federal wildland fire management goals and strategies." We strongly urge the concept paper to include a discussion of how the FCAT considers fire suppression in the context of the proposed forest management goals.

III. Developing an accurate understanding of past forest management.

The concept paper repeatedly laments the lack of forest management (in these references, logging), as in this passage from page 6: "In addition, past fire suppression activities and lack of fuels management have left California forests particularly vulnerable and weakened. Decades of conflict over the appropriate balance between active versus passive management and commodity production versus protecting or enhancing ecosystems has hindered progress on achieving a

[1] Available at http://www.fs.usda.gov/detail/r5/landmanagement/?cid=stelprdb5409054.

healthy forest landscape." This fails to recognize the role of logging in creating the current forest conditions and ignores completely the long-term impacts of high-grading, clearcutting, and plantation forestry implemented expansively throughout much of the state for decades. This biased version of history makes it impossible to take seriously the heavy emphasis the concept paper places on "active management" as a favored management tool and objective, as in this passage from the same section on page 6: "Some of this conflict has been declining in recent years as more stakeholders now recognize needs for active management to achieve and/or sustain desired ecosystem conditions." We strongly urge the FCAT to develop a historically accurate review of forest management that can provide a basis for future management goals.

Similarly, the discussion of carbon sequestration rates, starting on page 17 of the concept paper, appears completely unaware of the logging practices that have led to current forest conditions and resulting growth rates. For example, the section on Forest Service timberlands seems to imply that those forest stands are experiencing lower growth rates because logging has declined in recent years, and fails to contemplate that past logging in those stands has led to the forest conditions that now show lower growth rates.

IV. Developing a meaningful context for tree mortality.

The concept paper places much weight on current tree mortality rates in the southern Sierra Nevadas and beyond, with estimates as high as 29 million dead trees. Page 7. Elsewhere, the U.S Forest Service has estimated that in 2015 the ongoing drought and beetles created approximately 27 million new snags (standing dead trees), about 7 or 8 inches in diameter and larger, in California's forests. That is 27 million dead trees, out of of approximately 2.88 billion trees of this size in the state's 33 million acres of forestland; this is equivalent to approximately 1 percent of the trees in California's forests.

For these mortality statistics to be meaningful, it is absolutely critical that we place them clearly into the context of geographical scale and management objective. For example, the concept paper on page 7 cites a Forest Service publication that warns that California is at risk of losing 25% of standing live forest due to insects and disease over 5.7 million acres in the 15 years from 2013 and 2027. However, on the previous page, the concept paper cites two sources that 14 million acres and 9 million acres of these same forests are "overly dense." The concept paper strongly implies that reductions in tree density due to natural processes such as beetles, fire and drought have purely negative ecological consequences, while similar or greater reductions due to mechanical thinning operations are purely positive. The basis for this contradictory position is not clear. The FCAT needs to clarify precisely the criteria on which management objectives will be based with respect to tree density goals, and the scientific basis for those criteria.

V. The importance of fire as a natural ecosystem process.

The concept paper at page 3 acknowledges the role of fire as a natural ecosystem process: "Wildfire is an essential part of these ecosystems and many of the native tree and plant species are dependent on periodic disturbance from wildfire. However, altered wildfire regimes and changes due to land management have affected forest structure. Under these conditions many

western forests are overly dense and experiencing large and severe wildfires." While it is true that fire suppression and logging practices have altered forest structures, it is important to note that this does not eliminate the essential role of fire, including high-severity fire, as a natural ecosystem process in many forest types. In fact, fire can have an essential role in restoring forest structure at larger geographical scales.

Fire is a natural and necessary component of forest ecosystems, with many critical functions for diversity and wildlife. It would be a misunderstanding of the science and nature of forest and fire dynamics to approach these emissions in the same context as those from smokestacks, bioenergy and pile burning, which are discretionary activities that occur under direct human control.

Numerous studies and multiple lines of evidence indicate that the ponderosa pine and mixed-conifer forests of California are characterized by mixed-severity fire that includes ecologically significant amounts of high-severity fire (see review in Odion et al. 2014). Mixed-severity fire includes low-, moderate-, and high-severity effects that create complex successional diversity, high beta diversity, and diverse stand-structure across the landscape. High-intensity fire patches, including large patches, in large fires are natural in California mixed-conifer forests.

California's forested landscapes evolved with fire over thousands of years. This pre-European, forested landscape was shaped by mixed-severity fire, with low, moderate, and high-severity fire types. Plant and animal species in the forest evolved with fire, and many of these plant and animal species depend on wildfires, including high-severity fires, to reproduce and grow. For instance, fire can help return nutrients from plant matter back to soil, the heat from fire is necessary to the germination of certain types of seeds, and the snags (dead trees) and early succesional forests created by high-severity fire create habitat conditions that are beneficial to wildlife. Early successional forests created by high-severity fire support some of the highest levels of native biodiversity found in temperature conifer forests.

Several recent studies provide evidence for a mixed-severity fire regime in California forests, including an important role for high-severity fire, as well as declines in high-severity fire, as summarized here*:*

Beaty and Taylor 2001: On the western slope of the southern Cascades in California, historic fire intensity in mixed-conifer forests was predominantly moderate- and high-intensity, except in mesic canyon bottoms, where moderate- and high-intensity fire comprised 40.4% of fire effects [Table 7].)

Bekker and Taylor 2001: On the western slope of the southern Cascades in California, in mixed-conifer forests, fire was predominantly high-intensity historically [Fig. 2F].

Bekker and Taylor 2010: In mixed-conifer forests of the southern Cascades, reconstructed fire severity within the study area was dominated by high-severity fire effects, including high-severity fire patches over 2,000 acres in size [Tables I and II].

Collins and Stephens 2010: In a modern "reference" forest condition within mixed-conifer/fir forests in Yosemite National Park, 15% of the area experienced high-intensity fire over a 33-year period—a high-intensity fire rotation interval of approximately 223 years.

Nagel and Taylor 2005: The authors found that large high-severity fire patches were a natural part of 19th century fire regimes in mixed-conifer and eastside pine forests of the Lake Tahoe Basin, and montane chaparral created by high-severity fire has declined by 62% since the 19th century due to reduced high-severity fire occurrence. The authors expressed concern about harm to biodiversity due to loss of ecologically rich montane chaparral.

Odion et al. 2014: In the largest and most comprehensive analysis ever conducted regarding the historical occurrence of high-intensity fire, the authors found that ponderosa pine and mixed-conifer forests in every region of western North America had mixed-intensity fire regimes, which included substantial occurrence of high-intensity fire. The authors also found, using multiple lines of evidence, including over a hundred historical sources and fire history reconstructions, and an extensive forest age-class analysis, that we now have unnaturally low levels of high-intensity fire in these forest types in all regions, since the beginning of fire suppression policies in the early 20th century.

Numerous studies show that high-severity fire is beneficial to wildlife. High-severity fire creates very biodiverse, ecologically important, and unique habitat (often called "snag forest habitat"), which often has higher species richness and diversity than unburned old forest.

Bond et al. 2009: In a radio-telemetry study, California spotted owls preferentially selected high-intensity fire areas, which had not been salvage logged, for foraging, while selecting low- and moderate-intensity areas for nesting and roosting.

Buchalski et al. 2013: In mixed-conifer forests of the southern Sierra Nevada, rare myotis bats were found at greater levels in unmanaged high-severity fire areas of the McNally fire than in lower fire severity areas or unburned forest.

Burnett et al. 2010: Bird species richness was approximately the same between high-severity fire areas and unburned mature/old forest at 8 years post-fire in the Storrie fire, and total bird abundance was greatest in the high-severity fire areas of the Storrie fire [Figure 4]. Nest density of cavity-nesting species increased with higher proportions of high-severity fire, and was highest at 100% [Figure 8].

Cocking et al. 2014: High-intensity fire areas are vitally important to maintain and restore black oaks in mixed-conifer forests.

Donato et al. 2009: The high-severity re-burn [high-severity fire occurring 15 years after a previous high-severity fire] had the highest plant species richness and total plant cover, relative to high-severity fire alone [no re-burn] and unburned mature/old forest; and the high-severity fire re-burn area had over 1,000 seedlings/saplings per hectare of natural conifer regeneration.

Franklin et al. 2000: The authors found that stable or increasing populations of spotted owls resulted from a mix of dense old forest and complex early seral habitat, and less than approximately 25% complex early seral habitat in the home range was associated with declining populations [Fig. 10]; the authors emphasized that the complex early seral habitat was consistent with high-intensity fire effects, and inconsistent with clearcut logging.

Hanson and North 2008: Black-backed woodpeckers depend upon dense, mature/old forest that has recently experienced higher-intensity fire, and has not been salvage logged.

Hanson 2013: Pacific fishers are using pre-fire mature/old forest that experienced moderate/high-intensity fire more than expected based upon availability, just as fishers are selecting dense, mature/old forest in its unburned state. When fishers are near fire perimeters, they strongly select the burned side of the fire edge. Both males and female fishers are using large mixed-intensity fire areas, such as the McNally fire, including several kilometers into the fire area.

Hutto, R.L. 1995: A study in the northern Rocky Mountain region found that 15 bird species are generally more abundant in early post-fire communities than in any other major cover type occurring in the northern Rockies. Standing, fire-killed trees provided nest sites for nearly two-thirds of 31 species that were found nesting in the burned sites.

Hutto, R.L. 2008: Severely burned forest conditions have occurred naturally across a broad range of forest types for millennia and provide an important ecological backdrop for fire specialists like the black-backed woodpecker.

Lee and Bond 2015: California spotted owls exhibited high site occupancy in post-fire landscapes during the breeding season following the 2013 Rim Fire, even where large areas burned at high severity; the complex early seral forests created by high-severity fire appear to provide important habitat for the small mammal prey of the owl.

Malison and Baxter 2010: In ponderosa pine and Douglas-fir forests of Idaho at 5-10 years post-fire, levels of aquatic insects emerging from streams were two and a half times greater in high-intensity fire areas than in unburned mature/old forest, and bats were nearly 5 times more abundant in riparian areas with high-intensity fire than in unburned mature/old forest.

Raphael et al. 1987: At 25 years after high-intensity fire, total bird abundance was slightly higher in snag forest than in unburned old forest in eastside mixed-conifer forest of the northern Sierra Nevada; and bird species richness was 40% higher in snag forest habitat. In earlier post- fire years, woodpeckers were more abundant in snag forest, but were similar to unburned by 25 years post-fire, while flycatchers and species associated with shrubs continued to increase to 25 years post-fire.

Sestrich et al. 2011: Native Bull and Cutthroat trout tended to increase with higher fire intensity, particularly where debris flows occurred. Nonnative brook trout did not increase.

Siegel et al. 2011: Many more species occur at high burn severity sites starting several years post-fire, and these include the majority of ground and shrub nesters as well as many cavity

nesters. Secondary cavity nesters, such as swallows, bluebirds, and wrens, are particularly associated with severe burns, but only after nest cavities have been created, presumably by the pioneering cavity excavating species such as the Black-backed Woodpecker. As a result, fires that create preferred conditions for Black-backed Woodpeckers in the early post-fire years will likely result in increased nesting sites for secondary cavity nesters in successive years.

Swanson et al. 2010: A literature review concluding that some of the highest levels of native biodiversity found in temperate conifer forest types occur in complex early successional habitat created by stand-initiating [high severity] fire.

VI. Trends in fire behavior.

While climate change will almost certainly alter many forest processes, including fire behavior, in many ecosystems over the coming decades, the current body of science offers a complex range of projections for California forests. Notably, the majority of studies that have analyzed recent trends in fire severity and frequency in California forests have found no significant trends in these metrics. Studies that project trends in fire activity have no clear consensus on how climate change will affect fire behavior in California forests.

Nine studies have analyzed recent trends in fire severity in California's forests in terms of proportion, area, and/or patch size. Seven of nine studies found no significant trend in fire severity, including: Collins et al. 2009 (central Sierra Nevada), Dillon et al. 2011 (Northwest California), Hanson et al. 2009 (Klamath, southern Cascades), Hanson and Odion 2014 (Sierra Nevada, southern Cascades), Miller et al. 2012a (four Northwest CA forests), Odion et al. 2014 (eastern and western Sierra Nevada, eastern Cascades), and Schwind 2008 (California forests). The two studies that report an increasing trend in fire severity – Miller et al. 2009 and Miller and Safford 2012 (Sierra Nevada, southern Cascades) – were refuted by Hanson and Odion (2014) using a larger dataset.

Hanson and Odion (2014) conducted the first comprehensive assessment of fire intensity since 1984 in the Sierra Nevada using 100% of available fire intensity data, and found no increasing trend in terms of high-intensity fire proportion, area, mean patch size, or maximum patch size. Hanson and Odion (2014) reviewed the approach of Miller et al. (2009) and Miller and Safford (2012) for bias, due to the use of vegetation layers that post-date the fires being analyzed in those studies. Hanson and Odion (2014) found that there is a statistically significant bias in both studies ($p = 0.025$ and $p = 0.021$, respectively), the effect of which is to exclude relatively more conifer forest experiencing high-intensity fire in the earlier years of the time series, thus creating the erroneous appearance of an increasing trend in fire severity. Hanson and Odion (2014) also found that the regional fire severity data set used by Miller et al. (2009) and Miller and Safford (2012) disproportionately excluded fires in the earlier years of the time series, relative to the standard national fire severity data set (www.mtbs.gov) used in other fire severity trend studies, resulting in an additional bias which created, once again, the inaccurate appearance of relatively less high-severity fire in the earlier years, and relatively more in more recent years.

Three studies have analyzed recent trends in the number of fires in California's forests and have reported conflicting results for trends in fire frequency. Two studies found no trend in the number of fires -- Schwind (2008) and Syphard et al. (2007) -- while Westerling et al. (2006) reported evidence of an increasing number of fires.

Projection studies have generally not modeled trends in future fire frequency and severity. Instead most studies have projected changes in area burned and the probability of burning. There is no consensus among these studies on future fire activity.

Of seven studies that have projected trends in area burned in California forests, four projected both increases and decreases in total area burned varying by region, including: Lenihan et al. 2003, Lenihan et al. 2008, Krawchuk et al. 2009, and Spracklen et al. 2009. One study projected an overall decrease in area burned (McKenzie et al. 2004), while two studies projected increases: Fried et al. 2004 in a small region in the Amador-El Dorado Sierra foothills and Westerling et al. 2011. The projected increases reported in Westerling et al. (2011) are relatively modest: median increases in area burned of 15% and 19% by 2020 relative to 1961-1990 under a lower (B1) and higher emissions scenario (A2) respectively, 21% and 23% by 2050, and 20% and 44% by 2085.

Three studies have projected changes in the probability of burning or the probability of a large fire occurring, and these studies have projected no change, increases, or decreases varying by region: Krawchuk and Moritz 2012, Moritz et al. 2012, and Westerling and Bryant 2008.

The studies empirically investigating the assumption that the most fire-suppressed forests are burning predominantly at high severity have consistently found that forest areas in California that have missed the largest number of fire return intervals are not burning at higher fire severity. Specifically, six empirical studies that have investigated this question found that the most long-unburned (most fire-suppressed) forests burned mostly at low/moderate-severity, and did not have higher proportions of high-severity fire than less fire-suppressed forests. Forests that were not fire suppressed (those that had not missed fire cycles, i.e., Condition Class 1, or "Fire Return Interval Departure" class 1) generally had levels of high-severity fire similar to, or higher than, those in the most fire-suppressed forests, as found by Odion et al. 2004, Odion and Hanson 2006, Odion and Hanson 2008, Odion et al. 2010, Miller et al. 2012a, van Wagtendonk et al. 2012.

Finally, studies have found that California is experiencing a fire deficit compared to pre-settlement conditions, meaning that there is much less fire on the landscape than there was historically, and this deficit is detrimental to forests (Stephens et al. 2007).

VII. The carbon impacts of forest thinning.

The concept paper briefly acknowledges the carbon implications of management activities that remove biomass from the forest. However, the discussion of carbon storage, starting on page 16 of the concept paper, focuses almost entirely on the potential carbon storage of wood products without quantifying the associated carbon costs. The result is a highly one-sided defense of policy options to promote logging, followed by the burning of those woody materials for biomass energy production. However, studies that have specifically evaluated the

carbon implications of this strategy have found that thinning results in increased carbon emissions to the atmosphere for many decades.

Three recently published studies of forests in the western United States suggest that emissions from removal and combustion of forest materials for bioenergy would exceed emissions from even high intensity fires, at least for some period of time. One study examined forest carbon responses to three different levels of fuel reduction treatments in 19 West Coast ecoregions containing 80 different forest types and different fire regimes (Hudiburg et al. 2011). In nearly all forest types, intensive harvest for bioenergy production resulted in net carbon emissions to the atmosphere, at least over the 20-year time frame of the study. Even lighter-touch fire prevention scenarios produced net carbon emissions in most ecoregions. The study shows that at present, across a wide range of ecosystems, thinning for fuels reduction and using the thinnings for bioenergy increases carbon dioxide concentrations, at least in the short term.

A second study similarly found that thinning forests to avoid high-severity fire could actually increase overall carbon emissions (Campbell et al. 2011). Because the probability of a fire on any given acre of forest is relatively low, forest managers must treat many more acres than will actually burn in order to get much of a benefit—removing more carbon during "thinning" than would be released in a fire. The study also found that over a succession of disturbance cycles, models predicting forest growth, mortality, decomposition and combustion showed more carbon storage in a low-frequency, high-intensity fire regime than in a high-frequency, low-intensity fire regime. The study concluded: "we found little credible evidence that such efforts [fuel-reduction treatments] have the added benefit of increasing terrestrial C stocks" and "more often, treatment would result in a reduction in C stocks over space and time."

A review by Law and Harmon (2011) concluded that "Thinning forests to reduce potential carbon losses due to wildfire is in direct conflict with carbon sequestration goals, and, if implemented, would result in a net emission of CO_2 to the atmosphere because the amount of carbon removed to change fire behavior is often far larger than that saved by changing fire behavior, and more area has to be harvested than will ultimately burn over the period of effectiveness of the thinning treatment."

Furthermore, scientific studies have found that old forests store up to ~10 times more carbon in biomass per unit ground area than young forests, and old forests continue to have large carbon stores for hundreds of years (Luyssaert et al. 2008, Hudiburg et al. 2009, Law 2014, Schulze et al. 2012). Older trees not only store large amounts of carbon but actively sequester larger amounts of carbon compared to smaller trees (Stephenson et al. 2014). Contrary to the conventional forestry assumption that older trees are less productive, the mass growth rate for most temperate and tropical tree species increases continuously with age, meaning the biggest trees sequester the most carbon (Stephenson et al. 2014). In western USA old-growth forest plots, trees greater than 100 cm in diameter comprised 6% of trees, yet contributed 33% of the annual forest mass growth (Stephenson et al. 2014). Current research also shows that high-severity fire areas generally store the highest levels of carbon, due to the combination of the carbon in snags, downed logs, and post-fire regenerating vegetation, including shrubs and trees (Keith et al. 2009, Powers et al. 2013).

Logging significantly reduces forest carbon storage. Harvest of live trees from the forest not only reduces current standing carbon stocks, but also reduces the forest's future rate of carbon sequestration, and its future carbon storage capacity, by removing trees that otherwise would have continued to grow and remove CO_2 from the atmosphere (Holtsmark 2012). Even if harvested biomass is substituted for fossil fuels, it can be decades or centuries before the harvested forest achieves the same CO_2 reductions that could be achieved by leaving the forest unharvested (depending on harvest intensity, frequency, and forest characteristics) (Searchinger et al. 2009, Hudiberg et al. 2011, Campbell et al. 2012, Mitchell et al. 2012). It takes more than 100 years (~125-130 years) to make up for carbon loss after a forest is logged (Harmon 2014, Law 2014).

VIII. Accurate accounting of the carbon impacts of bioenergy

Any policy to promote the use of forest-sourced biomass for bioenergy production must fully account for the emissions and climate change consequences associated with those activities. In order to develop a program that makes sense within the forest carbon and GHG emissions contexts, biomass uses must be compared not only to alternative "waste diversion" options but to the full spectrum of alternative fates, including the carbon sequestration and storage associated with living and growing trees and forests.

Woody biomass combustion is not carbon-neutral, as acknowledged by numerous scientific studies (see, e.g., Searchinger et al. 2009, Repo et al. 2010, Brandão et al. 2013), the IPCC,[2] and the EPA.[3] Measured at the smokestack, replacing fossil fuels with biomass actually *increases* CO_2 emissions.[4] Notably, a recent study found that the climate impact per unit of CO_2 emitted seems to be even higher for the combustion of slow-growing biomass than for the combustion of fossil carbon in a 100-year time frame (Holtsmark 2013). The warming effect from biomass CO_2 can continue for decades or even centuries depending on the feedstock.

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[2] IPCC Task Force on National Greenhouse Gas Inventories, Frequently Asked Questions, at http://www.ipcc-nggip.iges.or.jp/faq/faq.html (last visited October 23, 2013) (Q1-4-5, Q2-10).

[3] U.S. EPA, Accounting Framework for Biogenic CO2 Emissions from Stationary Sources 11-12 (Sept. 2011) ("The IPCC . . . eschewed any statements indicating that its decision to account for biomass CO2 emissions in the Land-Use Sector rather than the Energy Sector was intended to signal that bioenergy truly has no impacton atmospheric CO2 concentrations."); see also Deferral for CO2 Emissions from Bioenergy and Other Biogenic Sources Under the Prevention of Significant Deterioration (PSD) and Title V Programs, 76 Fed. Reg. 43,490, 43,498 (July 20, 2011); Science Advisory Board Review of EPA's Accounting Framework for Biogenic CO2 Emissions from Stationary Sources 7 (Sept. 28, 2012) at 3.

[4] Typical CO2 emission rates for facilities:
Gas combined cycle 883 lb CO2/MWh
Gas steam turbine 1,218 lb CO2/MWh
Coal steam turbine 2,086 lb/CO2/MWh
Biomass steam turbine 3,029 lb CO2/MWh
Sources: EIA, Electric Power Annual, 2009: Carbon Dioxide Uncontrolled Emission Factors. Efficiency values used to calculate emissions from fossil fuel facilities calculated using EIA heat rate data. (http://www.eia.gov/cneaf/electricity/epa/epat5p4.html); biopower efficiency value is 24%, a standard industry value.

Multiple studies have shown that it can take a very long time for new biomass growth to recapture the carbon emitted by combustion, even where fossil fuel displacement is assumed, and even where "waste" materials like timber harvest residuals are used for fuel (Repo et al. 2010, Manomet Center for Conservation Sciences 2010, McKechnie et al. 2011, Mitchell et al. 2012, Schulze et al. 2012). One study, using realistic assumptions about repeat bioenergy harvests of woody biomass, concluded that the resulting atmospheric emissions increase may even be permanent (Holtsmark 2012).

In addition to producing large amounts of CO_2, biomass energy generation can result in significant emissions of other pollutants that worsen climate change and harm human health, such as black carbon. Many biomass emissions can exceed those of coal-fired power plants even after application of best available control technology.

Studies have found that global greenhouse gas emissions must peak by 2020 and drop sharply thereafter in order to preserve a likely chance of keeping global warming below 2°C — a level at which serious impacts will still occur (UNEP 2013). California's climate goals, as reflected in AB 32 and applicable executive orders (S-3-05 and B-30-15) also call for increasingly steep reductions in emissions over the next three decades. Yet the science shows this is precisely the time period during which biomass emissions released today will increase atmospheric CO_2 levels. The concept paper aims to inform development of the 2016 Scoping Plan, which will explicitly address the goal of reducing emissions 40 percent below 1990 levels by 2030. At a time when we need to reduce emissions dramatically in the short term and keep them down, California forest policy should not be promoting biomass burning that will exacerbate climate change.

IX. Conclusion

Thank you for your consideration of these comments. We look forward to working with the FCAT and the ARB in developing this strategy and implementing efforts to protect California's forests and promote forest resilience and carbon sequestration.

Please contact me if there are any questions about these comments or if you require any assistance with accessing background information and materials.

Sincerely,

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