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October 30, 2015

***Via website at*** *[http://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=slcpdraftstrategy-ws&comm_period=1](http://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=slcpdraftstrategy-ws&comm_period=1)*

Ryan McCarthy, Chair's Office
Dave Mehl, Manager, Energy Section
Glenn Gallagher, Research Division
California Air Resources Board
1001 I St, Room 164
Sacramento, CA 95814

**Re: Comments on the Draft Short-Lived Climate Pollutant Reduction Strategy**

Dear Mr. McCarthy, Mr. Mehl, Mr. Gallagher, and staff of the Air Resources Board:

These comments are submitted on behalf of the Center for Biological Diversity in response to the Draft Short-Lived Climate Pollutant Reduction Strategy paper released by the Air Resources Board on September 30. The Center for Biological Diversity appreciates the ARB's recognition of the importance of reducing short-lived climate pollutants ("SLCP") and its comprehensive approach to finding reduction options. Reducing short-lived climate pollutants is particularly important to low-income and vulnerable communities that are often situated closest to pollution sources and suffer the greatest health risk.

Despite the potential for substantial reductions of SLCPs under the Draft Strategy, the Center urges the ARB to carefully consider some of the suggested approaches to ensure that they do not inadvertently cause external environmental harms or create perverse incentives that could undercut the climate benefits of the Draft Strategy.

Methane

Leading the rest of the nation, the Draft Strategy adopts an updated 20-year global warming potential ("GWP") for methane, and we strongly support this step.[1] This is important because the time-horizon used to equate methane and $CO_2$ emissions has significant implications for policy decisions in which the time horizon of the GWP critically influences the cost-benefit analysis of mitigation options.

However, we strongly urge the ARB to use GWP values from the most recent IPCC Fifth Assessment Report ("AR5") for methane and F-gases. This is crucial because the science regarding the climate influences of various pollutants is evolving. We also note the Draft

[1] Draft Strategy at 24.

Strategy cites values for methane's GWP that omit carbon cycle feedbacks. This must be corrected: climate cycle feedbacks must be included to properly equate methane and $CO_2$ warming influences. The groundbreaking realization by the contributors to AR5 was that carbon cycle feedbacks are an inherent part of the warming caused by $CO_2$. Yet, until the most recent Assessment, they were omitted from GWP values for other greenhouse gases. As a result, until AR5, the GWP conversion was actually comparing apples to oranges. The only way to accurately compare among greenhouse gases – the entire purpose of a GWP – is to include carbon cycle feedbacks. This amounts to a 100-year methane GWP of 36 and a 20-year GWP of 87.[2]

The most effective means of reducing methane is to avoid generation altogether: that is, "keep it out of the ground" for organic waste and "keep it in the ground" for fossil fuels. Where methane generation is unavoidable, strong leak detection and repair is imperative. Both with regard to landfills and oil/gas operations, monitoring must be required on a frequent and consistent basis (at least quarterly). A common approach is to allow the interval between monitoring to increase if no leaks are detected. We strongly recommend against this approach. First, rewarding the failure to detect leaks creates a perverse incentive for operators to fail to find leaks. Second, when and where methane leaks occur – both at MSW landfills and at oil and gas facilities – is not predictable. A history of no leakage does not correlate to future leakage rates.

*Landfills*. Organics diversion is an essential component of addressing landfill methane emissions, and the Center applauds the ARB's adoption of a zero-organics goal[3] for California's landfills. The Center also appreciates the ARB's recognition of the difficulty in quantifying landfill methane emissions. We fully support continued efforts to better evaluate the sources of methane from MSW landfills. An associated point is how landfill gas collection efficiency is estimated. The Draft Strategy suggests that a collection efficiency of 75 percent is appropriate.[4] Yet, as the Draft Strategy also recognizes, there are reasons to suspect that this may not be accurate. We urge the ARB to continue to find quantitative methods to better understand what real-world collection efficiencies are. This is an important parameter to understand in order to select the most effective landfill gas policies.

Until complete organics diversion is achieved, California will have to carefully select landfill policies that motivate operators to maximize landfill gas collection while avoiding incentivizing practices that needlessly *increase* methane production. Although high-moisture content in landfills leads to more marketable concentrations of methane in landfill gas, the resulting fugitive methane emissions undercut the climate benefit of collecting landfill gas. This is primarily due to the fact that landfill gas collection efficiencies are much lower than typical estimates, ranging from only 35 to 70 percent.[5] The Draft Strategy selects a collection efficiency

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[2] G. Myhre et al., *Anthropogenic and Natural Radiative Forcing*, in CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE IPCC Table 8.7 at 714 (Cambridge Univ. Press 2013). Note that biogenic methane is according GWP-100 of 34 and GWP-20 of 86.

[3] Draft Strategy at 50.

[4] Draft Strategy at 49.

[5] See, e.g., Environmental Commissioner of Ontario, *EcoIssues: GHG11 Landfill Methane, available at* http://ecoissues.ca/GHG11_Landfill_Methane; M. Fischedick et al., (2014) *Industry. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate*

of 75 percent,[6] but this is overly optimistic.[7] Furthermore, landfill gas emissions are typically modeled rather than directly measured, and a recent study of models of landfill gas emissions indicates a significant under-estimation of emissions.[8]

Specifically, California must cease granting research development and demonstration ("RD&D") exceptions to the prohibition on outside liquids. The state should ensure that to the maximal extent possible moisture content is minimized in areas that receive high levels of precipitation. Furthermore, neither leachate recirculation nor delays in the installation of final covers should be allowed.

Finally, we urge ARB to ensure that "diversion" of organics is associated with careful guidelines for uses of organics that will not result in increases in greenhouse gas emissions or other unintended negative consequences..

*Biogas as transportation fuel.* The draft SLCP Strategy suggests that one use of biogas to fuel heavy-duty trucks.[9] We caution the ARB to carefully consider the ramifications of increasing the natural gas vehicle sector. Methane leakage, whether from fossil natural gas or biogas, is a significant concern for natural gas vehicles and fuel holding and supply systems.[10] Furthermore, many natural gas engines have lower work efficiency than diesel engines. Finally, we are concerned that increasing the market for natural gas vehicles, even if intended for biogas, will also increase the market for fossil natural gas and displace California's current, ambitious zero-emissions transportation efforts. The Draft Strategy alludes to the potential for negative consequences,[11] but we request that the ARB commit to a complete analysis before promoting biogas as a transportation fuel.

*Oil and gas.* Leak detection and repair is crucial for minimizing methane emissions from oil and gas operations. However, this is a band-aid approach to addressing the emissions from currently existing operations. To achieve California's emissions targets and the global emissions reductions necessary to avoid the worst impacts of climate change, this approach must be

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*Change* (Cambridge University Press 2014), *available at* https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter10.pdf; J. Levis & M.A. Barlaz, *Landfill Gas Monte Carlo Model Documentation and Results* (2014), *available at* http://www3.epa.gov/epawaste/conserve/tools/warm/pdfs/lanfl_gas_mont_carlo_modl.pdf; U.S. EPA *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)* Exhibit 7-9 (2015), *available at* http://www3.epa.gov/epawaste/conserve/tools/warm/pdfs/WARM_Documentation.pdf

[6] Draft Strategy at 49.

[7] Measured methane emissions from Puente Hills landfill, a well-managed landfill with a 6 foot think clay cap located in a dry climate, fully in compliance with the CARB requirements, were indicative of a 73% collection efficiency.[7] It is not plausible that the *average* collection efficiency is better than this example. Furthermore, as the draft strategy indicates, the data suggesting a 75% efficiency are self-reported.

[8] H.R. Amini, D. Reinhart & A. Niskanen, *Comparison of first-order-decay modeled and actual field measured municipal solid waste landfill methane data*, 33 WASTE MANAGEMENT 2720 (Dec. 2013).

[9] Draft Strategy at 39.

[10] See, e.g., INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION, ASSESSMENT OF HEAVY-DUTY NATURAL GAS VEHICLE EMISSIONS: IMPLICATIONS AND POLICY RECOMMENDATIONS 23-24 (Jul. 2015), *available at* http://theicct.org/assessment-heavy-duty-natural-gas-vehicle-emissions-implications-and-policy-recommendations

[11] Draft Strategy at 39.

accompanied by a prohibition on new oil and gas development in California and, ultimately, complete elimination of fossil fuel extraction in the state as we transition to one hundred percent renewable energy.

Black Carbon Emissions from Forest Fire

1) We appreciate and agree with the need to accurately account for black carbon emissions from forest fires. Furthermore, any reduction measures must be considered with the full recognition of the distinction between forest fire and its related emissions compared to anthropogenic sources of greenhouse gases. 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.

2) It is not clear from the draft report whether the estimate of black carbon emissions from forest fires differentiates black (elemental) carbon from so-called brown (or organic) carbon emissions in determining GWP. Appendix A: California SLCP Emissions indicates that the fraction of elemental carbon was determined for black carbon sources.[12] However, it is not clear that this applies to forest fire emissions, which were assessed and presented separately from all other black carbon source categories. Differentiating elemental from organic carbon is crucial in developing an accurate estimate of GWP from this source.

3) Some of the strategies contemplated in the forest section rely on the assumption that forests fires in California are increasing in size and intensity due to climate change, an assumption that is not supported by the preponderance of scientific research on this issue.[13] While climate change will almost certainly alter fire activity in many ecosystems, the current body of science does not support the statement that climate change will necessarily increase fire severity, size, and frequency in 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

[12] "California's black carbon emission inventory was developed using existing particulate matter (PM2.5) emission estimates, combined with speciation profiles that define the fraction of PM2.5 that is elemental carbon. Elemental carbon is the "best available indicator"4 of black carbon, but is not a perfect proxy for warming effects, which depend on the physical and chemical properties of the particles." Appendix A, page 3.

[13] "A century of aggressive wildfire suppression, coupled with a changing climate, has contributed to heavy accumulations of live and dead vegetation fuels on public forest lands. These fuels result in increasing fire size and severity, with long-term negative impacts to ecosystems and increased black carbon emissions." Draft report at 35.

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).

4) The SLCP report considers policy options to promote forest thinning to reduce fire hazard, followed by the burning of those woody materials for biomass energy production.[14] Studies that have evaluated 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 (Hudiberg 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. 2012). 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

[14] "In wildfire-prone forests, tree-based carbon stocks are best protected by fuel reduction treatments that produce low-density stands dominated by large, fire-resistant trees to reduce the expected increase in wildfire frequency, severity, and associated emissions." Draft report at 36.

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."

5) This section on forests appears to rely heavily on the recommendations put forth in North et al. 2012, in its estimate of the need for and current rate of fuels reduction activities in California.[15] It is important to note that this paper was specific to Sierra Nevada forests between Lake Almanor and Isabella Lake, and does not apply to lower elevation forests nor to regions outside that specifically defined area. In addition, wildfire management recommendations have significantly evolved since the publication of North et al. 2012, including changing views by the lead author. Current management recommendations emphasize restoring fire to the landscape in many areas instead of landscape-level thinning.[16]

6) The SLCP report, at page 36, sets out the following criteria for fuels reduction programs: "Forest programs should be crafted in coordination with state and local agencies as well as the Forest Carbon Plan and the Bioenergy Action Plan, to reduce catastrophic wildfire, accelerate fuels reduction, and incentivize productive use of forest biomass residues while ensuring the sustainability of forest ecosystems." We strongly encourage ARB to ensure that forest measures are not only "crafted in coordination with" an expected future Forest Carbon Plan, but explicitly include the goals of carbon sequestration and storage, as well as the protection and enhancement of wildlife habitat.

Forests play a critical role in carbon storage and sequestration, and these important ecosystem functions should be protected and enhanced. The United States has 33 million acres of high-biomass moist forests on public lands that hold tremendous carbon stores estimated at 10 million megatonnes (mt) of carbon (DellaSala 2014). In California, national forests including the Sierra, Shasta-Trinity, Klamath, and Six Rivers have globally significant carbon stores (DellaSala 2014).

Notably, 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, Hudiberg 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

[15] "The current rate of fuel reduction activity is insufficient to improve forest health and avoid catastrophic wildfire and produce resilient forests." Draft report at 36.
[16] For example, the Oct 26, 2015, Federal Forest Carbon Coalition conference issued several key points of consensus on forest management that were "generally supported by the three presenters," Malcolm North, Matthew Hurteau, and Bev Law, including the following consensus points:

- Fire is natural and essential for forest health and resilience and reintroducing fire will be critical to a more ecologically sound approach that enhances forest resilience: this includes letting fires burn in some locations, and introducing controlled burns where possible.
- Landscape level thinning is not technically possible in many locations, and will undermine ecological health, release more carbon, and in many cases likely undermine future forest carbon sequestration as well.

See http://www.forestcc.org/.

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).

7) 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.[17] 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,[18] and the EPA.[19] Measured at the smokestack, replacing fossil fuels with biomass actually *increases* $CO_2$ emissions.[20] Notably, a recent study found that the climate impact per unit of $CO_2$

[17] "Establishing a robust biomass use market with diverse wood product manufacturing and distributed bioenergy production is essential to provide value to biomass and thereby make it cost-effective to transport from the forest to end users." Draft report at 37. "Putting woody biomass to its most beneficial use requires lifecycle and economic analysis of the many waste diversion options to fully quantify the benefit and identify possible unintended consequences of each biomass use option by region." Draft report at 37.

[18] 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).

[19] 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.

[20] Typical CO2 emission rates for facilities:
Gas combined cycle 883 lb CO2/MWh
Gas steam turbine 1,218 lb CO2/MWh

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 biogenic $CO_2$ can continue for decades or even centuries depending on the feedstock. 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). Yet the science shows this is precisely the time period during which biomass emissions released today will increase atmospheric $CO_2$ levels. At a time when we need to reduce emissions dramatically in the short term and keep them down, the Short-Lived Climate Pollutant Reduction Strategy should not be promoting biomass burning that will exacerbate climate change.

Conclusion

Thank you for your consideration of these comments. We look forward to working with the ARB in developing this strategy and implementing these measures. Please contact us if there are any questions about these comments or if we can assist you with background information and materials.

Sincerely,

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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.

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