Sierra Forest Legacy
Protecting Sierra Nevada Forests and Communities

Testimony to the Little Hoover Commission
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April 27, 2017

Thank you for the opportunity to speak to you about fire, restoration and forest ecosystems in California. Sierra Forest Legacy[1] has been working on forest conservation on national forest lands for over twenty years. Our project level work focuses on forests in the Sierra Nevada bioregion, but our concerns about the critical role fire plays in maintaining healthy plant communities extends to all fire-adapted ecosystems in California. The testimony below draws on our many years of experience working with scientists, state and federal agencies, conservation groups, industry and other stakeholders to restore the beneficial use of fire to forest ecosystems.

Overview[2]

As noted by Dr. Scott Stephens, in his testimony before the Commission in January 2017, past management decisions related to logging and fire suppression in California's forests have created conditions that are more uniform and ecologically less diverse than historic conditions. Such conditions decrease the capacity of these forests to respond to disturbances like extreme drought or extreme wildfire. Fire suppression and fire exclusion for the past century has dramatically altered forest resilience, watershed health, and wildlife habitat, and have placed human communities at high risk.

Diversity in the structure and composition for forests leads to greater resilience to disturbance from wildfire (North et al. 2009). Unfortunately, some forest management practices over the past century have created the opposite condition: even-aged homogeneous forests with too many trees. Fire exclusion also has created natural stands with dense understories composed of fire-intolerant species. This lack of diversity in forest structure, species, and age-class is compounded by development patterns that have increased forest fragmentation and placed more human structures in proximity to potential damage from fires (Theobald and Romme 2007).

One valuable management tool for creating diversity across the landscape is fire. California's forests evolved with fire and are considered to be fire-adapted. Fire is a core ecological process that increases patchiness at the landscape scale, improves forest resilience by reducing surface and ladder fuels, prevents the shift to fire-intolerant species, and increases the diversity of habitats available to species adapting to climate change. Managed fires (i.e., allowing unplanned ignitions to burn under certain conditions) and prescribed burns are also important

[1] https://www.sierraforestlegacy.org/
[2] This Overview section draws on the letter sent by Pacific Forest Trust and Sierra Forest Legacy to Commission staff in January 2017. This letter is included as an attachment to this testimony.

tools to reduce fuel loads in forests and lower the risk of experiencing extreme fire (Sapsis et al. 2016).

Historic fire regimes in forest ecosystems were much more frequent than they are today. For instance, Stephens et al. (2007) estimate that prior to 1800 fires in California burned roughly 4.45 million acres annually. When compared to the period 1950-1999, fires burned only 5.6% of the area that would have burned in the pre-settlement era. This reduction in fire, caused primarily by fire suppression policies, has created a substantial "fire deficit" in forest ecosystems where the fire activity is far below what would be expected under current climatic conditions (Figure 1; Safford and Van de Water 2014). This dramatic reduction in fire activity has severe ecological, economic, and public health and safety impacts across California. Attempting to limit fire's role in ecosystem function is analogous to limiting rainfall, wind or the tides.

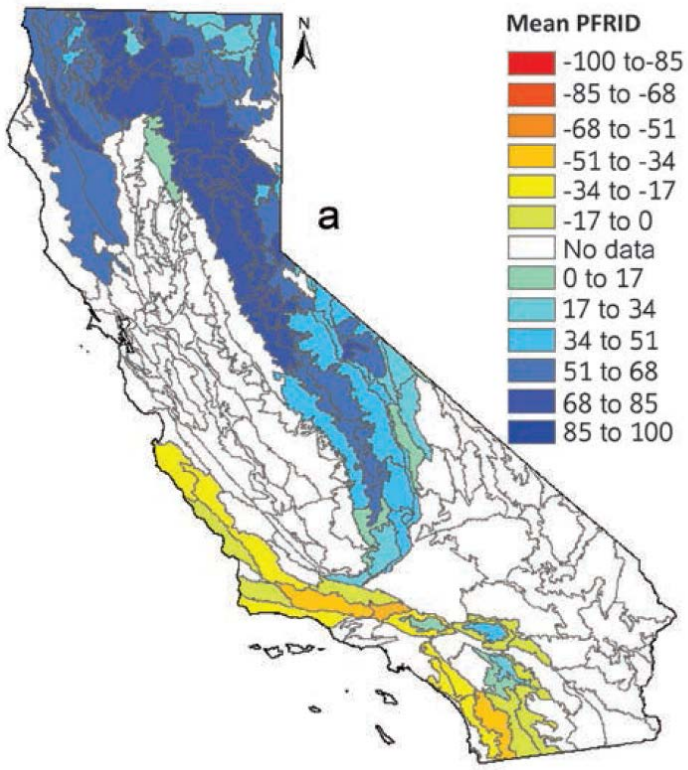

Figure 1. Mean proportional fire return interval departure for selected bioregions in California. Yellow-orange colors reflect the occurrence of too much fire versus green to blue reflects a deficit of fire. Taken from Safford and Van de Water (2014).

Living with fire and working with fire is the best choice and is critical in a changing climate. There is no "no-fire" option for forests in California today. Either the forested landscape will burn under extreme conditions when fire escapes suppression or we can choose to manage fire under more favorable conditions. Managing fire under favorable conditions will increase the health of the forests, improve adaptability to climate change, and improve the stability of forest carbon.

Accepting Fire as a Beneficial and Necessary Disturbance Process

We see significant promotion and acceptance of the beneficial use of fire in the scientific community, from state and federal land managers, in the restoration community, among some forestland owners, from conservation groups, and from air regulators. Ongoing research and the undesirable outcomes from extreme fires during the recent drought have provided compelling reasons for others to understand why managed fire is necessary to provide for the health of the forest.

Managed Fire MOU – A Partnership to Reduce Barriers to Use of Fire for Ecological and Other Benefits

Sierra Forest Legacy developed the Fire MOU Partnership in cooperation with the USDA Forest Service (Region 5) in 2015.[3] The goal of the partnership is to increase the use of managed fire[4] in California for ecological and other benefits. We recruited 10 other founding members, including California Department of Forestry and Fire Protection, Sierra Nevada Conservancy, National Park Service, four conservation organizations, and two prescribed fire councils. Additional partners have since joined including California State Parks, USDI Bureau of Land Management, California Fire Science Consortium, California Forestry Association, and several private parties. This unique partnership of government agencies and other stakeholders has agreed to provide an active voice in support of the societal and ecological benefits of increasing the use of managed fire in fire-adapted ecosystems. The current barriers to the use of fire include the lack of: staff capacity and training, public education on the benefits of prescribed and managed fire, evaluation of the air quality trade-offs, cross-jurisdictional fire collaboration, liability relief, and nuisance law relief.

The work of the Fire MOU Partnership is accomplished by a steering committee and three work groups: communication and outreach, policy, and capacity. The communication and outreach working group has developed a draft communication strategy with the aim of providing consistent messages for Fire MOU Partners to use when talking to media and others about the benefits of prescribed and wildfire managed for resource benefit. This work group draws on the communication departments from partner agencies and organizations. This work group came together to facilitate media highlighting the formation of the partnership in early 2016 and Wildfire Awareness Week 2016. This work group also has been working with scientists to present recent study results that illustrate the reduced impacts from smoke when using managed fire versus extreme wildfire, to policy makers and media contacts. The capacity and policy work groups have been working with air quality scientists to evaluate the barriers to burning, e.g., other biophysical conditions, staffing, etc., on the days that air quality regulators indicate are "available" for burning. This analysis will provide information to assist in designing solutions to maximize the use of the "available" burn days.

Addressing Opposition to the Use of Prescribed and Managed Fire

There are three main categories of argument against the use of prescribed fire: these are the adverse effect of smoke on air quality, the risk of a fire escaping, and the release of carbon. As a general matter, there are no "no-risk" or "no-fire" options for forests that evolved with frequent fire. We can choose "business as usual" and likely experience additional large,

[3] https://www.sierraforestlegacy.org/CF_ManagingFire/FireMOU.php

[4] For the purposes of the MOU, managed fire is defined as the use of natural or human-caused ignitions within burn prescription for the purposes including public safety and ecosystem benefits, where allowed under the policies of agencies with primary jurisdiction.

extreme fires in the years ahead, or we can actively use controlled fire to improve public health and the health of forest ecosystems.

Smoke that results from the burning of vegetation can lead to levels that are unhealthy, especially for individuals highly sensitive to smoke. The degree of impact depends on the biophysical conditions under which a fire burns and its proximity to the affected population (Long et al. 2017). Smoke more generally can impact recreational and other commercial uses within and adjacent to the area affected by wildfire. The impact of smoke cannot be denied, but fires that burn under moderate conditions that are managed for resource benefits can produce significantly less emissions compared to unplanned fire that burns under extreme conditions. Long et al. (2017) demonstrated that the burden from smoke was much less in the case where an ignition was managed for resource benefit in favorable weather conditions compared to an extreme wildfire event (Figure 2, below). The Grouse and Hardin Fires also resulted in the desired ecological benefit to this fire-adapted landscape and improved resilience to future fires. Thus, the emissions from these managed fires produced modest daily emissions with significant long term benefit.

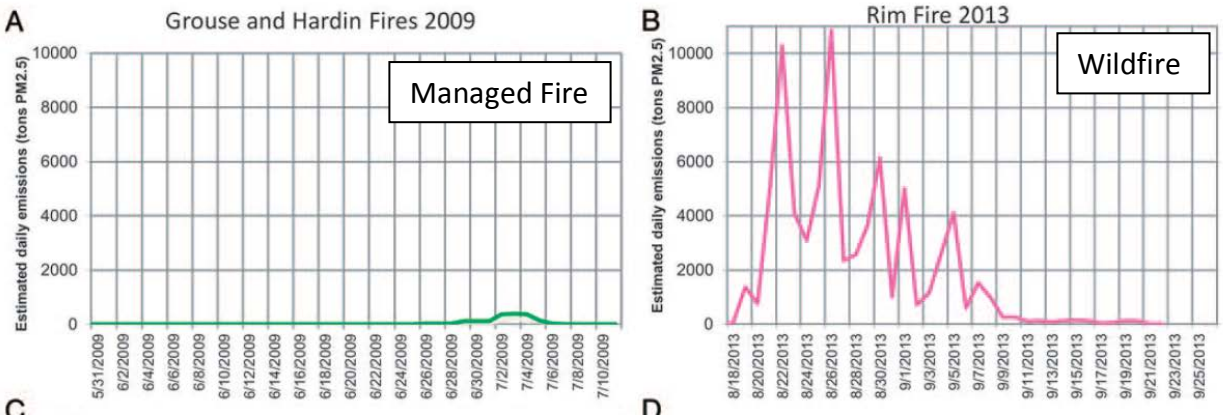

Figure 2. Daily emissions from (A) two fires managed for resource benefit on the left versus (B) a wildfire that resisted suppression on the right. Taken from Long et al. 2017.

Prescribed fires that escape control and damage resources are uncommon, but they have been known to occur.[5] The damages to property from wildfire that resists suppression far exceed the damages from prescribed fires that have escaped. The most effective steps to avoid escapes of prescribed fire are well-trained and experienced practitioners and a prescribed fire support team that can effectively use weather and other biophysical data to evaluate fire behavior in real-time. These steps give land managers the skills and tools they need to judge the

[5] A report of escaped fires on national forest lands from 1996 to 2004 found that only 30 prescribed fire escapes or near misses during that time frame throughout the nation. A report from the Wildland Fire Lessons Learned Center found that nationwide in 2012 there were 16,626 prescribed fires treating 1.97 million acres with only fourteen escaped fires (0.08 percent) (http://www.wildfirelessons.net/orphans/viewincident?DocumentKey=8bcbdeb7-875e-48ef-96ed-7d43ff602eb2).

appropriate response to control a prescribed fire.

Carbon is emitted when vegetation burns. There is an ongoing debate and exploration about the net carbon benefit of thinning and prescribed fire. It has been hypothesized that the increase in resilience to wildfire from the treatments will reduce future carbon emissions and provides a net carbon benefit since these areas will burn less intensively when fire does occur. Hurteau et al. (2016) found this to be the case for dry pine forests in the Southwest. Modeled wildfire emitted more carbon in forests that were not treated versus the combined removals of carbon by wildfire and treatment. This means that in this dry and fire-prone forest type, there was a net carbon benefit from treatments, even though the treatments, i.e., thinning and prescribed fire, removed carbon. However, forest types associated with less frequent fire regimes show little to no carbon benefit from treatments, even though these treatments reduce the size and severity of future fires (see for example Campbell et al. 2011 for forest types in the Pacific Northwest and Chiono et al. 2017 for forest types in the Sierra Nevada). Given the increasing frequency of large wildfires and area burned in California expected from climate modeling studies (Lenihan et al. 2008; Westerling et al. 2011), Chiono et al. suggest that a shift to a more fire-prone system, similar to what is experienced in the Southwest, could lead to increased carbon benefits from landscape level treatments and that this deserves more study.

Forest Resilience to Fire, Clearcutting and Other Harvest Methods

The nature of forest fuels and their relationship to fire behavior and fire effects has been extensively studied in California and elsewhere. The fuels in a forest stand consist of surface, ladder, and canopy fuels.[6] The amount and arrangement of surface and ladder fuels (including shrubs and small trees) have the greatest contribution to fire effects, with the fuels in the canopy of the trees providing a much smaller contribution (Agee et al. 2000; Agee and Skinner 2005; Stephens et al. 2009). This means that increasing fire resiliency can be accomplished by focusing on the removal of surface fuels and ladder fuels, i.e., generally trees under 16 inches in trunk diameter (North et al. 2009; Collins et al. 2011).

There are many different harvest practices applied in California. Their selection is driven by land owner objectives, regulations and law, and the condition of the forest stands. Clear-cutting is a type of logging that removes all of the trees in a section of land and the cleared area is subsequently planted with trees. These areas are referred to as plantations or tree farms. The intention of clear-cutting is to create an even-aged stand of trees that could be then harvested again at a set time in the future. High numbers of trees are initially planted and thinned over time to make sure that growth on the site is maximized.

[6] Surface fuels are "fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants"; ladder fuels are those which provide vertical continuity between the surface and crowns of trees and include small trees and shrubs in the understory; and canopy fuels contain the crowns of the tallest vegetation present (living or dead), usually above 20 feet (https://www.nwcg.gov/glossary-of-wildland-fire-terminology).

Fire modeling has shown that even-aged plantations are not as resilient to the effects of fire compared to thinned stands or forest reserves (Stephens and Moghaddas 2005). This study, completed at the Blodgett Experimental Forest, evaluated a variety of silvicultural practices, including thinned and unthinned plantations and untreated old growth forest reserves. They found that overall tree mortality in thinned or unthinned plantations was greater than 80 percent with plantations up to 5 years old or less experiencing 100 percent mortality. The lowest levels of mortality were found in reserve stands and stands that had been thinned from below. Weatherspoon and Skinner (1995) reported similar results from an assessment of fire-affected stands in northwest California. Uncut stands had less fire damage compared to plantations with or without site preparation. The dense horizontal arrangement of flammable vegetation close to the ground causes the plantations to be more susceptible to moderately severe fire compared to older stands that have a greater distance between the surface fuels and canopy fuels with low levels of ladder fuels. In addition, forest stands that are more variable in structure with fine scale gaps and openings and that include large fire resistant tree species are more resilient to fire (North et al. 2009).

Mechanical thinning can improve fire resiliency, but only if treatments reduce surface and ladder fuels (Agee and Skinner 2005, Stephens and Moghaddas 2005). In addition, thinning to improve fire resiliency need not remove large trees (greater than 10 inches to 16 inches in diameter) to accomplish this benefit (North et al. 2009).

Increasing Support for Prescribed Fire

I offer the following recommendations to raise statewide awareness of prescribed fire as an important and necessary management technique:

- Support and strengthen the cooperation among air regulators and land managers by encouraging agency staff to participate in the bi-annual meetings of the Air, Land, Water Managers hosted by the Forest Service and California Air Resources Board;
- Promote active participation in the Fire MOU Partnership to seek mutually acceptable solutions to the barriers to expanding the use of managed fire;
- Promote the use of managed fire at an ecologically relevant scale wherever possible; and
- Support increased outreach to stakeholders and the public-at-large about the necessity of fire to maintain a healthy forest and reduce impacts from smoke

Recommendations for Increasing Forest Resilience[7]

Building on the wealth of historical and ecological knowledge, there is ample research to support forest policies that encourage more natural conditions and increase resilience. However, many state policies continue to perpetuate forest mismanagement, particularly

[7] These recommendations are described in greater detail in the letter sent by Pacific Forest Trust and Sierra Forest Legacy to Commission staff in January 2017. This letter is included as an attachment to this testimony.

indiscriminate fire suppression and forest practices that reduce complexity and create excessively dense even-age conditions. Restoring fire as a core ecological process and at significant ecological scales in fire-adapted forests can increase resilience to drought and climate change.

We see a need for a significant policy shift towards the goal of restoring fire to the landscape where possible, creating more balanced and ecologically appropriate fire regimes. In addition to the recommendations above, some steps that would go a long way towards achieving this goal include:

Increase community fire protection through incentives, increased outreach, education, and/or enforcement as part of a landscape fire strategy. By supporting Firewise Communities/USA and Fire Safe community fire safety programs, we can increase the certainty that communities and structures are safe. Community fire protection makes it possible to reintroduce fire responsibly and reduces risks to communities in the wildland-urban interface.

Improve air quality monitoring efforts with better coordination between fire managers and air quality regulators and by using the latest modeling tools and spatially explicit information about air currents. This will ensure that air quality monitoring is precise and provides a more accurate evaluation of public health and economic tradeoffs between the potential risk of a high severity fire occurring in the absence of increased prescribed or managed fire (Schweizer and Cisneros 2016; Long et al. 2017).

Revitalize CAL FIRE's prescribed burn program which is an effective way to restore fire to the landscape in collaboration with federal and private partners. CAL FIRE could also help promote the use of prescribed fire more broadly by increasing standardized training and certification.

Apply a broader range of tools to increase forest resilience. Too often, fire treatments are considered only in the context of fuels reduction, with mechanical thinning and prescribed burns the only management techniques considered. These are both vital tools. However, there are additional complementary forest management practices that can increase and maintain the resilience of the forest to fire and other disturbances, including:

- Managing for older, larger trees;
- Increasing the diversity within the forest;
- Decreasing forest fragmentation caused by development;
- Harnessing disturbance to promote positive change; and
- Providing incentives for private landowners to change management

Recommendations to Address Tree Mortality

The recent drought in California was the driest period on record in the last 1,200 years. We have no prior experience of drought of this intensity. During the last 100 years, humans have exerted an undeniable force on forest ecosystems by suppressing fire and overriding the climatic effects on fire activity (Taylor et al. 2016). The tree mortality response to drought is largely the result of our disruption of the fire regime and exacerbated by climate change. It is critical to clearly identify humans as drivers of environmental conditions in order to plan an alternative path to the future.

Some might suggest that we can log or thin our way out of any concerns about forest lands. Logging or thinning as the solution is highly misplaced though since significant areas in the Sierra Nevada, for example, are not accessible to timber operations because the area is too steep, there are no roads, or the land does not support enough timber to be commercially viable (North et al. 2015). In these areas where operations are constrained, the only management option is to use fire to beneficially manage the landscape.

The need to establish the fire regime is relevant to areas strongly affect by the drought, e.g., southern Sierra Nevada, as well as other locations less impacted. In the southern Sierra Nevada, it is critical to initiate a managed fire program now as the needles from dead trees begin to accumulate on the forest floor. Reducing these fine fuels now, followed by additional fire as limbs and then tree bolls begin to fall allows fire to incrementally reduce the dead biomass overtime. Land managers in the southern Sierra Nevada are considering this approach now. The Forest Service recently conducted a prescribed burn in an area where about 25 percent of the trees were standing dead. This 700-acre burn stayed within prescription and under control despite the standing dead. The burn also produced the desired ecological outcomes while reducing fuels and fire risk. Prescribed burning and managing fire for resource benefit needs to be applied more extensively to alter the fuels created by the tree mortality event. Taking advantage of weather conditions favorable to burning now and in the coming 2 years will be critical to positioning the drought affected landscape to be resilient to future fire.

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Sierra Forest Legacy
Protecting Sierra Nevada Forests and Communities

To: Krystal Beckham, Little Hoover Commission Project Manager
From: Paul Mason and Abby Halperin, Pacific Forest Trust
Craig Thomas, Sierra Forest Legacy
Date: January 3, 2017
Re: Little Hoover Commission Review of Forest Management

As the Little Hoover Commission sets forth on a much-needed critical examination of forest management practices in light of the recent tree mortality crisis, we are happy to provide background context for current conditions. We are also pleased to share the following recommendations to help increase forest resilience to disturbance and secure the many benefits forest provide. Based on a review of past forest management, we recommend that:

1. Fire needs to be restored to the landscape as a core ecological process, at significant ecological scales across California,
2. A broad range of tools should be considered to increase forest resilience, and
3. Private landowners need incentives for changes in management.

Each of these recommendations is built on greater coordination among state agencies and collaboration with federal and private partners.

Background:

Past management decisions for California's forests have created unnatural conditions that decrease the capacity of these forests to respond to disturbance.

It is a well-established ecological principle that more diversity leads to greater resilience to disturbance (Hooper et al., 2005). However, many of the forest management practices over the past century have done precisely the opposite by creating even-aged homogeneous forests that are overstocked. Fire exclusion has also created natural stands with dense understories composed of fire-intolerant species. This lack of diversity in forest structure, species, and age class is compounded by development patterns that have increased forest fragmentation and placed more human structures in proximity to potential damage from fires (Theobald and Romme, 2007).

One valuable ecological tool for creating diversity on the landscape is fire. Many of California's forests are fire-adapted. Fire is a core ecological process that increases patchiness at the landscape scale, improves forest resilience by reducing surface and ladder fuels, prevents the shift to fire-intolerant species, and increases the diversity of habitats available to species adapting to climate change. Managed fires (i.e., allowing natural fires to burn under certain conditions) and prescribed burns are also important tools to reduce

fuel loads in overstocked forests that might otherwise burn at high severity (Sapsis et al., 2016).

Historic fire regimes were much more frequent than they are today (Baker, 2015; Hurteau et al., 2014; Mallek et al., 2013; Marlon et al., 2012; Steel et al., 2015; Stephens et al., 2007; van de Water and Safford, 2011; Whitlock et al., 2003). For instance, Stephens et al. (2007) estimate that during pre-settlement times California fires burned roughly 4.45 million acres annually and that from 1950-1999, fires burned only 5.6% of the area that would have burned in the pre-settlement era. The drop in fire caused primarily by fire suppression policies has created a substantial "fire deficit" where the fire activity is far below what would be expected under current climatic conditions (Marlon et al., 2012). This dramatic reduction in fire activity has severe, ecological, economic, and public health and safety impacts across California.

Recommendations:

Building on the wealth of historical and ecological knowledge, there is ample research to support forest policies that encourage more natural conditions and increase resilience. However, many state policies continue to perpetuate forest mismanagement, particularly indiscriminate fire suppression and forest practices that reduce complexity and create excessively dense even age conditions. Moving forward to address this and further crises, we recommend that the following principles are kept in mind:

1. **Fire needs to be restored to the landscape as a core ecological process, at significant ecological scales across California.**

Fire suppression policies have created many of the problems currently faced by California's forests. A significant increase in fire is necessary and will help address the current tree mortality crisis as well as the large patches of high severity burns (North et al. 2012). There needs to be a larger policy shift towards the goal of restoring fire to the landscape where possible, creating more balanced and ecologically appropriate fire regimes. Here are some key steps that would go a long way towards achieving this goal:

A. **Increase community fire protection** through incentives, increased outreach, education, and/or enforcement as part of a landscape fire strategy. By supporting Firewise Communities/USA and Fire Safe community fire safety programs, we provide increased certainty that communities and structures are safe. Community fire protection makes it possible to reintroduce fire responsibly and reduces risks to communities in the wildland-urban interface. While there here has been success in locations throughout California where fuels reduction work has limited negative fire effects, the recent Butte and Valley fires (2015) clearly point to the need for increased incentives, outreach, and enforcement of fire safe policies that protect homes and communities in California's fire-prone landscapes. We believe increased

community fire awareness and protection will translate into broader fire use and greater public acceptance of fire as a key ecological process.

B. **Improve air quality monitoring efforts** that can otherwise hinder much needed prescribed burns or managed natural fires. With better coordination between fire managers and air quality regulators and by using the latest modeling tools and spatially explicit information about air currents, air quality monitoring can be more responsive and precise in avoiding adverse impacts on human health. Furthermore, these air quality standards could better incorporate the public health and economic tradeoffs between the potential risk of a high severity fire occurring in the absence of increased prescribed or managed fire across California's fire-dependent landscapes (Schwiezer and Cisneros 2016; Long et al. 2017 in review).

C. **Revitalize CAL FIRE's prescribed burn program** which is an effective way to restore fire to the landscape in collaboration with federal and private partners. By implementing the prescribed burns, CAL FIRE takes on the liability can otherwise limit landowners from using fire and makes a real difference on the ground. Restoring CAL FIRE's prescribed burn program could be a valuable use of the State Responsibility Area fee fire prevention program. CAL FIRE could also help promote the use of prescribed fire more broadly by increasing standardized training and certification. This would promote increased collaborative, ecological fire use across California that places a high value on resilience and public safety.

D. **Promote the established, multi-party Fire MOU** for prescribed and/or managed natural fire across ownership boundaries. Supporting policies that eliminate or reduce barriers to increased fire use benefits forest lands, restores ecological health, and improves resilience. Current barriers include the lack of: staff capacity and training, public education on the benefits of fire use, evaluation of the air quality trade-offs, cross-jurisdictional fire collaboration, liability relief, and nuisance law relief.

2. A broad range of tools should be considered to increase forest resilience.

Too often, fire treatments are considered only in the context of fuels reduction, with mechanical thinning and prescribed burns the only management techniques considered. These are both vital tools. However, there are additional complementary forest management practices that can increase and maintain the resilience of the forest to fire and other disturbances, including:

A. **Managing for older, larger trees.** Many research studies point to larger, well-spaced trees as the desired condition for resilient forests because this more closely mimics historic forest structure (e.g., Hurteau and Brooks, 2011). Increasing the space between trees through fuels reduction is just one part of achieving this desired forest state. It takes time for trees to grow older and larger and there need

to be mechanisms in place to ensure that the forest has the time to grow into the desired state. This is especially important as it can take up to 50 or 60 years for the forest to resequester the carbon emitted from treatments (Loudermilk et al., 2016). Some progress has been made in ensuring that state-funded forest improvement work provides time for forests to grow older, such as the requirement in SB 859 (2016) that GGRF funds applied to landscape scale forest health initiatives ensure that the benefits persist for at least 50 years. All forest restoration programs must recognize the critical role of time in restoring resilient forest conditions and include provisions to ensure the development of older trees.

B. **Increasing diversity within the forest.** Many management techniques can increase diversity, which is a well-established way to improve resilience (Hooper et al., 2005). These techniques include (re)planting a mixture of native species, managing for a diversity of age classes within a forest from early seral to late, and using fire to create patchiness on a landscape scale. A diversity of species and ages, with some drought tolerant and others fire adapted, will help the forest continue to provide core ecosystem services. This is because, in the face of disturbance, there is a much greater likelihood in a diverse forest than even-aged homogenous plantation that some of the trees adapted to survive that particular disturbance will be present. There are also co-benefits to increased diversity, such as the improvement of wildlife habitat and the decreased risk of impaired watershed function.

C. **Decrease forest fragmentation** which leads to greater fire risk to property as more human structures are located in the wild-urban interface (Theobald and Romme, 2007). These fragmented forests interlaced with human structures are a particularly challenging place to both fight the fires that endangered properties and reintroduce fires that could help restore ecological processes. Fires are also more likely to occur in fragmented forests as there is an increased risk of a human-caused ignition (Franklin and Forman, 1987). Fragmentation can be effectively reduced through funding for proactive conservation initiatives that increase landscape connectivity and by modifying (or better enforcing) local zoning laws in high and very high fire hazard areas. Coupled with increased community fire protection efforts, limitations on down-zoning in high fire risk areas would rein in skyrocketing fire suppression cost.

D. **Harness disturbance to promote positive change.** Disturbances such as fire and beetle outbreaks are not always devastating and are sometimes useful in improving forest health and resilience to later events. For instance, while the beetle outbreak is dramatic, in many places it is likely to result in stand densities more appropriate to current and future climate conditions. While there are obvious public safety issues to address, we need to be careful not to assume that every instance of disturbance is inherently a natural disaster. California's forests are ecological systems that will fluctuate between a range of different conditions. Maintaining the status quo is not

only impossible, but often inadvisable in light of the state's goals for resilient forests that sequester carbon, sustain wildlife habitat, and provide sources of water. Remembering root causes, including a century of fire exclusion exacerbated by advancing climate change, will help us avoid making huge ecological missteps again.

3. Private landowners need incentives for changes in management.

In California's checkerboard landscape, managing forests across ownership boundaries is critical to landscape level goals such as increased resilience. State and federal agencies need to work with private landowners, NGOs, and other partners to effectively improve forest resilience. These improvements in resilience will likely also result in better watershed function, wildlife habitat, and carbon sequestration. However, they are also unlikely to occur on private lands without some policy intervention – either carrot or stick.

Strategic use of working forest conservation easements can be an appropriate tool for both connecting forest patches to prevent additional fragmentation and to develop forest characteristics that take time. Easements provisions can outline the desired outcome for forest conditions - creating more natural forest structures, letting trees go older, and making the forest more resilient. Permanent easements are a cost-effective tool to provide private landowners with the incentive to manage their land for public benefit. These easements not only aid in climate change mitigation by increasing carbon stores and preventing development, but they also can help adaptation to climate change by improving habitat conditions, increasing habitat connectivity, and securing water supplies.

Sincerely,

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**these papers are attached*