Working from the Home Outward:

Lessons from California for Federal Wildfire Policy

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Environment Now®

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Executive Summary

- The dominant current approaches to wildfire policy promoted by the Forest Service— wildlands fire suppression and forest alteration through extensive tree-cutting—are failing to keep the public safe, with record losses of lives and homes during wildfires.
- In contrast, an approach of "working from the home outward," focusing on fire-safety home retrofits and the zone immediately around houses and communities, offers the most effective and cost-efficient tools for increasing public safety during wildfires.
- Most wildfire-related government funding subsidizes forest alteration and fire suppression rather than home-outward actions, even in "all of the above" approaches to fire policy. Less than 4% of California's 2021 fire-related budget is for "community hardening."
- A new task force is needed to answer this central question—Which actions will produce the greatest public safety benefits during wildfires in the most cost-efficient manner?
- This task force should include, but not be limited to: public safety experts, scientists not reliant on Forest Service funding, the insurance industry, fire managers outside of the Forest Service, indigenous representatives, and environmental groups currently challenging Forest Service fire-related projects.
- Mechanized wildfire suppression was developed during the cooler, wetter conditions in the 20th century. This approach is increasingly expensive and ineffective amid the hotter, drier conditions of the 21st century and wind-driven fires.
- Forest-altering approaches to fire policy are often based on erroneous claims that misconstrue the role of mixed-intensity wildfires in western forests.
- Tree-cutting results in significant carbon emissions, whereas wildfire is a comparatively small and short-term source of carbon emissions. Protecting forests from logging via "proforestation" can sequester five times as much carbon as tree-planting does.
- Fire policies that subsidize using trees and other forest material to fuel biomass power facilities are polluting (both for the climate and vulnerable communities), ineffective, and expensive.
- Fire policies for forest ecosystems often are not appropriate in chaparral ecosystems, which can lead to more flammable landscapes, destruction of critical habitat, and ineffective protection of nearby communities.
- While prescribed fire has a role in fire policy, the results of large-scale prescribed fire are likely to be disappointing. It can lead to ecological damage, as well as a ten-fold increase in the total amount of smoke. And prescribed fire is a relatively inefficient tool when compared to managed wildfire, cultural burning, and fire-safety home retrofits.

Video Summary

Some of the contributors to this report were interviewed for the upcoming fire documentary *Elemental*. For a short video featuring excerpts of these interviews, see: https://vimeo.com/543710055.

Introduction

A New Direction for Federal Wildfire Policy: Running Faster in the Wrong Direction is Not a Solution

by Douglas Bevington, PhD, Forest Program Director, Environment Now

In the wake of lives lost and communities burned, there is eagerness for more action on wildfire policy. However, *when you are running in the wrong direction, running faster is a problem, not a solution*. Yet, that is exactly what is occurring with wildfire policy in California and the West.

In the 20th century, the dominant approach to wildfire was suppression, attacking fire in remote wildlands. As discussed on pp. 9-10 of this report, *the mechanized approach to wildfire suppression that was developed in the wetter, cooler conditions of the 20th century is increasingly ineffective amid the hotter, drier conditions of the 21st century*, especially during wind-driven events such as the Camp Fire that devastated the community of Paradise in California. Yet, there is now record-level spending on outdated fire suppression approaches and 20th century technologies such as airtankers. The reality is that firefighting airplanes are not able to operate effectively in the windy conditions in which home loss is most likely to occur, and these aircraft were grounded while Paradise burned (see p. 10).

Likewise, in the past quarter century, every time there are wildfires, the Forest Service, the timber industry, and biomass power lobbyists have consistently pushed for more money to subsidize logging under benign-sounding euphemisms such "fuel reduction", "thinning", "restoration," and "forest management," and some well-intended people have joined this drumbeat. Yet, this forest-altering approach to fire policy is often based on outdated and erroneous claims about wildfire (see pp. 11-12). And, as more money has subsidized cutting trees under fire-safety justifications, we are seeing unprecedented loss of lives and homes.

The forest-altering approach has failed to keep the public safe. Instead, it mainly produces stumps, depleted budgets, and excuses. After each failure, logging proponents conveniently claim that things will be different if they get more money for more cutting. Yet, we now see the fires burning readily in places where they have already done lots of cutting. In fact, some of the fastest and most intense fire spread is occurring in these cut areas (see p. 12).

Beyond being ineffective and even counterproductive, the forest-altering approach puts more carbon into the atmosphere (see pp. 13-15) and more pollution in vulnerable communities (see p. 15). And perhaps biggest harm from *the forest-altering approach is that it diverts attention and resources away from real solutions, such as fire-safety home retrofits that genuinely protect communities during inevitable wildfires* (see pp. 7-8, p. 18) The La Tuna Fire in Los Angeles illustrated the effectiveness of home-safety approach when community-level fire-safety standards *enabled more than 99% of the houses in the path of a large wildfire to survive* amid triple-digit temperatures and high winds (Hanson 2018). In addition to being more effective, *home-safety actions can produce more jobs and better-paying jobs* than an equivalent amount of money spent subsidizing logging and other forest-altering activities (Niemi 2018).

“Working from the Home Outward” or the “All of the Above” Run-Around?

How can federal policymakers ensure that fire policies turn in a more productive direction and avoid repeating the mistakes of the past? This report builds on lessons identified in a 2019 report done in conjunction with the Leonardo DiCaprio Foundation, titled “A New Direction for California Wildfire Policy—Working from the Home Outward.” That report brought together fire and forest carbon experts from partner organizations of the Environment Now foundation—which supports environmental protection in California-- to prepare concise synopses of key points that are often misunderstood or overlooked in fire policy discussions.

It also featured a piece by Dr. Jack Cohen, a retired US Forest Service scientist. Dr. Cohen has been a pioneer in the study of the importance of home features and the zone right around them for preventing home ignitions during wildfires. Despite the significant implications of Dr. Cohen’s research, not nearly enough has been done to incorporate these findings into current fire policies. As one investigative report summarized, “*Cohen thought he had come up with a way to save houses and to let fires burn naturally* — he thought it was a win-win. And so in 1999, he presented a paper about his findings at a fire conference in front of people from the Forest Service and state fire agencies. These were people who were in a position to change policies. But Cohen says they were totally uninterested. Cohen’s research implied that *basically everything about how the Forest Service dealt with wildfires was wrong*” (99PI 2018). Dr. Cohen’s discoveries provide the cornerstone for a more effective new direction for wildfire policy—summarized as “*working from the home outward*”— in which the greatest public safety benefits come from prioritizing actions in or near homes and communities.

While the 2019 report was written for California’s state-level policymakers, Environment Now’s new report updates those findings with the goal of sharing lessons from California with federal policymakers. New content has also been added to address *two activities that have received increasing attention in the past two years, but that unfortunately are overstated in terms of their actual benefits— tree-planting (see p. 14) and prescribed fire* (see pp. 19-22).

Unfortunately, in California, we have not yet seen the needed change in direction from state leaders. While there have been a few steps to increase attention on home-safety retrofits, this has been buried within an approach described as “all of the above.” *“All of the above” sounds commonsensical, but in practice it is an abrogation of leadership*. The reality is that some fire policy actions are significantly more effective at increasing public safety than others. We need to actively identify and prioritize funding the most effective solutions. Yet, in “all of the above,” the well-established but failing approaches still tend to prevail in getting the biggest slices of the budgetary pie. When California’s Governor announced his billion-dollar wildfire budget for 2021, *less than 4% of those funds were designated for “community hardening”* (LAO 2021). *Even though home retrofits offer some of the most effective tools for increasing public safety during wildfires, that approach is still getting the crumbs from the actual expenditures*. Meanwhile, state leaders continue putting more money into subsidizing tree-cutting, even when these projects cause ecological damage, put more carbon into the atmosphere, increase fire intensity, and divert resources away from home-safety actions (Hanson and Hansen 2019).

A Key Lesson for Federal Policymakers

One key reason that California state leaders have not pivoted to a more effective direction for wildfire policy is that they have continued to rely heavily on the state-level fire suppression agency (CalFire) and its allies to steer policy recommendations. Unfortunately, we are unlikely to see real change advanced by the same people who promoted the failing fire policies of recent decades. Likewise, *federal policymakers should not expect to find a substantively new approach to wildfire coming from the leaders of the US Forest Service and their allies* who are invested in the current approach focused on suppression and forest-alteration.

Real progress will come from recognizing that *fire policy is fundamentally a public safety issue*, and then seeking out public safety experts rather than relying mainly on "forest management" discussions in which home-safety actions keep getting relegated to the margins. This will likely require setting up a new task force to focus specifically on *this central question—Which actions will produce the greatest public safety benefits during wildfires in the most cost-efficient manner?* While many actions may claim to have some potential benefits under particular circumstances, it is important not to fall into the "all of the above" run-around. Instead, there must be a rigorous and transparent comparative assessment of the costs and benefits of different alternatives, so that resources can then be focused primarily on the most effective actions. To produce an accurate assessment, the following guidance is recommended:

- Public safety experts should be at the forefront. This includes fire marshals, experts in home design, and community planning experts.

- As the Forest Service exerts significant influence over its scientists (Hanson 2021a), it is prudent to ask scientists to be transparent about any Forest Service funding they receive and to actively seek scientists who are not reliant on Forest Service funding.

- The insurance industry has a direct financial stake in identifying which actions are really the most effective in preventing homes from burning.

- Seek alternatives to the Forest Service for information from fire managers, including Tribes with long traditions of working with fire, municipal fire departments on the frontlines of keeping communities safe, and wildland firefighter whistleblowers (see Firefighters United for Safety, Ethics, and Ecology). Likewise, the National Park Service has explored innovative fire management policies. Now, wildfires generally burn less intensely in national parks than national forests (Bradley et al. 2016). Meanwhile, the Forest Service spends more than five times as much on fire per acre burned than the Park Service and other agencies in the Dept. of Interior (Bevington 2018, Stahl 2018).

- There has been a tendency to elevate those environmental organizations that promote the Forest Service's approach to fire policy, which readily turns into an echo chamber. In contrast, environmental groups that are actively challenging Forest Service fire-related projects can provide due diligence in assessing Forest Service claims (Bevington 2018).

A More Effective Approach for Preventing Wildland-Urban Fire Disasters

By Jack Cohen, PhD, Research Physical Scientist, US Forest Service, retired

Summary

Communities exposed to inevitable extreme wildfire conditions do not have to incur inevitable disastrous fire destruction. Research shows that the characteristics of a home and its immediate surroundings within 100 feet (30 meters) principally determine home ignitions. This area, called the *home ignition zone* (HIZ), defines wildland-urban (WU) fires as a home ignition problem and not a problem of controlling wildfires. Communities can readily reduce home ignitability within the HIZ to prevent WU fire disasters instead of increasing wildfire suppression that fails during extreme wildfire conditions. Reducing the ignition conditions within the HIZ to produce ignition resistant homes provides an effective alternative for preventing WU fire disasters without necessarily controlling extreme wildfires.

Inevitable Wildfires and Extreme Burning Conditions

Wildfire occurrence is inevitable and thus, a small percentage of wildfires will inevitably attain uncontrollable extreme wildfire conditions. For over one-hundred years U.S. fire suppression has successfully controlled 95 to 98 percent of wildfires with initial attack (Stephens and Ruth 2005). However, there is no historical evidence or current fire management trend to suggest that all wildfires can be excluded and if not excluded, controlled with an initial suppression response. Thus, we can assume the inevitability of wildfires and the occurrence of extreme wildfire conditions (Williams 2013). Most wildfires controlled at initial attack occur during moderate to high wildfire conditions. During severe conditions of drought, high winds, low relative humidity and multiple ignitions, 2 – 5 percent of the wildfires producing rapid growth with high burning intensities escape initial attack suppression.

Figure 1.

Paradise, CA; 2018 Camp Fire

Southwest CO; 2002 Missionary Ridge Fire

S Cal; 2007 Grass Valley Fire

The primary federal, state and local approach for protecting structures from wildfires and preventing community fire disasters is wildfire control using suppression added by pre-suppression fuel breaks and shrub and forest fuel treatments (Finney and Cohen 2003, Cohen 2010). However, disastrous community wildfire destruction (greater than 100 homes destroyed) has only occurred during extreme wildfire conditions when high wind speeds, low relative humidity and continuous flammable vegetation result in rapid fire growth rates and numerous spot ignitions from showers of burning embers (firebrands); that is, the conditions when wildfire control fails (Cohen 2010, Calkin et al. 2014).

Community fire destruction during wildfires will continue as long as wildfire suppression continues to be the primary residential protection approach. The inevitability of uncontrolled extreme wildfires suggests inevitable disastrous home destruction; however, research on how homes ignite during extreme wildfires indicates practical opportunities for effectively creating ignition resistant homes and thereby preventing community fire disasters without necessarily controlling wildfires (Cohen 2000a, Cohen 2001, Cohen 2004, Cohen and Stratton 2008, Cohen 2010, Calkin et al. 2014, Cohen 2017). We can immediately see how homes were not ignited during a wildfire from the readily observable patterns of destruction.

Patterns of Home Destruction during Wildfires

Total home destruction surrounded by green tree canopies following the Camp Fire in Paradise, CA (Figure 1, top photo) has been reported as unusual; however, unconsumed vegetation adjacent to and surrounding total home destruction is the typical WU fire pattern associated with extreme wildfire conditions (Cohen 2000b, Cohen and Stratton 2003a, Cohen 2003b, Cohen and Stratton 2008, Graham et al. 2012, Cohen 2017). The center photo (Figure 1) shows an example of a burning home that could have only ignited from lofted burning embers (firebrands) on the home and low intensity surface fire spreading to contact the home. The three photos (Figure 1) of home destruction with adjacent unconsumed shrub and tree vegetation indicate the following:

- **High intensity wildfire did not continuously spread through the residential area as a wave or flood of flame.**
- **Unconsumed shrub and tree canopies adjacent to homes did not produce high intensity flames that ignited the homes; ignitions could only be from firebrands and low intensity surface fires.**
- **The 'big flames' of high intensity wildfires did not cause total home destruction.**

High intensity wildfires do not spread through residential areas such as Paradise. The continuous tree and shrub canopies required to maintain high intensity wildfire spread (crown fires) are broken by fuel gaps such as streets, driveways and home sites (Cohen 2010). Figure 2 shows how a crown fire spread to but could not continue beyond the first residential street. Although the crown fire terminated at the street, firebrands showered downwind into the residential area initiating fires resulting in several blocks of total home destruction (Cohen 2010). Extreme wildfire conditions initiate ignitions within residential areas but the residential fuels, structures and vegetation continue the residential burning resulting in total home destruction. Commonly, homes ignite and burn hours after the wildfire has ceased active burning near the community (Cohen and Stratton 2008; Cohen 2010).

Figure 2.

Figure 3.

Furthermore, the typical WU fire patterns indicate that conditions local to a home principally determine home ignitions with firebrands the principal source of ignitions within the residential area. The totally destroyed home in Figure 3 indicates firebrands as the only possible ignition source, potentially igniting the home directly and the flammable materials adjacent to the home. Firebrands are a given during extreme WU fire conditions; however, regardless of the distance firebrands were lofted, firebrand ignitions depend on the local conditions of the ignitable surfaces on or adjacent to a home.

An Effective Approach for Preventing WU Fire Disasters

Research (Cohen 2004) has quantified "local ignition conditions" to be an area of a home and its immediate surroundings within 100 feet (30 meters). This area is called the *home ignition zone* (HIZ) (Cohen 2010, NFPA 2018). The relatively small area of the HIZ principally determines home ignitions during extreme wildfires and defines WU fire destruction as a home ignition problem that can be prevented by readily addressing home ignition vulnerabilities within the HIZ without necessarily controlling wildfires. For example, an ignition resistant home does not have a flammable wood roof, flammable tree debris on the roof, in the rain gutters, on decks or on the ground within 5 feet (1.5 m) of flammable siding, no open firewood within 30 feet (9 m), or unscreened vents. Clearing the HIZ of vegetation is not necessary. As indicated by the typical patterns of WU fire destruction, shrub and tree canopies are not spreading high intensity fires through communities. The inevitability of uncontrolled extreme wildfires spreading to communities does not mean WU fire disasters are inevitable if we address the problem with the readily available approach of reducing home ignitability. Ignition resistant communities increase community fire protection effectiveness, life-safety options for residents and firefighters, and decrease wildfire suppression costs while preventing WU fire disasters without attempting to protect communities by controlling wildfires.

20th Century Fire Suppression Policy is Not Appropriate for a 21st Century Climate

by Timothy Ingalsbee, PhD, Executive Director, Firefighters United for Safety, Ethics, and Ecology

Up until the mid-20th century, we had a lot more fire on the land.
Hundreds of fire history studies document that wildland fires burned significantly more area than burns now. Even in the 20th century up until the 1950s, several tens of millions of millions of acres burned in the U.S. each year (NIFC n.d.).

Then we began mechanized firefighting in the 20th century.
Federal agencies such as the U.S. Forest Service (USFS) began fighting fires in 1905, but with minimal effectiveness due to the large expanse of undeveloped wildlands, the limited size of its workforce, and primitive technology. This changed in the post-World War II period with an influx of military surplus vehicles and equipment in fire suppression (Pyne 1982). Cutting firelines with bulldozers and airtankers dropping chemical retardants brought annual burned acreage crashing. In California alone there was a 36% decline in area burned from the 1940s to the 1950s, the start of a trend of rapidly declining acres burned that continued until the 1980s (CalFire n.d.). This created a historically unprecedented shortage of fire on the landscape that is still adversely affecting fire-adapted ecosystems across the West.

But the post-war surge of suppression success accompanied a change in climate.
At the same time that mechanized firefighting was pushing deeper into backcountry wildlands and containing nearly all wildfires at a small size, the climate had changed. A prolonged cool, wet period from a natural cycle of climate variability called the Pacific Decadal Oscillation (PDO) greatly aided firefighters' efforts in stopping wildfire spread (Littell et al. 2009, Peterson et al. 2011). This created an unprecedented shortage of fire on the landscape during the 1950s and 60s. During this post-war period with its anomalously and artificially low level of wildfire activity, people developed a distorted perception of wildfires as absolutely bad along with a false sense of security that firefighters could put them all out (Murphy et al. 2018).

21st century climate change is making wildfires start easier and spread faster.
At the end of the 20th century that cool, wet PDO cycle ended and was replaced with much warmer and drier conditions that are now being amplified by global warming from fossil-fuel emissions. Prolonged droughts punctuated by frequent severe fire weather conditions (high temperatures, high winds, and low relative humidity) are making vegetation ignite much easier and fires spread more rapidly. Beginning in the 1980s but accelerating after 2000, the signal of anthropogenic climate change is now registering in greatly increased wildfire activity that is leading to longer fire seasons and increased amount of acres burned. But even this recent increase in large fires masks the fact that there still much less fire on the land than is necessary for maintenance of fire-adapted forest ecosystems across many Western landscapes.

21st century climate is ending the efficacy of conventional firefighting.
Conventional firefighting tactics of dumping retardant, cutting firelines, and lighting backfires cannot stop wind-blown flames from jumping over firelines or firebrands lofting in the sky and landing on flammable rooftops miles away from a wildfire's flaming front. Now that 21st century anthropogenic global warming is causing severe fire weather conditions to become more frequent, the efficacy of conventional suppression is further declining. Conventional firefighting strategies and tactics are unable to either prevent or suppress large wildfires that are now being driven by climatic conditions that will be with us for the far foreseeable future.

Suppression spending is soaring.
In response to increasing wildfire activity, both federal and state agencies have been dramatically escalating their suppression spending in recent decades. There had never been a billion-dollar wildfire season before 2000, but now it is nearly an annual occurrence. The most recent 5-year average indicates that firefighting costs have risen to almost $2 billion per year (NIFC 2020). Forest Service tactics remain rooted in a suppression-based approach that is proving more and more expensive and less and less effective in a 21th century climate. In fact, the last four years have seen the highest suppression spending in the Forest Service's existence—accompanied by huge urban fire disasters and record numbers of homes destroyed.

Expanding the fleet of airtankers would be a poor investment of taxpayer dollars.
A signature example of a costly and increasingly ineffective 20th century approach to fire suppression is the emphasis on airtankers. Airtankers are one of the most expensive resources used in wildfire suppression, but several recent studies have found that airtankers are routinely deployed at times, places, and conditions where they are least useful or effective (Stonesifer et al. 2016, Stonesifer et al. 2015, Calkin et al. 2014, Thompson et al. 2012). They are particularly likely to be impaired by high winds associated with severe fire weather. In California, airtankers are required to be grounded when there is even moderate turbulence or windspeeds exceed 35 mph. Heavy smoke is another impediment to effective airtanker use. For example, while the Camp Fire raged through Paradise, a fleet of airtankers located next door in Chico was grounded by high winds and dense smoke.

Fighting fires in backcountry wildlands depletes resources needed to protect communities.
Systematic attempts to exclude or suppress all fires regardless of whether or not they are near communities is costly to taxpayers and puts communities at risk from lack of suppression crews and resources actually protecting homes. For example, in 2016 a joint USFS/CalFire effort spent over $262 million on the Soberanes Fire that burned mostly in the Ventana Wilderness Area and became the most expensive wildfire suppression operation in U.S. history (Ingalsbee et al. 2018). A USFS internal investigation (USDA-FS 2017) concluded that the excessive spending reflected "systemic fire management issues" revolving around lack of fiscal accountability that have yet to be solved. These large expenditures on fire suppression in remote areas pull limited resources away from the actions that are most effective at preventing home loss during fires.

Recommendations:

- *Wildland fires are ecologically necessary and inevitable, but losses of life and property in urban fire disasters need not be inevitable if we adopt new fire management policies and practices suitable for 21st century climate conditions. We need to move away from 20th century mechanized fire suppression strategies, tactics, and tools (e.g., large airtankers) that are inappropriate and increasingly ineffective in the current climate.*

- *Suppression resources should be redirected away from fighting fires in remote wildlands where fire is ecologically necessary and instead focused on directly protecting communities.*

- *Invest in preparing communities to live safely and sustainably in a fire-prone environment: retrofit homes to reduce home ignitability, improve emergency communications, maintain safe evacuation routes, construct community fire shelters, bury powerlines, and implement other infrastructure projects needed to create fire-compatible communities.*

Common Myths about Forests and Fire

by Chad Hanson, PhD, Ecologist and Director, John Muir Project

Do We Currently Have an Unnatural Excess of Fire in our Forests? No. There is a broad consensus among fire ecologists that we currently have far less fire in western US forests than we did historically, prior to fire suppression (dozens of studies discussed in Hanson et al. 2015). Even a very big fire year in modern times, such as the 4-million-acre 2020 fire season in California, would have been merely average historically (Stephens et al. 2007, Baker 2017). California's forests have always burned with a mixture of intensities, including patches of high-intensity fire. We have less fire of all intensities now, including less high-intensity fire (Stephens et al. 2007, Mallek et al. 2013, Baker et al. 2018).

Do Current Fires Burn Mostly at High-Intensity Due to Past Fire Suppression? No. Current fire is mostly low/moderate-intensity in western US forests, including the largest fires (Mallek et al. 2013, Baker et al. 2018). The most long-unburned forests experience mostly low/moderate-intensity fire (Odion and Hanson 2008, Miller et al. 2012, van Wagtendonk et al. 2012).

Do Large High-Intensity Fire Patches Destroy Wildlife Habitat or Prevent Forest Regeneration? No. Hundreds of peer-reviewed scientific studies find that patches of high-intensity fire create "snag forest habitat", which is comparable to old-growth forest in terms of native biodiversity and wildlife abundance (DellaSala and Hanson 2015). In fact, more plant, animal, and insect species in the forest are associated with this habitat type than any other (Swanson et al. 2014). Forests naturally regenerate in ecologically beneficial ways in large high-intensity fire patches (DellaSala and Hanson 2015, Hanson and Chi 2021).

Is Climate Change a Factor in Recent Large Fires? Yes. Human-caused climate change increases temperatures and can exacerbate drought, which influences wildland fire. Some mistakenly assume this means we must have too much fire but, due to fire suppression, we still have a substantial fire deficit in our forests. For example, historically, snag forest habitat, from high-intensity fire and patches of snag recruitment due to drought and native bark beetles, comprised 27% to 34% of the forests in the Sierra Nevada (Baker 2014, Baker et al. 2018). Currently, based on federal Forest Inventory and Analysis data, it comprises less than 8% of Sierra Nevada forests (Hanson and Chi 2020).

Are Forests Unnaturally Dense and "Overgrown", and Do Denser Forests Necessarily Burn More Intensely? No. Our forests actually have a carbon deficit, due to decades of logging. Historical forests were variable in density, with both open and very dense forests (Baker et al. 2018). Recent studies by U.S. Forest Service scientists omitted historical data on small tree density and density of non-conifer trees. When the missing historical data were included, it was revealed that historical tree density was 7 times higher than previously reported in ponderosa pine forests, and 17 times higher than previously reported in mixed-conifer forests (Baker et al. 2018). Wildfire is driven mostly by weather/climate (Bradley et al. 2016). Forest density is a "poor predictor" (Zald and Dunn 2018).

Are Recent Large Fires Unprecedented? No. Fires similar in size to the Rim fire and Creek fire, or larger, occurred prior to modern fire suppression (Bekker and Taylor 2010, Caprio 2016).

Do Occasional Cycles of Drought and Native Bark Beetles Make Forests "Unhealthy"? Actually, it's the opposite. During droughts, native bark beetles selectively kill the weakest and least climate-adapted trees, leaving the stronger and more climate-resilient trees to survive and reproduce (Six et al. 2018). In areas with many new snags from drought and native bark beetles, most bird and small mammal species *increase* in numbers in such areas because snags provide such excellent wildlife habitat (Stone 1995).

Do Forests with More Dead Trees Burn More Intensely? Small-scale studies are mixed within 1-2 years after trees die, i.e., the "red phase" (Bond et al. 2009, Stephens et al. 2018), but the largest analysis, spanning the entire western U.S., found no effect (Hart et al. 2015). Later, after needles and twigs fall and quickly decay into soil, and after many snags have fallen, such areas have similar or *lower* fire intensity (Hart et al. 2015, Meigs et al. 2016). In the 380,000-acre Creek fire of 2020 in the Sierra Nevada, unlogged forests with the highest densities of snags from the 2014-2017 drought had the lowest fire severity, while logged areas, where live and dead trees were removed under the guise of "fuel reduction", had high-severity levels that were 8 to 10 times higher (Hanson 2021b).

Does Reducing Environmental Protections, and Increasing Logging, Curb Forest Fires? No, based on the largest analysis ever conducted, this approach increases fire intensity (Bradley et al. 2016). Logging reduces the cooling shade of the forest canopy, creating hotter and drier conditions, leaves behind kindling-like "slash" debris, and spreads combustible invasive weeds like cheatgrass.

Do "Thinning" Logging Operations Stop Wildland Fires? No. "Thinning" is used as a euphemism for intensive commercial logging projects that kill and remove many of the trees in a stand, often including mature and old-growth trees. With fewer trees, winds, and fire, can spread faster through the forest. In fact, extensive research shows that commercial logging, conducted under the guise of "thinning", often makes wildland fires spread *faster*, and in most cases also *increases* fire intensity, in terms of the percentage of trees killed (Cruz et al. 2008, 2014).

Did the Rim Fire Emit Carbon Equal to Over 2 Million Cars? No. Unpublished reports from the Forest Service and the California Air Resources Board regarding wildfire carbon emissions are based on a flawed model (FOFEM) that has repeatedly been shown to exaggerate carbon emissions by nearly threefold (French et al. 2011). Further, the FOFEM model falsely assumes that no post-fire regrowth occurs to pull CO2 out of the atmosphere. Field studies of large fires find usually only about 11% of forest carbon is consumed, and only 3% of the carbon in trees (Campbell et al. 2007), and vigorous post-fire forest regrowth absorbs huge amounts of CO2 from the atmosphere, resulting in an overall *net decrease* in atmospheric carbon within a decade after fire (Meigs et al. 2009).[1]

Would Landscape-Scale Prescribed Burning Reduce Smoke? No, it's the opposite. Prescribed fires do not stop wildland fires when they occur. Though they can briefly alter fire intensity, prescribed-burn areas can burn again in a wildfire in less than a year (Stephens et al. 2009). High-intensity fire patches produce relatively lower particulate smoke emissions (due to high efficiency of flaming combustion in higher-intensity fire patches) while low-intensity prescribed fires produce high particulate smoke emissions, due to the inefficiency of smoldering combustion. Therefore, even though high-intensity fire patches consume about three times more biomass per acre than low-intensity fire (Campbell et al. 2007), low-intensity fires produce 3-4 times more particulate smoke than high-intensity fire, for an equal tonnage of biomass consumed (Ward and Hardy 1991, Reid et al. 2005). As a result, a landscape-level program of prescribed burning would cause at least a ten-fold increase in smoke emissions relative to current fire levels if, for example, prescribed fire was conducted every 10 years in any given area, as many land managers propose (Rhodes and Baker 2008).

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[1] For example, Campbell et al. (2007) found that the Biscuit fire of 2002 emitted an average of 19 tons of carbon per hectare, and Campbell et al. (2016) found that decay of fire-killed trees in the Biscuit fire emitted an average of about 0.75 tons of carbon per hectare per year over the first 10 years post-fire (there were lower emissions from decay in subsequent decades). Therefore, for the first 10 years post-fire, the total carbon emissions from the Biscuit fire (carbon emissions from the fire itself, plus subsequent emissions from decay) were approximately 26 tons of carbon per hectare. Meigs et al. (2009) (Table 5) report that, by only five years after fire, regrowth was pulling 3.1 tons of carbon per hectare per year out of the atmosphere. Therefore, by 10 years post-fire, this equates to approximately 31 tons of carbon pulled out of the atmosphere by regrowth—i.e., an overall net increase in carbon of 5 tons per hectare relative to pre-fire levels.

California Forests, Wildfires, and Carbon

By Dominick DellaSala, PhD, Chief Scientist, Wild Heritage

California's older forests (e.g., Sillett et al. 2020) and large trees (e.g., Stephenson et al. 2014) are nature's unique climate solutions readily absorbing and storing massive amounts of carbon for centuries. Protecting the carbon stored in these and other native forests from logging is key to a climate-safe future for California. However, recent misinformed policies proposed by the State seek to elevate logging in response to wildfires, which runs counter to biodiversity conservation, climate mitigation, and may actually intensify wildfires (Bradley et al. 2016). These policies are sometimes portrayed as ways to sequester and store more carbon in forests and wood products. However, there is a better way to address pressing climate issues in California. In sum, this means protecting carbon stocks present in older forests and large trees and allowing young forests time to reach their full carbon potential (referred to as "proforestation," Moomaw et al. 2019).

Do forest fires emit massive amounts of carbon dioxide?

Most of the carbon in a forest remains on site after a wildfire (Campbell et al. 2007, Meigs et al. 2009, Mitchell 2015). Total annual emissions from wildfires over large regions are generally much less (~10% in active fire seasons) than total annual emissions from logging in the same region (Meigs et al. 2009, Campbell et al. 2012, Law et al. 2018, Oregon Global Warming Commission 2018). Some prior estimates of wildfire emissions have grossly exaggerated combustion of carbon during a wildfire. In reality, however; only a small portion of a trees' biomass (mainly twigs and leaves) is actually combusted. Moreover, about half the carbon in burned forests remains bound to the soils for nearly a century, the rest of the soil carbon builds over millennia (Singh et al. 2012). After fires, growth of surviving trees and new vegetation sequester carbon, offsetting emissions within about 5-50 years (depending on site factors; Meigs et al. 2009, Mitchell 2015).

Does logging store or release carbon?

Depending on logging intensity, forest type, and forest age class, over 80% of carbon stored in a forest is released to the atmosphere within 100 years of logging due to decomposition (or burning) with additional emissions released during transport and manufacturing of wood products especially over large hauling distances (Oregon Global Warming Commission 2018, Law et al. 2018, Hudiburg et al. 2019). A small portion of the carbon is temporarily embodied in wood product pools ranging from 1 year (paper) to decades (buildings) before decomposing and emitting CO_2 in landfills (Oregon Global Warming Commission 2018, Hudiburg et al. 2019). Instead, carbon stocks in forests can be doubled if forests are protected from logging on federal lands, timber harvest rotations extended from ~35 to 70 years on industrial lands, and other forestry improvements (Law et al. 2018). Avoiding emissions from forestry is recommended by the Intergovernmental Panel on Climate Change as an effective means for preventing warming in excess of 1.5° C globally. According to NASA's Earth Observatory (2017), California already is pushing temperature increases dangerously close to unsafe levels.

Does “thinning” reduce emissions from wildfires?

Studies of landscape-scale logging (“thinning”) to reduce the probability of crown fires show that this practice will not reduce carbon emissions under current or future climate scenarios and may in fact make matters much worse especially if thinning residues are burned as biofuels (Meigs et al. 2009, Hudiburg et al. 2009, 2011, Campbell et al. 2012, Mitchell et al. 2012, Schulz et al. 2012, Law et al. 2013). This is because the amount of carbon removed by landscape-scale thinning and related activities (e.g., road building and maintenance) is larger than that potentially avoided from a fire. Importantly, fire only occurs on a fraction of the areas thinned (Rhodes and Baker 2009, Campbell et al. 2012, Schoennagel et al 2017).

What is the carbon potential from tree-planting compared to proforestation?

While some scientists (Bastin et al. 2019) estimate planting a trillion trees globally could sequester ~200 Gt C within 100 years, others (Veldman et al. 2019) have shown that the correct number is ~42Gt C. Thus, there are better ways to increase the carbon stored in forests. It is estimated that forests currently store only half their potential carbon capacity due to repeat short-interval logging (Erb et al. 2018). Thus, land managers could double the forest carbon stock over a century by simply allowing existing forests time to reach their full carbon potential. Protecting already forested areas so they can mature via proforestation would sequester 120 Gt C by century end, nearly five times that of planting trees (Moomaw et al. 2019). Thus, compared to the “trillion trees initiative,” maintaining existing forests is a much more prudent strategy.

Conclusions

California’s forests have always benefitted ecologically from periodic mixed-severity fires that create diverse wildlife habitat (DellaSala and Hanson 2015), stimulate plant growth and nutrient cycling, and carbon sequestration. Overall, they are not a major source of emissions currently as most of the carbon remains on site after natural disturbance and new vegetation restarts uptake. Much bigger emissions are produced by logging and other industrial sectors. Thus, policies that advocate for increased logging are inconsistent with California’s otherwise ground-breaking climate change efforts, and the recommendations of the Intergovernmental Panel on Climate Change. Protecting forests from logging is a natural climate solution on par with global efforts to mitigate climate change impacts (Griscom et al. 2017). California has some of the most carbon dense forests on the planet and these forests should form the backbone of a comprehensive climate change strategy that includes avoiding emissions from all sectors especially forestry while preparing for unavoidable consequences of climate impacts.

Understanding Why Forest Biomass Energy is a Bad Idea is as Easy as P-I-E

by Shaye Wolf, PhD, and Brian Nowicki, Center for Biological Diversity

Understanding why incinerating forests to generate electricity is a bad idea is as easy as P-I-E.

Forest biomass power is:

- **Polluting**, emitting greenhouse gases, worsening the climate crisis, and harming vulnerable communities
- **Ineffective** for protecting communities during wildfires
- **Expensive** and dependent on subsidies that take resources away from truly clean energy alternatives

Fire policies in California rely heavily on efforts to increase logging to alter forest fire behavior paired with burning cut forest biomass for energy production. Biomass power is often portrayed as being carbon neutral, but it is not. Instead, biomass facilities increase greenhouse gas emissions; undermine the transition to clean, renewable power; pose public health threats in already disadvantaged communities; and distort policies for forest and fire management.

Biomass energy is more climate-polluting than coal.
Forest-sourced woody biomass energy generation emits about 50% more CO2 per megawatt-hour of electricity produced than coal-fired power and three times the CO2 of natural gas (Booth 2014). While the baseline emission rate for California's current electricity portfolio is about 485 lbs of CO2e per MWh (CARB 2020), biomass can emit more than 3,000 lbs of CO2 per MWh (Booth 2014, Center for Biological Diversity 2021), and smaller-scale facilities using gasification technology are similarly carbon-intensive (Ascent Environmental 2012).

Using forest biomass as a feedstock causes a significant negative impact to the climate.
In addition to smokestack emissions, an accurate accounting of the climate harms of biomass energy must include the carbon consequences of the tree removals that generate the feedstock. Thinning operations tend to remove about three times as much carbon from the forest as would be avoided in wildfire emissions (Campbell et al. 2011), and the removal of live trees from the forest results in a loss of future growth and carbon sequestration by those trees.

The climate damage of biomass energy can persist for decades to centuries.
Incinerating biomass for energy instantaneously releases stored carbon to the atmosphere, increasing greenhouse gas emissions and creating a "carbon debt." Numerous studies show that, even if forests cut for bioenergy are allowed to regrow, it can take several decades to more than a century, if ever, to capture the carbon that was released, and to discharge the "carbon debt." This is the case even where "waste" materials like timber residues and thinning debris are used for fuel (Searchinger et al. 2009, Manomet Center for Conservation Sciences 2010; Campbell et al. 2011, Hudiburg et al. 2011, Law and Harmon 2011, Holtsmark 2012, Mitchell et al. 2012, Schulze et al. 2012, Booth 2018, Sterman et al. 2018). Meanwhile, that carbon pollution worsens the climate crisis and contributes to the probability of passing climate tipping points, causing irreversible harms.

Biomass results in significant emissions of air pollutants, often in California's most polluted communities.

In addition to producing large amounts of CO2, biomass generation can result in significant emissions of air pollutants that harm human health (Booth 2014). Biomass emissions can exceed those of coal-fired power plants even after application of best available control technology. Many of California's biomass power plants are concentrated in vulnerable communities in the Central Valley already suffering from high pollution burdens (Center for Biological Diversity 2021). For example, the Rio Bravo biomass plant in Fresno is located less than a half-mile from the Malaga Elementary School and surrounding homes in a majority Latinx neighborhood with the state's highest pollution burden score.

Logging for biomass energy Is ineffective for protecting communities during wildfires.

Biomass energy is often promoted as a tool to incentivize large-scale tree-cutting ("thinning") under the claim that this will protect communities and forests during wildfires. However, this approach is ineffective at protecting houses and communities, which is best achieved through a home-focused fire-safety strategy that helps communities safely coexist with inevitable wildfires. Although biomass energy is promoted as a means for disposing of debris piles from forest thinning projects, it is mostly lumber mill residues from commercial logging that end up being subsidized (CalRecycle 2018). Meanwhile, biomass extraction does significant ecological damage to forests.

Policies that subsidize forest biomass divert funds from zero-carbon sources like solar and wind and impede the transition to renewable energy.

Biomass power is the most expensive of California's common electricity sources. In 2018, the levelized cost of biomass power averaged $166 per megawatt hour compared to $49 for solar and $57 for wind (California Energy Commission 2019). Yet, California requires that electricity suppliers collectively purchase 175 MW of forest-sourced woody biomass power annually.

Conclusion: Forest biomass energy is an expensive and highly polluting

Instead of promoting biomass energy that harms our climate, communities, and forests, policymakers should:

- Stop mandating, subsidizing, or otherwise incentivizing biomass power production, and instead direct investments toward truly clean energy production such as solar and wind.
- Fully account for the smokestack emissions from biomass power plants and stop incorrectly treating biomass power as "carbon neutral."
- Create climate-smart wildfire and forest policy that invests in proven home and community-focused approaches to wildfire safety rather than forest-cutting, while increasing forest protections that keep carbon stored in forest ecosystems as an essential climate solution.

To learn more, see "Forest Biomass is a False Solution" (Center for Biological Diversity 2021): https://www.biologicaldiversity.org/campaigns/debunking_the_biomass_myth/pdfs/Forest-Bioenergy-Briefing-Book-March-2021.pdf

Forest Fire Policies are Being Misapplied to Chaparral Ecosystems

by Richard Halsey, Executive Director, California Chaparral Institute

Chaparral is California's most extensive plant community. It is found in every county in the state. Characterized by drought-hardy shrubs, a Mediterranean-type climate, and infrequent, high-intensity fire, chaparral provides the habitat richness responsible for making California one of the most biodiverse regions on earth (Halsey and Keeley 2016). The chaparral's relationship to fire is dramatically different from that of California's forests. *Actions that are often proposed for addressing fire in forest ecosystems are not appropriate in chaparral ecosystems and can lead to more flammable landscapes, destruction of critical habitat, and are an ineffective approach to protecting human communities built in these areas.*

High-intensity fire is required.
The natural fire regime for chaparral is characterized by large, high-intensity crown fires with a return interval of 30 – 150 years (Keeley and Fotheringham 2001, Lombardo et al. 2009, Safford et al. 2014). Research has demonstrated that the higher the intensity of the fire, the better the chaparral is able to recover (Keeley et al. 2005a). Therefore, concerns over reducing fire intensity and severity are irrelevant to chaparral ecosystems; there's no such thing as a low-intensity chaparral fire except at the edges of fire perimeters or when localized conditions (e.g. boulders, wind shifts, moisture) reduce fire intensity. By the very nature of the physical structure of shrubs, high intensity fire is an inherent part of chaparral fires.

Long fire return intervals are required, and too much fire causes loss of chaparral.
When compared to most forests, chaparral has comparatively long intervals between fires (30 – 150 years or more). Long fire return intervals are vital for the chaparral's ecological health. It can take up to thirty years for the native shrubs to build up enough seed in the soil to provide adequate germination rates post fire.

However, increases in fire frequency due to human-caused ignitions and the effects of climate change cause chaparral stands to become more open and are often invaded by nonnative grasses. Fire-return intervals fewer than 10 years have been shown to be highly detrimental to the persistence of chaparral species (Haidinger and Keeley 1993, Jacobsen et al. 2004). As grasses increase, the flammability of the chaparral ecosystem also increases. As a consequence, a positive feedback loop is created whereby more grass encourages frequent ignitions. Such frequent fires not only eliminate the native shrubs, but they facilitate the further spread of invasive weeds and grasses due to the fact that grass fires are less intense than shrubland fires. The type conversion process can ultimately lead to the complete replacement of native chaparral with nonnative grasses (Halsey and Syphard 2015).

Prescribed burns and vegetation clearing are destructive to chaparral and increase fire.
When fire management policies commonly used in forests—such as prescribed fire and vegetation clearing—are misapplied to chaparral, the results are destructive to the ecosystem and can actually increase fire. Since there is too much fire in chaparral plant communities due to human-caused ignitions, adding more through prescribed burns only increases the threat to the chaparral ecosystem's continued existence and conversion to invasive grasses that bring more frequent fires. Furthermore, prescribed burns are typically conducted in the late spring when the ecosystem is the most vulnerable to damage: the plants are growing, the soil is still moist, and many animal species are breeding. Therefore, prescribed burns can cause significant damage to plant growth tissues and destroy seeds in the soil due to soil moisture turning into steam, leading to chaparral type conversion.

Similarly, large-scale vegetation clearing projects ("fuelbreaks") also cause the loss of native chaparral and the spread of invasive grasses that leads to more frequent fires. Amid the increasing dangers to chaparral from the effects of climate change, it is imperative that land management agencies do not exacerbate the loss of chaparral through activities like prescribed burns and large-scale habitat clearance projects away from homes. Instead, fire management in chaparral should focus on reducing the unnaturally high level of fire ignitions that has accompanied human development in this ecosystem (Keeley et al. 2005b, Keeley 2006, Syphard et al. 2007).

Focus on homes and their immediate surroundings to make fire-safe communities.

While fire's role in chaparral is different from in forests, the most effective way to keep homes from igniting during wildfires is the same in chaparral areas as in forest areas— focus on fire-safety features for homes and the zone right around them, rather than large-scale vegetation alteration in wildlands.

In a comprehensive study of the 2007 Witch Creek Fire in San Diego County, researchers found, "Wind-blown embers, which can travel one mile or more, were the biggest threat to homes in the Witch Creek Wildfire. There were few, if any, reports of homes burned as a result of direct contact with flames" from wildland fuels (IBHS 2008).

In a study examining 700,000 addresses in the Santa Monica Mountains and part of San Diego County researchers mapped the structures that had burned in those areas between 2001 and 2010, a time of devastating wildfires in the region (Syphard et al. 2012). Buildings on steep slopes, in Santa Ana wind corridors and in low-density developments intermingled with wild lands were the most likely to have burned. Nearby vegetation was not a big factor in home destruction. Looking at vegetation growing within roughly half a mile of structures, the authors concluded that the exotic grasses that often sprout in areas cleared of native habitat like chaparral could be more of a fire hazard than the shrubs. "We ironically found that homes that were surrounded mostly by grass actually ended up burning more than homes with higher fuel volumes like shrubs," Syphard said.

Working only on defensible space is not sufficient. Many homes with adequate defensible space have still burned to the ground because embers have entered through attic vents, ignited flammable materials around the home (litter in the gutter, wood stacks, wood fencing), or found their way under roofing materials (Maranghides and Mell 2009). The solution is to reduce the flammability of the home as much as possible: install ember resistant vents, Class A roofing, exterior sprinklers operated by an independent system, and remove flammable materials 100 feet from around the structure.

Myths of Prescribed Fire: The Watering Can that Pretends to be a River

by Bryant Baker, M.S., Conservation Director, Los Padres ForestWatch and Douglas Bevington, PhD, Forest Program Director, Environment Now

The use of prescribed fire—intentionally setting fires in forests and other ecosystems under planned circumstances—has received increased attention in California and elsewhere in recent years. On the one hand, it is good that there is growing recognition that fire is a natural and necessary part of forests and other ecosystems. On the other hand, current advocacy for large-scale prescribed fire across vast areas is often built on outdated assumptions and overstated claims, while downplaying problems stemming from how prescribed fire is actually being implemented. This factsheet identifies five key sets of myths regarding prescribed fire and shows how they can lead to misguided policies and missed opportunities to better accomplish public safety and ecological restoration goals in a more cost-effective manner. To create effective fire policies, we need to face these facts—*Prescribed fire increases fire and smoke. Prescribed fire is inefficient for public safety compared to home retrofits. Prescribed fire is inefficient for ecological restoration compared to managed wildfire. Prescribed fire can be harmful. And prescribed fire and cultural burning are not the same*.

Prescribed fire increases fire and smoke.

A central myth is that increasing prescribed fire will lead to less fire and smoke overall. Proponents of prescribed fire highlight examples where a portion of a wildfire halted when it encountered a previously burned area, but these anecdotes are the exception rather than the rule. The reality is that wildfires can burn through previously burned areas as soon as eight months after the prior fire (Stephens and Moghaddas 2005). Over 106,000 acres within the 2020 LNU Lightning Complex in California had burned within the previous five years, with 67,000 acres having burned just two years prior. As fire researchers have stated, *"fuel treatments are not intended to stop wildfires*" (Omi and Martinson 2004). Instead, the main goal of prescribed fire is to somewhat alter subsequent fire intensity in the affected area, though that may not occur under unfavorable weather conditions. In other words, *prescribed fire is additive to, rather than being a substitute for, wildfire.* Even in instances where prescribed fire has been found to limit wildfire extent, the acreage of a prescribed burn significantly exceeds the acreage of subsequent wildfire reduction, with 3-4 units of prescribed fire needed to reduce wildfire by one unit (Fernandes 2015). Furthermore, the effects of prescribed fire on wildfire behavior fades within a few years. Within as little as 2 or 3 years after prescribed fire, combustible understory vegetation can return to levels equal to or greater than levels prior to prescribed burning (Knapp et al. 2007). Thus, prescribed fires would need to be reapplied on a regular basis, repeatedly adding fire to many places that otherwise might not encounter a wildfire until many years in the future. For all these reasons, *increased use of prescribed fire will likely lead to a net increase in the total amount of fire* (Hunter and Robles 2020).

With that additional fire comes additional smoke. Proposals to implement *landscape-wide prescribed fire could result in ten times as much smoke* (Hanson 2021a; see also p. 12 in this report). In addition to increasing the total amount of smoke, *increasing prescribed fire also increases the duration of smoke* *exposure*. While wildfire smoke is concentrated in the height of fire season—and landscape-scale use of prescribed fire would not preclude this—prescribed fires are typically lit in the "shoulder seasons" when wildfires are less likely, and thus prescribed fires prolong smoke exposure into times when it would not otherwise occur. There can be circumstances where it is appropriate to use prescribed fire, but it should be done knowing that the effect will be an overall increase in the amount and duration of fire and smoke.

Prescribed fire is inefficient for public safety compared to home retrofits.
Prescribed fire is an inefficient and relatively ineffective way to protect homes and communities during wildfires. As Dr. David Lindemayer recently summarized, *"The peer-reviewed evidence is that burning forest miles from houses doesn't protect those houses*" (Foley 2021). As discussed above, prescribed fires generally do not stop subsequent wildfires, and altering fire intensity is largely irrelevant to community safety because home ignitions during wildfires are rarely caused by direct contact with high-intensity fire (Cohen and Stratton 2008, Syphard et al. 2017). Instead, home fire-safety retrofits ("home hardening") offer the most effective ways to keep communities safe during wildfire. Yet the resources to help communities with fire-safety retrofits are currently quite limited compared to the government funding for prescribed fire and associated "fuel treatments" in wildlands. For example, in California's 2021 proposed budget for wildfire preparedness, *less than 4% of the funding is directed to "community hardening"* (LAO 2021). While prescribed burning adjacent to communities can potentially have some benefits, proposals to use large-scale prescribed fire across vast landscapes away from communities represent a remarkably indirect and inefficient way to protect houses when compared with the direct benefits of home retrofits.

Prescribed fire is inefficient for ecological restoration compared to managed wildfire.
One positive outcome of the greater attention on prescribed fire is that it has contributed to growing recognition that fire is a necessary part of forests and other ecosystems, and that currently many forests have a shortage of fire compared to levels prior to modern fire suppression. Unfortunately, many advocates for prescribed fire rely on an *outdated "good fire/bad fire" dichotomy that is out of step with the science*. In this false dichotomy, prescribed fires are characterized as "good" because they are associated with low-intensity fire, whereas wildfires are characterized as "bad" because they are associated with mixed-intensity fire that includes some areas of high-intensity fire. However, there is a growing body of research showing that high-intensity fire has always been a part of forests and other ecosystems, and it produces ecological benefits by creating excellent wildlife habitat and stimulating nutrient cycling (DellaSala and Hanson 2015). In contrast, low-intensity fire associated with prescribed burning does not generate the habitat creation and the nutrient cycling associated with higher-intensity fire. *Each type of fire intensity has its role in a mixed-intensity fire regime, and low-intensity fire is not a substitute for the benefits from some higher-intensity effects in forests*.

Another myth repeated by some prescribed advocates is the erroneous notion that forests that previously experienced fire suppression will now "burn up" in all or mainly high-intensity fire when a wildfire occurs, unless those forests first get prescribed fire or other "fuel treatments." But multiple studies have shown that areas that experience wildfire following long periods of fire suppression still burn mainly at low and moderate intensity, along with some high-intensity patches that provide the benefits described above (Odion and Hanson 2008, Miller et al. 2012). In fact, research has found that forests with the longest fire exclusion actually burn at somewhat lower intensity (Odion et al. 2010). *This is exciting news for efforts at ecological restoration because it means that large-scale prescribed fire or other "treatments" are not needed as a precondition to allowing mixed-intensity wildfire back into forests*.

Instead, *managed wildfire offers a much more efficient way to restore fire to forests that currently have a shortage of fire*, and this has economic and practical benefits. Managed wildfire (also known as wildland fire use) differs from fire suppression in that, rather than trying only to extinguish a wildfire, fire managers seek to shepherd the fire away from communities and into wildland areas where the fire will provide ecological benefits. This is less intensive and costly than full suppression. Likewise, managed wildfire differs from prescribed fire because the latter has an extensive planning process and often quite restrictive parameters before a prescribed fire ignition can occur, whereas managed wildfire works with natural fire ignitions to provide more fire where it is needed in a more expeditious manner.

This is not to say that prescribed fire does not have a role in fire policy, but instead that role has been overstated. Prescribed fire is a useful tool when there are special circumstances where fine-scale control over fire is needed. In this regard, prescribed fire has a role equivalent to the role of watering can. A watering can is a good tool for tending the plants around your house, but *if you are faced with a dry field in need of irrigation, it would be absurd to propose buying thousands of watering cans. Yet this is basically equivalent to current proposals relying mainly on prescribed fire to restore fire to vast areas*. Instead, the right way to water a large field is through large-scale irrigation—a river, not a watering can—and the most efficient way to restore fire to large landscapes is through managed wildfire. Yet, despite its benefits, managed wildfire currently gets surprisingly little attention in current fire policy discussions, compared to prescribed fire.

Prescribed fire can be harmful.

Prescribed fire is sometimes called "good fire" by its proponents, but the reality is that, while it can be useful in some circumstances, *prescribed fire can also cause ecological damage*. One example is when prescribed fire policies get applied to non-forest ecosystems such as chaparral, Great Basin sagebrush, or pinyon-juniper woodlands. Research over the past few decades has established that these ecosystems naturally and historically burned infrequently, with several decades or even centuries between fires (Floyd et al. 2004, Baker 2006, Mensing 2006, Keeley and Zedler 2009, Baker and Halsey 2020). In these ecosystems, the use of prescribed fire can shorten fire-free intervals needed for slow-growing shrubs to re-establish, and such fire conducted outside of the natural fire season can inhibit seed germination for many species while favoring growth of non-native plants that can be more flammable (Parker 1987, Le Fer and Parker 2005, Baker 2006, Syphard et al. 2006).

Prescribed fire can also be harmful in forests, especially when done outside of the main fire season. Wildlife have evolved strategies to coexist with summer forest fires, but prescribed fires are often lit in the spring when bird eggs and nesting chicks cannot get away from fires (Hanson 2021a). There can also be significant ecological damage when logging ("thinning") is treated as a prerequisite for prescribed fire. On national forests, this means that Forest Service projects involving prescribed fire can also include substantial amounts of logging that damages wildlife habitat. Furthermore, logging results in cut vegetation debris that then gets piled up and burned. *The Forest Service is now calling this pile burning* *"prescribed fire,"* but it causes sustained burning in a concentrated location that can scorch and sterilize the soil, and it does not produce the beneficial post-fire wildlife habitat created during genuine forest fire restoration (Korb et al. 2004). *In light of these potential harms, projects involving prescribed fire should not be exempted from proper environmental review*.

Prescribed fire and cultural burning are not the same.

As attention on prescribed fire has grown in recent years, there has also been broader awareness that Native Americans have long traditions of applying fire to the land in practices known as cultural burning. Cultural burning was outlawed or severely restricted when federal and state policymakers imposed their wildfire suppression policies on Indigenous peoples. Now some Indigenous groups seek to restore their ability to do more cultural burning. Traditionally, burning has been done for a variety of purposes, including stimulating the growth of plants that are particularly useful to their communities, such as for basket-weaving or food production. In this regard, traditional cultural burning is notably different from current approaches to prescribed fire from the Forest Service and other agencies that primarily focus on trying to suppress forest fire intensity across vast areas. Yet, the Forest Service's approach to prescribed fire often gets conflated with traditional cultural burning in discussions of fire policy. This can result in cultural appropriation that superimposes Forest Service goals on Tribal practices. The evidence is clear that, prior to modern fire suppression policies, *Native American cultural burning and mixed-intensity forest fires were both much more common than they are now* (Odion et al. 2014, 2016, Vachula et al. 2019, Wahl et al. 2019). *They coexisted, and one did not preclude the other*. Both have been suppressed and marginalized by federal and state agencies.

Conclusion—The disappointing results of prescribed fire

When all is said and done, *the actual results from broad-scale application of prescribed fire would likely be disappointing for most people*. Those who thought it would reduce fire would instead experience more fire and smoke from large-scale prescribed burning. Those who are concerned about public safety would realize that communities would have been much safer if the money used to subsidize backcountry prescribed fires and associated "fuel treatments" had instead been focused on directly assisting with fire-safety home retrofits as part of a home-outward strategy. Those who want to help ecosystems would realize that managed wildfire offers a more efficient and practical way to restore fire to forests, whereas prescribed fire is often tied to increased logging. And those who want to support Tribes' cultural burning would find traditional practices getting appropriated by federal and state agencies. *While prescribed fire can have some benefits in special circumstances, it is important to not overstate the role of prescribed fire—a watering can should not pretend to be a river—or we risk missing more effective and cost-efficient solutions using managed wildfire, traditional cultural burning*, and *home fire-safety retrofits.*

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