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Forest fire policy: change conventional thinking of smoke management to prioritize long-term air quality and public health

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Abstract Wildland fire smoke is inevitable. Size and intensity of wildland fires are increasing in the western USA. Smoke-free skies and public exposure to wildland fire smoke have effectively been postponed through suppression. The historic policy of suppression has systematically both instilled a public expectation of a smoke-free environment and deferred emissions through increased forest fuel loads that will lead to an eventual large spontaneous release. High intensity fire smoke is impacting a larger area including high density urban areas. Policy change has largely attempted to provide the avenue for increased use of ecologically beneficial fire but allows for continued reliance on suppression as a primary tool for a smoke averse population. While understanding the essential role of suppression in protection of life and property, we dispute the efficacy of attempting to eliminate smoke exposure through suppression in a fire prone area to protect human health at the population level. Sufficient consideration to future negative health outcomes needs to be considered in fire management decisions. It is likely that long term air quality is inextricably linked to ecosystem health in the Sierra Nevada. We contend that landscape use of ecological fire is essential to forest and human health. Radical change is needed where beneficial wildland fire smoke is treated as natural background and exempted from much of the regulation applied to anthropogenic sources. Tolerance of the measured release of routine smoke emissions from beneficial fire is needed. Using present air quality standards in the more remote areas will provide an opportunity to increase burning in many forests while protecting public health.

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Wildland fire has long been understood to perform many beneficial ecosystem functions (Kilgore 1981; Stevens et al. 2014) including helping to maximize carbon sequestration in fire-prone areas (Hurteau et al. 2008). Recurring lower intensity wildland fire additionally limits fire spread, reduces fire progression (Parks et al. 2015), and may provide an avenue to control high-severity emissions of smoke (Steel et al. 2015), localizing the subsequent health impacts, decreasing exposure and population at risk. Past fire management policy has primarily been intended to prevent or contain wildland fire with the consequence of reducing ecological integrity in fire-adapted ecosystems (Dellasala et al. 2004). Climate change will likely contribute to increased fire size and frequency while also increasing the length of the fire season (Westerling et al. 2006). Although suppression at times is the correct response to protect life and property, currently, it has the potential to be the default management action. This suppression bias in wildland fire fighting is a product of institutional practice from over 100 years of full suppression. Additionally, fire managers are influenced by political matters such as zero tolerance for an escaped prescribed fire, failure to achieve desired objectives of a managed lightning fire, and pressure from a public that is conditioned to expect smoke free skies and fires that can always be fully suppressed.

Future policy will likely continue to be based almost exclusively on property protection and suppression unless the entrenched disincentives of current policy are overcome and proactive use of ecologically beneficial fire is supported (North et al. 2015a). Full suppression is the path of least resistance, given the current fire management environment, where managing a fire often comes with additional

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complexities. These include smoke management and the additional temporary monitoring, nuisance complaints, airshed capacity limits, and public health concerns as well as increased local political pressure, lack of public support, and limited resources (both personnel and monetary). There is always a reason not to burn (Boer et al. 2015) and current policy reinforces this by creating a path where managed fire can happen but the default remains suppression (Thompson et al. 2015). Policy has adjusted as the natural role and function of fire has become better understood and the policy discussion continues (Topik 2015; North et al. 2015b). This includes smoke management plans at state and local levels that attempt to allow for more burning. At the federal level, legislation such as the Exceptional Events Rule (2007) has provided guidance that has not been consistently applied across all regions of the USA.

Smoke from wildland fire is one of the many reasons there is a reluctance to use fire as a resource tool. Air quality will likely become a more significant factor in the decision process as the public is confronted with additional smoke and more nuisance complaints are generated. Research on smoke from wildland fire has primarily focused on health impacts from exposure during large canopy replacing events. This easily leads the public and health officials to an assumption that all wildland fires have the same impacts to air quality. Currently, there is a limited understanding of the tradeoffs between more frequent use of smaller fires versus larger higher intensity fires that are fully suppressed and the product of full suppression.

Without understanding the impacts from wildland fire smoke under historic or natural fire regimes, it is easy to understand how suppressing all emissions for public health would appear to be sound policy. Unfortunately, this is a short-term solution where future emissions and forest health are essentially ignored and priority is given to restricting wildland fire emissions as much as possible with the assumption that future fire will not occur.

The Sierra Nevada of California example

The Sierra Nevada and adjacent areas of California are particularly compelling example of where wildland fire policy collides with air quality and public health policy. The combination of large tracts of federally protected land including multiple wilderness areas in the fire-adapted ecosystem of the Sierra Nevada bordered by the densely populated Central Valley of California, which has some of the worst air quality in the country (independent of wildland fire emissions), provides a crucible through which land and air managers attempt to navigate. In practice, air regulators are often confined by political boundaries which many times have little practical value for air quality determination when dealing with wildland fire emissions. Pollutants monitored at large urban areas are assumed to represent entire districts. Blanket policy and action options handcuff regulators to make decisions about wildland fire emissions in the wilderness in the same context as industrial, agricultural, or vehicle emissions in an urban area. Air basins which include large tracts of federally protected land within these districts can be considered for regulatory purposes non-attainment even when they are below federal and state thresholds (Cisneros et al. 2014). This leads regulatory decisions to favor suppression and allow burning only under certain meteorological conditions. These conditions of "good dispersal" are often simply when the smoke is blowing out of their district.

Anthropogenic emissions in the Central Valley leave little to no room for air managers to accommodate any increase in pollutant emissions. The perception that any wildland fire creates unwanted air quality impacts that would otherwise not occur also restricts air management decisions. The concept that ecologically beneficial wildland fire could be managed to minimize public health impacts from smoke is difficult for policy makers to embrace. The necessity to limit emissions today to meet air quality attainment and for protection of public health continually pressures land and air management to limit wildland fire smoke whenever possible, reinforcing suppression bias when managing wildland fire. Our ability to limit smoke today through suppression is giving a false sense that wildland fire smoke can be completely eliminated.

The Clean Air Act (CAA), the primary enabling legislation on air quality management, is intended to protect human health from the mounting dangers to the public health and welfare from growth in the amount and complexity of air pollution brought about by urbanization, industrial development, and the increase use of motor vehicles in the expanding metropolitan and other urban areas. Fire policy could meet CAA intentions by managing emissions through the use of ecologically beneficial fire today, reducing the risk of large emission events in the future from continued fuel accumulation and ecosystem degradation.

Impacts from fire suppression have the potential to greatly increase both smoke emissions and the subsequent impacts to public health by radically altering the current ecological system and its ability to self-regulate fire size and intensity. The large canopy replacing suppression fires becoming more frequent in the Sierra Nevada are creating more smoke that is impacting a larger geographic area and subsequently including more densely populated areas. Increases in both the spatial extent and exposure from large fires not typical of the Sierra Nevada will result in an increased potential for negative health impacts that would not occur with increased use of ecologically beneficial fire. Actively managing wildland fire can improve forest health and provide the best long-term air quality.

Wildland fire and the subsequent extent and impacts of smoke have increased since the beginning of widespread monitoring of air quality in California. This is due to uncontrolled

wildland fires that have increased in size and intensity, impacting a larger area with an increased population. Megafires like the Rim and King Fires impacted regional air quality including multiple urban centers in addition to local communities. This increase is due to fire suppression, which has both temporarily limited emissions and increased fuel loads—creating a backlog of wildland fire emissions (Hurteau and North 2009) that will likely be increased with expected future climate scenarios (Hurteau et al. 2014). Smoke historically was present throughout the Sierra Nevada for much of the summer and fall as high-frequency ground fire was needed to sustain the Sierra Nevada ecosystem mosaic (Swetnam et al. 2009; Baker 2014). The routine emissions from this higher frequency fire likely made the spatial extent of these smoke events smaller and more localized.

The Central Valley of California frequently exceeds federal and state air quality standards. Air pollution is prevalent in this relatively economically poor area of California. This environmental injustice, primarily driven by anthropogenic emissions of air pollutants, may be subjected to further impacts through the historic fire management policy of fire suppression in the adjacent Sierra Nevada. As federal land managers attempt to restore fire to the landscape, pressure is increased from air managers who have no capacity to increase emissions in an already polluted air shed. This short-term protection of human health may be leading to the degradation of environmental health. A more comprehensive decision needs include the mid- and long-term impacts of this policy. We may very well be reducing the immediate human health impacts from smoke but it comes at the expense of future generations who will face increased exposure. It is very possible without immediate and aggressive re-introduction of natural fire to the landscape, large high intensity fires such as the Rim Fire (2013), King Fire (2014), and Rough Fire (2015) that highly impact air quality over heavily populated areas will be the new normal.

Wider policy suggestions

It is likely the best long-term air quality is inextricably linked to ecosystem health in the Sierra Nevada and our current predisposition to suppress wildland fire is leading to adverse impacts to long-term forest health that is not being adequately represented in the decision process. The Sierra Nevada fire-adapted ecosystem may be the most obvious example of the failure of full suppression, but the warnings from this system may be the best indicator for other wilderness areas where it is less obvious. This is not to say suppression is not needed. Suppression is necessary to protect life and property and indeed should be well-funded to protect communities, but when a wildland fire originates in and has little to no potential to burn outside of wilderness or into communities, why utilize limited funding and put fire personnel into harms way suppressing it? Wilderness fires performing ecologically beneficial results in these areas could be allowed to burn by directing fire and air management to first consider the longer ecological benefits. Smoke will inevitably impact air quality no matter how or when it is emitted but could be managed to federal $PM_{2.5}$ compliance in the Sierra Nevada (Schweizer and Cisneros 2014). The Exceptional Events Rule can be used to help air managers during smoke events in wilderness. Further, the backlog of emissions from the management action of fire suppression in wilderness areas seems particularly appropriate when considering an exceptional event impact to air quality.

Although policy does not typically try to control natural events like blizzard and hurricanes, to some degree, we can control this natural process, which has led to the accumulation of fuels from past fire suppression. Wildland fire is inevitable and smoke is coming. Further insight into smoke-created public health impacts is necessary to create a more informed decision through the understanding of the nuances encountered when trying to manage fire size, intensity, and proximity to populated areas. After all, are the consequences on air quality worth the trade-off for an ecologically beneficial wildland fire or is a single air pollution event from a stand replacing fire in the best interest of public health?

Radical change is called for when regulating wildland fire smoke emissions for air quality and public health. The more localized smoke impacts from fire of historic size and intensity should be encouraged. The impacts to human health must take into consideration that suppression of these fires is deferring the risk to the future. Not only are ecological benefits often lost but each large, high-intensity wildland fire (Cisneros et al. 2012) will impact a much larger area than the smaller, lower-intensity burns (Schweizer and Cisneros 2014). It is easy to understand how high-intensity fire emissions even from remote locations will then increasingly impact high-density urban areas as larger portions of the forest burn quicker lofting and dispersing the increased emissions more regionally as has been witnessed increasingly throughout the western USA. Local land and air managers need the support of sound policy. Current policy needs to be fundamentally changed so as to incorporate long-term sustainability of air quality in and around areas with a fire-adapted ecosystem. Tolerance of routine emissions from wildland fire smoke both from the public and managers is needed. Natural ignition ecologically beneficial wildland fire may best be treated as natural background and exempt from much of the regulation necessary for anthropogenic sources. Regulating to present standards (i.e., 3-year average concentrations for $PM_{2.5}$) in the more remote areas where the ecologically beneficial fires typically burn would provide an opportunity to increase burning in many forests while protecting public health. Understanding smoke impacts and public health advisories to protect exposure during any event is necessary and should be increased to better

understand the presence and absence of impacts across the landscape.

Public awareness to potential long-term benefits from ecologically beneficial fire is easily overlooked because of the immediate difficulties of tolerating smoke. An increase in public awareness of the complexity of wildland fire decisions based on air quality is absolutely necessary to provide the public support needed to allow landscape level reintroduction of fire. It is much easier, from a smoke tolerance point of view, for fire and air managers to suppress fire and remove the potential of immediate public health consequences and nuisance complaints, but policy makers need to question the path of full suppression and ask the question—is fire suppression the most appropriate way to protect air quality or just the easiest way for us today to handle a difficult decision while we mortgage the health of future generations?

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