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Insights from wildfire science: A resource for fire policy discussions

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Record blazes swept across parts of the US in 2015, burning more than 10 million acres. The four biggest fire seasons since 1960 have all occurred in the last 10 years, leading to fears of a 'new normal' for wildfire. Fire fighters and forest managers are overwhelmed, and it is clear that the policy and management approaches of the past will not suffice under this new era of western wildfires. In recent decades, state and federal policymakers, tribes, and others are confronting longer fire seasons (Jolly et al. 2015), more large fires (Dennison et al. 2014), a tripling of homes burned, and a doubling of firefighter deaths (Rasker 2015). Federal agencies now spend $2 to $3 billion annually fighting fires (and in the case of the US Forest Service, over 50% of their budget), and the total cost to society may be up to 30 times more than the direct cost of firefighting. If we want to contain these costs and reduce risks to communities, economies, and natural systems, we can draw on the best available science when designing fire management strategies, as called for in the recent federal report on Wildland Fire Science and Technology. Here, we highlight key science insights that can contribute to the public discourse on wildfire policy and associated management of forests, woodlands, and shrublands. This information is fundamental to decisions that will promote resilient communities and landscapes facing more fire in the future.

 http://headwaterseconomics.org/wildfire/insights
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1. Fire size and frequency will increase under a warmer and drier climate

Weather and climate are the primary determinants of the total acreage burned in nearly all western forests, woodlands and shrublands (Littell et al. 2009, Jolly et al. 2015, Jin et al. 2015). While past human activities—like fire suppression or logging—can fuel bigger, hotter fires, these effects are small compared to the role of drought, temperature and wind on annual area burned. Centuries of evidence of past fire activity from tree-ring and lake-sediment records clearly show that more total area burns during warm periods than during intervals with cool or average climate conditions (Kitzberger et al. 2007, Marlon et al. 2012, Calder et al. 2015). As the climate continues to warm, our knowledge of the past tells us that more area will burn across the West. *Because climate's influence on wildfire is so strong, we are facing an inevitable trend of increasing annual area burned, and will need to learn how to adapt to more wildfire.*

2. Fuel reduction on federal lands will do little to reduce acreage burned and homes lost

Efforts to "thin the threat" and expand fuels reduction treatments (e.g. thinning and/or prescribed fire) on federal lands are often promoted to reduce the flammability of wildlands and save homes. Increasing the pace and extent of fuel treatments is a valuable goal because treatments can sometimes reduce fire severity and assist tactical firefighting locally (Hudak et al. 2011). However, the costs of thinning are high and the operational challenges are considerable, limiting where, and the extent to which, treatments are feasible (Calkin et al. 2015, North et al. 2015, Boer et al. 2015). Furthermore, federal fuel management programs do not have jurisdiction to directly mitigate fire risk on private lands, where the threat to public safety and property is most acute. By some estimates, private land accounts for 52 million acres of forests considered to be at highest fire risk across the Western states (American Forest Foundation, 2015) and most land in and around western communities is private, limiting federal agency ability to treat near homes (Schoennagel et al. 2009). *We will never be able to treat enough land to alter the trend of increasing acreage burned, but prioritizing federal fuel treatments around communities and creating better mechanisms for reducing fuels on private land can help reduce home loss and better protect communities.*

3. Not all forests need restoration

The need for forest restoration to undo the effects of past fire suppression is often invoked in fire policy discussions, yet only some landscapes need such restoration (Schoennagel et al. 2004). Restoration is often appropriate in dry forests where logging and fire suppression since the 1950s have shifted open, park-like forests to less patchy, dense forests today. The increased and more continuous fuel loads have shifted fires from past frequent low-severity to present-day high-severity events (Stephens et al. 2013, Hessburg et al 2015). For example, in some forests dominated by ponderosa pine, thinning and prescribed fire can help restore low tree density, reduce fuel continuity, lower fire severity, and provide important ecosystem services such as watershed protection, climate modulation, wildlife habitat, scenery, recreational opportunities, and wood products.

Not all western forests need restoration to remedy effects of past fire suppression. In contrast to dry and formerly open low-elevation forests, moister and cooler high-elevation forests naturally support high tree densities and fires of mostly high severity. Here, forest densities have changed little from their pre-suppression-era condition; therefore, such restoration is not needed. A large portion of western forests fall in between these two extremes, and the restoration need in such mid-elevation, mixed-severity-fire forests is highly variable and the subject of active debate. Climate change may also render restoration less important than adaptation and mitigation in many natural systems, since future environmental conditions may or may not resemble those of the past. In short, not all forests are equally "out of whack" due to past fire suppression, and the need for restoration is not universal.

4. High severity fires often have ecological benefits

High-severity fires are the norm in many systems, such as chaparral, lodgepole pine and spruce-fir forests. While it is easy to understand why humans perceive severe fires as "catastrophic", severely burned landscapes are neither "destroyed" nor "lifeless" in terms of their ecological integrity. Many plant and animal species require recently blackened forests of standing dead trees to persist (Bond et al. 2012, Hutto et al. 2015) and are clearly adapted to high-severity fire. For example, the black-backed woodpecker's association with blackened trees is reflected in its jet-black coloration, and its prey (the jewel beetle) detects newly burned forest using its infrared heat sensors. These animals, and others, reflect a long evolutionary history between organisms and severe wildfire. Such adaptations also confirm what we know from tree-ring and lake-sediment records, namely, that severely burned conditions have occurred for millennia across a broad range of shrublands and forests throughout the West (Whitlock et al. 2008, Keeley et al. 2011). Large severe fires often create complex patterns in which much of the burned area is close to unburned seed sources. In these landscapes, trees and/or shrubs naturally re-establish soon after fire without active post-fire restoration efforts (Turner et al. 1994, Kemp et al. 2015). *Severe fire is not necessarily ecologically catastrophic, but rather a natural mechanism of renewal and diversity.*

5. Insect outbreaks do not necessarily make fires worse

In the last 15 years, tiny, native insects called bark beetles have killed trees on more than 47 million acres of forest in the western US. But just like fires do not burn every tree, beetle outbreaks vary widely in their impacts, with many areas only lightly affected. Beetle outbreaks have occurred periodically for millennia, and forests that have co-evolved with these insects recover well from outbreaks without management intervention. Expensive programs to remove insect-attacked trees, even in remote areas, have been proposed out of understandable fear that the dead trees will fuel large fires. However, data show that *bark beetles have little influence on the occurrence (Hart et al. 2015) or severity of forest fires in the 10 to 15 years after the trees have died (Harvey et al. 2014)*. In high-elevation and high-latitude forests (where many of the worst outbreaks have occurred), high-severity wildfires are the norm, so bark beetle activity rarely makes those fires more severe than fires occurring in the absence of bark beetle outbreaks. In general, weather and climate are the key drivers of fire occurrence; large severe fires are more likely when it's hot, dry and windy, regardless of beetle outbreaks.

6. Land-use planning can reduce wildfire risk

Most firefighting risks and costs are directly related to protecting communities from active wildfires, especially during warm dry years, when widespread fires threaten many communities at the same time (Morgan et al. 2008, Rasker 2015). However, most fire policy and management to date has focused on taming fire risk in relatively undeveloped landscapes, not on directly reducing risk to communities. *Better community planning efforts and homeowner practices will keep people and structures out of harm's way* (Moritz et al. 2014, Calkin et al. 2014). Strengthening national programs like Fire Adapted Communities, Fire Adapted Communities Learning Network, and FIREWISE, will help homeowners select fire-resistant building and landscaping materials and encourage routine yard maintenance within ~200 feet of their homes. Social science indicates stronger incentives for builders and local governments will create more fire defensible developments that would ultimately reduce costs to taxpayers (Rasker 2015). Some cities have already adopted community planning tools to reduce wildfire risk: San Diego enforces strict brush management regulations, the Flagstaff fire department uses a successful Wildland Urban Interface development code to protect properties, and Santa Fe applies stringent fire-safe regulations on new developments to protect its watershed. There's ample opportunity for land-use planning to play a positive role—84% of Wildland Urban Interface lands in the West do not yet have homes (Gude et al. 2008), and future fire risk greatly depends on how or if such areas get developed.

7. Managing more fires to burn safely can reduce risk and increase ecological benefit

Fire fighters suppress at least 95% of all fires, but managing some fires to burn safely is one important way to reduce future wildfire threat and increase ecological benefit (Calkin et al. 2015, North et al. 2015). Natural or prescribed fire today can help prevent worse fires tomorrow—flames consume debris and live fuel, often limiting the places where new fires can burn (Prichard et al. 2014, Parks et al. 2015). Monitoring and managing fires that occur under moderate climate conditions can restore landscapes, aid vegetation recovery, and may reduce the risk of large severe fires during extreme conditions. *Strategic planning for future fires is a crucial part of integrated fire management, where fire can restore and maintain healthy natural systems with minimal threat to people, their homes, and the places they value.*

Conclusion: Learning to live with wildfire

We can live with fire (Moritz et al. 2014, Hessburg et al. 2014) and we must. As the West is demonstrating, wildfire is part of our past and will also be an important part of our future. Relevant wildfire science can help us plan for and adapt to living with wildfire.

As wildfire scientists, we want to share relevant insights from fire science as a resource to policy makers. We take our 'social contract' as scientists seriously (Lubchenco 1998), and seek to contribute information in support of a policy process that helps promote resilient communities and landscapes facing more fire in the future. Research indicates that wildfire will continue to increase in frequency and extent as the climate warms. Targeted fuel reduction treatments can help reduce risk to residential communities and restore landscapes affected by past fire suppression, but cannot overcome the increasing trend in acreage burned. Science indicates that past beetle outbreaks do not significantly increase the chance or severity of fire. Because fire is a mechanism of ecological renewal and diversity, allowing space and time for fire-adapted forests and shrublands to burn and recover from fire is important to maintain the landscapes we and other species depend on. Given the natural role of fire in the West, managing prescribed and naturally ignited fires to burn will help reduce future wildfire threats and increase ecological benefits in many systems. Better fire and forest management is part of the solution, but the most effective changes in terms of protection of people and property, will be near homes and on private property. Fire-smart land-use planning, building, and landscaping are essential to creating fire-adapted communities that can survive and thrive despite inevitable wildfire. Policy guidelines such as the National Cohesive Strategy are beginning to recognize fire as fundamental to healthy landscapes. Further integration of relevant insights from wildfire science can lead to more robust policy and practice.

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