R&D
USDA Forest Service
Pacific Southwest Research Station

Research Brief: Restoring fire can protect air quality by minimizing unhealthy smoke

Fire is an inevitable and ecologically important process that maintains the health of forest ecosystems in the Western United States. A century of fire suppression has increased fuel loads to the point that inevitable wildfires often burn too fast and too hot to be contained, thus overwhelming suppression efforts. In response, national forests in the West are increasingly using large prescribed fires, as well as allowing the moderate spread of unplanned wildfires under favorable conditions, to make forests more resilient to drought, bark beetle outbreaks, and wildfires under extreme conditions. Land and resource management plans for many of these national forests are undergoing revisions that are likely to increase the use of fire in wildlands to achieve resource objectives. Such efforts create a growing challenge for land managers and air regulators who are charged with minimizing impacts to air quality in nearby communities.

When fire is used under favorable weather and fuel conditions, large areas of forest can be restored while keeping daily emissions below levels that are likely to harm people downwind of the fire. Forest Service scientists in California recently demonstrated the effectiveness of that strategy with a case study from the central Sierra Nevada. They suggested and then applied a framework for evaluating smoke impacts by accounting for the number and vulnerability of people in areas that may be affected by wildland fire smoke, rather than simply counting the total area burned or total emissions generated. They found that many people in California and Nevada were likely exposed to the enormous plumes of smoke from the Rim Fire in 2013 (fig. 1). That extreme event had a smoke impact per unit area burned that was several times greater than fires used to achieve resource objectives in the same area around Yosemite National Park between 2002 and 2013.

Brian Smithers

National Weather Service

Figure 1—The Rim Fire of 2013 generated enormous smoke plumes that extended from California (left) to distant urban areas such as Reno, Nevada (right), exposing millions of people to unhealthy air quality and restricting their outdoor activity.

Strategically using wildland fires to achieve objectives reduces the potential for harmful smoke impacts for several reasons:

- In forests where fuel loads have been strategically managed through treatments or recent fires, and under appropriate weather and fuel conditions, fires often spread moderately, emit less pollution per day, and produce fewer pollutants per unit area by avoiding the increased consumption of logs and tree crowns that occurs during severe fires.
- Once a fire is underway under suitable conditions, managers can also accelerate ("push") fire spread when weather lofts smoke away from communities (fig. 2), or can slow them down ("pull") when dispersion is less favorable.
- Using fires under favorable conditions allows for more advance warning of potential smoke impacts and helps members of the public to reduce their exposure to potential harm.
- Over time, managers can prioritize prescribed fires, appropriate use of wildfire, and other fuel treatments in places and times to create landscape-scale "anchors" that can constrain both the extent and rate of spread of future wildfires.

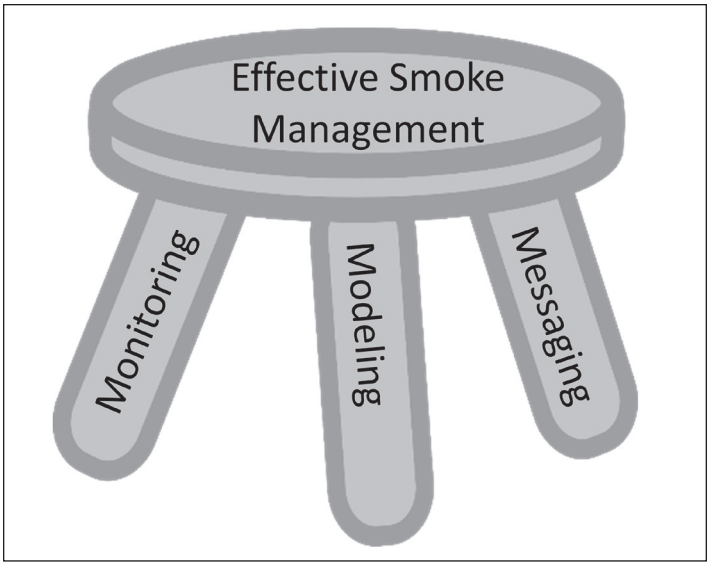

Figure 3—Modeling, monitoring, and messaging work together to support effective smoke management.

Figure 2—Managers in Yosemite National Park "pushed" the Grouse Fire to spread when dispersion was favorable, including times at night, to minimize smoke impacts.

Applying the framework to reduce smoke impacts, rather than area burned, relies upon a combination of modeling, monitoring, and messaging (fig. 3).

First, modeling of fires and smoke can inform planning and demonstrate tradeoffs in deciding how to use fire. Managers and regulators can collaboratively use various tools, including the BlueSky framework (https://www.airfire.org/bluesky/), to predict daily emissions from a fire, project the dispersion of the resulting plumes and downwind concentration of pollutants in exposed human communities, and then evaluate the size and vulnerability of those populations. Those predictions can help to identify and warn populations when and where potential smoke impacts might occur. Such advance notice is important to minimizing smoke exposure.

Second, monitoring (including remote sensing and air quality sampling) is critical for managing prescribed fires to avoid harmful impacts, demonstrating whether fires caused subsequent impacts, and validating the accuracy of fire modeling.

Third, messaging is valuable in helping communities better understand the importance and strategic benefits of using fire in forest wildlands. Messaging is also critical for advising the public what they can do to reduce their exposure to smoke and informing them when conditions are favorable for outdoor activity.

Assigning Air Resource Advisors to aid managers on both prescribed fire and wildfires can help reduce impacts using all three legs of effective smoke management. They improve public communication and support fire planning, risk analysis, and operations to minimize smoke exposure.

Because extreme, fast-spreading wildfires can generate so much smoke so quickly and affect large populations, smoke risk is one of the most important, yet underappreciated, aspects of forest and fire management. The social and economic impacts of extreme wildfires and their smoke in terms of human health, safety, suppression costs, emergency response, and impacts to daily activities are expected to grow unless we can stem the tide through more proactive strategies. By encouraging fires to spread moderately under favorable conditions, rather than releasing that pent-up energy when conditions are extreme, we can protect human communities while still using fire to help restore our forests.

For more information, read this journal article:

Long, J.W.; Tarnay, L.W; North, M.P. 2017. Aligning smoke management with long-term ecological and public health goals. Journal of Forestry. 115. https://www.fs.fed.us/psw/publications/jwlong/psw_2017_long002.pdf.

or contact its authors: Jonathan Long, research ecologist (jwlong@fs.fed.us); Leland Tarnay, (ltarnay@fs.fed.us); or Malcolm North (mnorth@fs.fed.us).