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Science FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

Polishing the Prism: Improving Wildfire Mitigation Planning by Coupling Landscape and Social Dimensions

Bureau of Land Management

A prescribed fire in western Oregon helps to reduce wildfire risk as it burns accumulated fuel in this wildland urban interface. New research describes the benefits of broadening the scale of community wildfire protection plans so they better align with the scale of the local fireshed.

IN SUMMARY

Effectively addressing wildfire risk to communities on large multi-owner landscapes requires an understanding of the biophysical factors that influence risk, such as fuel loads, topography, and weather, and social factors such as the capacity and willingness for communities to engage in fire-mitigation activities. Biophysical and social processes often are disconnected in wildfire mitigation planning frameworks because of mismatches in scale. The different spatial and temporal scales of these processes usually are not recognized in the planning process. Forest Service scientists Alan Ager, Jeff Kline, and Paige Fischer (now with the University of Michigan) show how scale mismatches can undermine community wildfire mitigation planning, and how using a coupled analysis of biophysical and social factors can lead to more effective outcomes.

Typically, risk assessments focus on estimates of the probability and magnitude of adverse events. The scientists describe a coupled biophysical-social systems approach that leverages biophysical and social sciences to augment and improve existing wildfire mitigation planning. It describes a new way of defining wildfire protection planning boundaries based on the scale of wildfire risk, rather than administrative and political boundaries. Communities show their strength when pulling together after a disaster; the challenge is to revise the way we approach and deal with fire risk so that communities can pull together to take preventative action before a disaster.

"A hidden connection is stronger than an obvious one."
—Heraclitus (c.536-470 BC)

Attitudes toward wildfires have changed dramatically over the long history of the Forest Service. Gone are the days of the so-called 10 a.m. policy, which decreed that every newly reported fire should be suppressed by 10 a.m. the following morning. Fire is now seen as integral to forest ecosystems, ultimately providing key services such as clearing the forest floor, creating new habitat, reducing disease, and opening the way for new generations of trees and plants.

In this, human life and property need to be protected. An expanding wildland-urban interface, climate change, and the legacy of past fire suppression add further complexity to the picture.

For more than a decade, the Community Wildfire Protection Process (CWPP) has helped communities and land managers make great strides when it comes to reducing the risk of fire. The CWPP framework dates back to the 2003 Healthy Forests Restoration Act and has been used by thousands of communities. Local stakeholder groups that apply the CWPP process receive state and federal assistance and have the opportunity to influence fire-prevention activities on nearby federal land.

Work remains to be done in reducing risk. More than 34,000 homes were destroyed by wildfire in the United States between 2003 and 2012, a span in which the annual bill to fight fires ranged from $1 to $2 billion.

Under its broad mission to sustain the health, diversity, and productivity of the nation's forests, the Forest Service now spends over half its budget fighting fires, often using money earmarked for fire prevention. And surely the starkest measure of all is the human cost—seven firefighters died in the line of duty in 2015.

Longer fire seasons and "uncharacteristically" severe fires are becoming the norm. This poses a major problem given that housing developments are expanding into fire-prone wildlands, a result of population growth, exurban development, and Internet access, which allows more people more choice in where they work, including in proximity to beloved wild landscapes.

Alan Ager, a Forest Service scientist with a focus on national forest planning, wondered if part of the community protection problem could be traced to the existing community protection planning process.

With support from the National Fire Plan and the National Science Foundation, Ager and his colleagues Jeff Kline and Paige Fischer began exploring a new means to improve mitigation planning on fire-prone landscapes. This new approach makes use of new computer tools to better simulate how fire might travel across a landscape and how people and communities in that landscape might act beforehand to reduce fire-related risk. Their work has been published in various refereed journals, including the November 2015 issue of *Risk Analysis*.

"Unfortunately, wildfire risk modelers don't spend a lot of time talking to social scientists, so it's no surprise that the disciplines are disconnected in science and management" says Ager, who has spent a decade modeling wildfires, first with the Pacific Northwest (PNW) Research Station, and now with the Rocky Mountain Research Station.

Working with Kline, a research forester with the PNW Research Station, and Fischer, a social scientist, also with PNW Research Station at the time, Ager explored options for better defining the scale of wildfire risk, which turned out to extend beyond the areas covered by most wildfire protection plans, potentially contributing to ineffective planning and continued wildfire losses.

KEY FINDINGS

- The boundaries for community wildfire protection planning are defined by administrative or political boundaries that may be unrelated to the scale of wildfire risk transmission to communities or the social factors that influence risk mitigation behavior among private landowners.
- Recent advances in wildfire and social science can improve planning by enabling planners to map large wildfire risk transmission across landscapes and among landowners, and describe landowners' likelihoods to mitigate risk based on biophysical, socioeconomic, and social network factors.
- Opportunities for risk management could be better identified by: (1) mapping firesheds based on the biophysical risk surrounding communities; (2) using network analyses to identify risk transmission relative to both federal and private lands; and (3) determining the likelihood that private landowners will mitigate fire risk.

Jeff Kline

Forest managers and community leaders need improved ways to target limited wildfire risk-mitigation funds to reduce the likelihood of severe wildfires, such as this one, ignited by lightning in southwestern Oregon.

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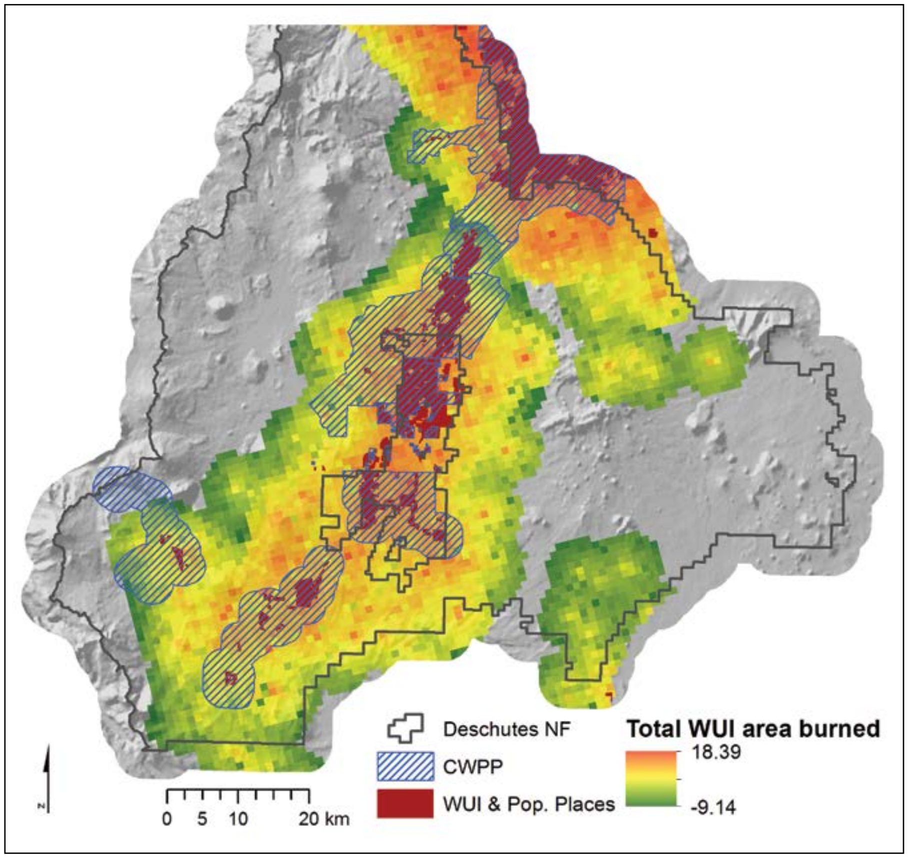
BROADENING THE BOUNDARY

Today, CWPPs define a planning boundary in which flammable vegetation is thinned to create firebreaks and buildings are upgraded with nonflammable materials. However, the boundary often extends no more than 1.5 miles beyond a community's edge, as per guidance in the planning guides.

"There is plenty of evidence that suppression is ineffective during extreme blow-up events that occur with huge fires," says Ager. "Fuel conditions need to be changed for many miles around communities to stop these blow-ups from occurring in the first place."

Extreme may be an understatement. These increasingly common megafires can burn across 30 or more miles before they reach a community, along the way raging through a patchwork of forest and fuels and—most significantly—property lines and forest management regimes. The current planning process does not typically consider who owns the risk across these vast fire-prone areas, or if these owners are likely or even able to reduce fuels and thus risk. The scientists note that the area of wildfire exposure around communities is often more than 50 times larger than the community itself. In some cases, these areas include federal lands where mechanical fuel treatments are prohibited or highly restricted—as in, for example, federally designated wilderness or roadless areas, which encompass 43 percent of the area of 82 western U.S. national forests.



Source: Ager et al. 2015

Map of the southern half of the Deschutes National Forest in central Oregon showing the boundaries of: (1) community wildfire protection plans (CWPP), the areas marked by blue diagonal lines; (2) the wildland-urban interface (WUI), the areas in red; and (3) the "fireshed," the multi-colored orange-green areas showing how simulated wildfires on this national forest might burn into the populated WUI area. The relatively small size of CWPP boundaries are dwarfed by the estimated fireshed.

A second problem is potentially much thornier, as it concerns human behavior. Earlier research by Fischer suggests that among people living in fire-prone areas, there is wide variation both in awareness of wildfire risk and the capacity to reduce it. Current CWPP efforts don't account for this variation, which the social scientists can map and predict with at least some degree of certainty. Information on local ecological conditions, and land parcel attributes and uses, can be used to calculate the vulnerabilities of diverse groups.

But the real problem is the disconnect between social and biophysical domains of risk—the risk transmission from large fires on fire-prone, fragmented landscapes and the web of social ties among the people and communities who call these forests home. Both realms, trees and people, matter when it comes to nearly any fire risk, but especially within the larger context of the large fires that can burn hundreds of thousands of acres and cause huge losses around the wildland-urban interface (WUI). According to one estimate, the WUI, loosely defined as a landscape on which structures and flammable vegetation potentially merge in a wildfire-prone environment, has grown at the rate of 2 million acres per year across the country.

"What we're trying to point out is that there's this big disconnect in how we plan and work as a society to mitigate wildfires," says Kline. "Realistically, I don't think federal budgets are going to allow us to 'treat' our way out of the problem by reducing forest fuel via thinning and prescribed burning. So we as a society are going to have to learn how to live with wildfire. Part of that involves learning to be very strategic in how we expend the limited dollars we have for managing wildfire risk."

NETWORKING AROUND FIRESHEDS

Being more strategic starts with taking advantage of the best new science from various disciplines, much of which depends on powerful algorithms and computer coding skills.

Ager and his colleagues cite new tools that make it possible to describe and chart wildfire risk on a large scale. In this era of big data, precise information is available on past wildfires that allows fine-scale calibration of simulation models. This information can be used to run many thousands of computer simulations on how future fires might behave, allowing planners to create a picture of risk that contains both a much broader perspective and more fine-grained detail than do current planning efforts.

The simulations reveal firesheds, which are delineated areas of fire-prone landscapes roughly analogous to watersheds. The models are sophisticated and powerful enough to then take a closer look within the boundaries of the fireshed, highlighting responsible landowners and coupling this information on the capacity, willingness, and likelihood of each of them to manage fuels and reduce risk.

Making better predictions about human behavior is getting easier all the time, in part because of better social-science tools such as network analysis. Epidemiologists routinely use such tools to build maps of social networks to understand how diseases spread. Similarly, wildfire mitigation efforts could include maps of social connections among private property owners, local land management agencies, and conservation and natural resource groups, and highlight the degree to which they communicate information and risk.

The information that flows through these networks influences risk perceptions among landowners and land managers. Reading about a crown fire is one thing. Knowing someone who has witnessed up close this most intense kind of fire, which races through the tree canopy in a firestorm, is something else altogether.

Consider two ways of looking at central Oregon, home to the 1.8 million-acre Deschutes National Forest. The first is a map of the region showing the mix of public and private ownerships across the landscape, which is increasingly fire prone. The second is a wildfire transmission network derived from simulation outputs for the same region. Depicted graphically, the nodes in the network represent landowners, and the line weight represents the predicted annual fire exposure transmitted between the nodes in a simulation.

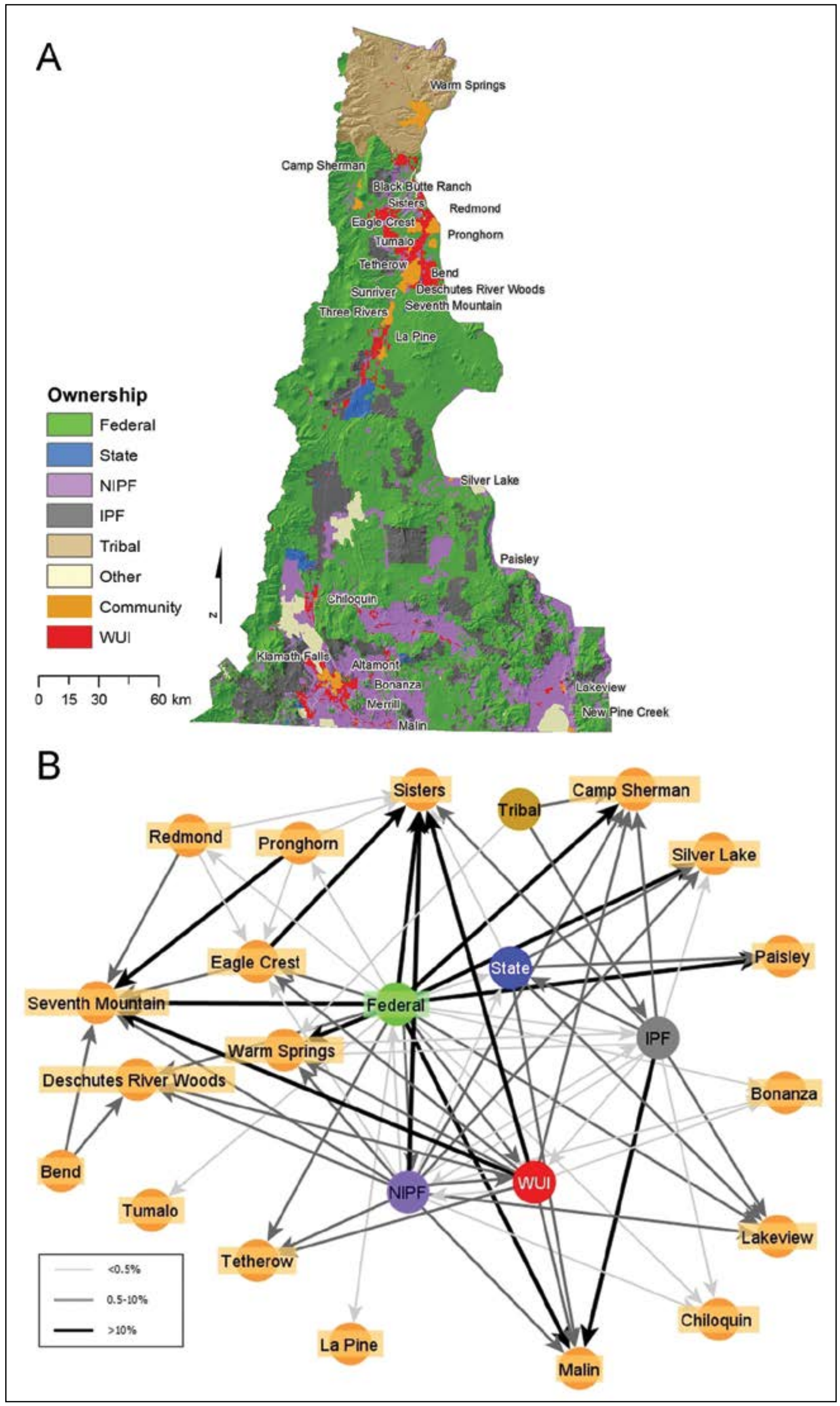
"Risk networks show who owns the risk, and how risk is shared among landowners and between landowners and communities; it's the starting point for a dialogue about managing risk from large fires," says Ager.

Ager is applying network analysis to wide swath of communities and WUIs across the western United States to identify locations where wildfire risk transmission and capacity for risk mitigation overlap, and thus where opportunities exist for reducing wildfire risk.

On the social side, Fischer built a more intricate map of actors in a wildfire governance network in Oregon. Groups that interact are closer to each other than they are to groups that do not interact. Her work illustrates that groups that focus on forest restoration, and those that focus on fire protection, don't interact nearly as much as they should.

"The different actors across a landscape may think that they're working with others, but network analysis provides the empirical evidence of whether those relationships actually exist, and also the nature of those relationships and whether they are strong enough to actually foster coordination," says Fischer.

Ultimately, the goal of these researchers is to merge the two ways of looking at a landscape—one showing networks of risk based on fire behavior, and the other showing the social structures that overlap with the land and must work together to reduce risks.



Source: Ager et al. 2015

(A) Map of land ownership in central Oregon showing the mix of public and private ownerships across a fire-prone landscape.
(B) Wildfire transmission network derived from simulation outputs for central Oregon. The nodes in the network represent landowners, and the link weight represents the predicted annual fire transmitted between the nodes from simulation expressed as a percentage of the area parcel. IPF = industrial private forest; NIPF = nonindustrial private forest; WUI = wildland-urban interface.

Combining the social and fire networks could help communities and landowners define conflicts and opportunities for reducing long-term wildfire risk.

Says Ager: "Every community has a different risk problem in terms of who owns the risk, how it arrives at the community, and what can be done about it. Some communities are aware of the high wildfire risk in their area, but don't have the resources or money to do anything about it. Other communities are in denial—wildfires are a relatively rare event for individual communities, which contributes to poor risk perception. Some communities are exposed to potential wildfires from wilderness areas, and traditional fuel-reduction projects are not an option—only wildfires themselves will reduce future risk. The idea is to peel back the layers of this social-biophysical system to understand what's the best future course and how state and federal agencies can help get them on this course, rather than just drawing a half-mile buffer around the community and saying 'let's cut a few trees down, put in some hydrants, and clean our roofs.'"

LAND MANAGEMENT IMPLICATIONS

- Wildfire risk management opportunities can be identified by examining the juxtaposition of wildfire risk transmission and the capacity and likelihood that landowners will conduct mitigation activities. Biophysical-social assessments within firesheds are a key step in identifying localized comparative advantages in mitigation.
- Wildfire mitigation planning could partition wildfire risk within firesheds among major land ownerships according to mitigation capability. Locations where wildfire risk transmission and risk mitigation potential coincide would indicate places where the most significant opportunities exist for reducing wildfire risk.
- Areas where high risk of wildfire transmission coincides with low mitigation potential by landowners could benefit from targeted policy interventions, such as education and technical assistance, to facilitate efforts among private landowners to reduce wildfire hazards.

FOUR STEPS

Ager and his colleagues suggest a four-step fireshed assessment: run simulations to map perimeters of firesheds; describe the connectivity of the landscape within the fireshed, particularly in terms of ownership and management capability (for example, noting if regulations limit what can be done inside wilderness areas); conduct a social network analysis and add to the map locations where property owners are more or less likely to mitigate risk; and consider the social and biophysical information together to assess the problem strategically.

Some elements of this approach already exist. For example, wildfire simulation and risk modeling tools are quite advanced, though generally not used in local planning efforts. Other tools need further development, especially sociological aspects, given the large number of organizations that are involved in community protection planning and their relationships with community members.

Ager and his colleagues note just how many factors go into developing and implementing effective fuels management on large landscapes. A major one is the cost of fuel reduction treatments, which often turn out to be a barrier to building fire-adapted communities and fire-resilient landscapes.

The issue of economics is key," says Fischer. "Even if you've observed a risk, if it costs too much to transport whatever material comes out of the forest to the wood processing facility so you won't have any net income at the end, you might not do anything."

"All of the pieces need to fit together—social risk perception, public policy, economics, stakeholder engagement—and a lot of other pieces, besides," adds Ager.

The scientists are now building and studying wildfire risk networks for over 5,000 communities in the western United States. Social information has been gathered on over 200 communities, and the Forest Service has funded a 5-year project to characterize wildfire transmission networks and various community types based on social factors that influence mitigating wildfire potential. The study is contributing to decisions about allocating hazardous fuels funding to individual national forests that potentially expose specific communities to wildfire.

At smaller scales, detailed studies are being conducted in individual communities that will help revise local community wildfire protection planning. Ager, Kline, and Fischer have submitted a National Science Foundation proposal to further develop and test ideas about socioecological networks and wildfire-risk governance on fire-prone landscapes.

"I read about how communities come together after large fire disasters," Ager notes. "Our challenge is to change risk governance so they get together and take preventative action before these events, rather than after."

"The more sand has escaped from the hourglass of our life, the clearer we should see through it."

—Johann Paul Friedrich Richter (1795)

WRITER'S PROFILE

Geoff Koch is a dad, science writer, and poet in Portland, Oregon, where he is usually frustrated in some capacity by all three roles.

FOR FURTHER READING

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JEFF KLINE is a research forester and economist with the PNW Research Station. His research examines the effects of population growth and land use change on forests and their management, as well as related changes in how the public uses and values forests. Much of his recent work has involved working with interdisciplinary teams of scientists to examine how biophysical and socioeconomic data and methods can be combined to address the wildfire issue.

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PAIGE FISCHER, formerly a social scientist with the PNW Research Station, is now an assistant professor at the University of Michigan. Her research aims to increase scientific understanding of human behavior as it relates to the sustainability of socioecological systems. She is interested in understanding what motivates individuals and organizations to cooperate on natural resource management and environmental conservation.

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