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Science

FINDINGS

“Science affects the way we think together.”

Lewis Thomas

FORESTS AT RISK: INTEGRATING RISK SCIENCE INTO FUEL MANAGEMENT STRATEGIES



Years of fire suppression combined with hotter and longer summers have many forests poised for unusually large and severe fires. Forest managers are struggling to find ways to thin the fuels and reduce the risk of uncharacteristic wildfires.

“The most extensive and serious problem related to health of national forests in the interior West is the over-accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires.”

—General Accounting Office 1999

On Forest Service land, about 75 percent of all wildfire ignitions are squelched before they burn a single acre; 99 percent are extinguished before they reach 300 acres. With over 100 years of experience, the agency is masterful at wildfire suppression. Nonetheless, the country’s attention is rightfully focused on the 1 percent of wildfires that get away. These are the ones

we hear about on the news: the ones that escape the agency’s best efforts and blow up under extreme weather conditions—low humidity, high temperature, gusty winds—and scorch tens or even hundreds of thousands of acres.

Under these extreme weather conditions, the fate of an escaped wildfire is largely determined by fuels, topography, and weather. Of these, only fuels can be managed. So it’s no wonder that in this era of increasingly large and severe wildfires, land managers across the West have ramped up their efforts to reduce forest fuel loads.

“The threat posed by wildfire in the West is well recognized, but the most efficient long-term solution is a hot topic of debate,” says Alan Ager, an operations research analyst at the Western Wildland Environmental Threat Assessment Center in Prineville, Oregon. “The question is: how can agencies like the Forest Service best allocate money and effort over the long run to reduce wildfire risk?”

Foresters have long understood how to treat forest fuels to reduce the intensity of wildfires. By lowering the density of trees and removing surface and ladder fuels that elevate fire into the canopy, the risk of high-intensity fire can be reduced. Data suggest that the benefits of fuel treatments can last more than a decade. There is far less understanding, however, about the optimal placement of these types of fuel treatments to reduce fire risk over large landscapes.

IN SUMMARY

The threat from wildland fire continues to grow across many regions of the Western United States. Drought, urbanization, and a buildup of fuels over the last century have contributed to increasing wildfire risk to property and highly valued natural resources. Fuel treatments, including thinning overly dense forests to reduce fuel and lower fire risk, have become a priority for land managers. Planning fuel treatments on public lands is a complicated problem. Treatments must address multiple management objectives that are often conflicting and burdened with regulatory constraints.

Researchers at the Western Wildland Environmental Threat Assessment Center are building tools to streamline the fuel treatment planning process, and applying concepts from the risk sciences to better measure the potential benefits of landscape fuel treatment designs. The risk-based approach combines information about fire spread, fire intensity, and change in resource value into a single measure that can be used to communicate the potential benefits of fuel reduction. These risk-analysis methods are being incorporated into the Fireshed Assessment process, in which multiple stakeholders can propose management options and see how those options affect fire risk in real time. This collaborative approach to planning is being embraced by land managers across the country.

FIRESHED PLANNING

In the past, fuel treatments targeted potential fire behavior in specific stands and rarely considered how large fires spread throughout the landscape. Yet it makes sense that the landscape perspective is important when the bulk of the area burned is from a few large fires that spread over long distance. Another problem is that wildfires spread across ownership boundaries, thus land managers need to coordinate fuel treatment programs with a diverse group of stakeholders. Faced with the problem of large fires and multiple landowners and stakeholders all vying for a seat at the planning table, Forest Service



Fireshed planning is a collaborative process in which fuel managers and landowners can interactively design fuel treatment scenarios and then test their effectiveness in near real time with virtual wildfires generated by fire simulation models.

PUTTING IT TOGETHER

Meanwhile, Ager and several colleagues were working on a forest landscape management project with the La Grande Ranger District in the Blue Mountains in eastern Oregon. Ager observed the planning teams struggling with a confusing array of wildfire models and data sources to design and test fuel treatments. The problems were similar to those faced by the Fireshed teams in California.

“Designing fuel treatment projects on large landscapes is a long complicated process, and all the parts have never been adequately linked together,” says Ager. Frustrated with the options available, Ager proposed a vision of an integrated, modular toolbox for landscape fire planning to the interagency Joint Fire Science Program, which funded the project.

Ager set out to build a package that would automate the Fireshed planning process

KEY FINDINGS	
• The wildfire risk assessment process considers the spread and intensity of large fires and change in resource value in a probabilistic framework that offers managers a consistent and quantitative measure to evaluate fuel treatment scenarios.	
• A case study on the Five Buttes project on the Deschutes National Forest demonstrated a wildfire risk analysis for the northern spotted owl where models indicated that fuel treatments on just 10 percent of the landscape reduced the probability of habitat loss by about 40 percent.	

employees in California developed a process called “Fireshed Assessment” as a means for designing landscape-level fuel treatments in a collaborative and interactive setting.

“The Fireshed process was ahead of its time, and was intended to build consensus among stakeholders about landscape wildfire issues and fuel treatment strategies. By providing an interactive forum to simulate and test fuel treatment strategies, managers can balance among often competing objectives,” says Ager. “It begins with the delineation of geographic units with similar wildfire risk issues. Then, in real time, fuel treatments are located on digital maps with input from land managers and landowners, and then tested with wildfire simulation models to examine the treatment’s effect on wildfire spread and intensity.”

and streamline forest landscape planning. The result is ArcFuels—a software package that operates within an existing geographic information system (GIS) called ArcMap. “ArcFuels makes it easy to leverage an array of wildfire programs and the power of GIS routines to quickly build and test treatment scenarios in a collaborative setting,” he says. Stakeholder groups can keep running through scenarios until some consensus develops on the best fuel treatment configuration.

At the same time, Mark Finney, a research forester at the Forest Service Fire Lab in Missoula, Montana, was tackling the issue of using wildfire models to help locate treatments to best block the path of large fires. The result was a new version of the FlamMap fire simulation program. Fast and relatively simple to use, FlamMap allowed planners to model the treatments in the face of large fires on large landscapes. This was exactly what

In addition to the participants, each assessment requires a number of support staff, including geographic information specialists, database analysts, and fire modelers, and a comprehensive library of vegetation and other natural resource data. Nonetheless, collaboration is so important to federal forest planning that the Forest Service Washington, DC, office (WO) initiated a pilot program called SPOTS (Spatially Optimized Treatments) to help mainstream the Fireshed process across the Nation.

“When we first observed Fireshed Assessments, the process was still a bit clunky,” says Ager. “The right tools did not exist to really model the landscape fire behavior and actually pull off real-time collaborative planning with all the stakeholders in the room. It was a great idea, but technically, there was room for improvement.”

the Fireshed planners needed. FlamMap made it possible to measure the offsite benefits that previously were speculative and impossible to quantify.

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RISKY BUSINESS

“Wildfire occurrence is a highly random event,” explains Ager. “Predicting the location of the next large wildfire is impossible.” This makes planning extremely challenging and is the reason Ager and others are turning to the risk sciences to further help fuel planners. “Once we had ArcFuels and FlamMap, we could build and simulate lots of interesting treatment alternatives, but the issue became which treatment package is best at reducing wildfire risk?”

Risk science was developed to deal with uncertainties and randomness, making it a perfect match for wildfire planning and fuels management. Nonetheless, Ager’s recent work is one of the first efforts to formally integrate risk science into a Forest Service fuels management project.

“Wildfire risk has two parts: the likelihood an area will burn and the resulting change in ecological or financial value if it does,” explains Ager. “Our definition of wildfire risk is the product of the probability of a fire at a specific location by the change in financial or ecological value.”

Finney had already realized that better measurements were needed for fuel treatments, and had added routines to the FlamMap program to enable simulation of thousands or tens of thousands of wildfires on a landscape, generating a map that indicates the probability of a fire burning in a specific location. This “conditional probability” represents the



Many factors influence the ignition, spread, and intensity of wildfires, and the precise location of future large fires is impossible to predict. Researchers are using concepts from the risk sciences to cope with this uncertainty and quantify the likelihood of a fire that results in damage to resources and property.

likelihood of a specific point burning given a random ignition. FlamMap also generates a distribution of fire intensities at each point.

The second part of the risk equation relates to the consequences of the burn. “Fire is not always a bad thing,” says Ager. “Many ecosystems rely on frequent low-intensity fires as a natural process. So, in the risk equation, we need to consider the net effect of wildfire—both positive and negative.”

Ager says there is still one missing part of the risk equation—the loss functions that relate fire intensity to losses and benefits. Once those functions are in hand, the risk science approach can be used to determine which fuel treatment scenario is best at reducing wildfire risk to specific resources of concern.

A PLANNING PARADOX

Ager, Finney, and colleagues recently used their risk assessment framework to investigate ways to conserve habitat on the Five Buttes area in the Deschutes National Forest for the northern spotted owl—a threatened species famously linked to multistoried, old-growth forests.



Fuel treatments in the dry forests east of the Cascade Range use selective thinning to create stands of late seral, fire-adapted species with relatively low amounts of canopy and surface fuel.

Managers trying to protect spotted owl habitat in drier forest, such as those found on the east side of the Cascades, are faced with a paradox. On one hand, wildfire accounted for 75-percent of the loss of spotted owl habitat between 1994 and 2003, and it is widely believed that fuel treatments are needed to improve the long-term protection of habitat. On the other hand, spotted owls prefer dense, multistoried forests—precisely the characteristics that increase the risk of high-severity fire and would be targeted by fuel treatments.

“Our results suggested that by strategically locating fuel treatments to control fire spread, managers could significantly reduce fire risk within spotted owl habitat without ever entering the spotted owl habitat stands,” says Ager.

The scientists defined risk to owls as the probability of a wildfire burning with sufficient intensity to eliminate habitat

characteristics. They then simulated 2000 wildfires that included multiple configurations of fuel reduction treatments—all relegated to outside actual spotted owl habitat. By utilizing natural fire breaks, such as lakes and lava flows, and strategically locating fuel treatments to interrupt the flow of fire, they were able to significantly reduce wildfire risk to owl habitat without ever altering the habitat itself.

“Fuel treatment on 20 percent of the forested landscape resulted in a 44-percent decrease in the probability of spotted owl habitat loss,” says Ager.

To Ager, these findings are as much a “proof-of-concept” as they are a solution to the spotted owl and fire paradox. “The methods we developed can be directly applied toward the conservation of any wildlife species for which we know their habitat requirements in terms of forest tree species and size,” he says.

GETTING THE WORD OUT

“Specialists on national forests charged with analysis of alternative fuel treatments remain largely baffled by the array of existing tools, their functionality, required data formats, and how they can be leveraged for project-level work,” says Ager. “Our wildfire risk assessment framework and ArcFuels focuses on the design and simulation of landscape-scale fire behavior and evaluation of fuel treatment scenarios.”

And that is why there has been a growing demand for training in Fireshed Assessments with ArcFuels. So far, six hands-on workshops in California and the Pacific Northwest were conducted to demonstrate and apply the risk analysis framework on specific fuel treatment projects. The workshops combined the mechanics of designing and analyzing landscape fuel treatment strategies with wildfire analysis and concepts from the risk framework. At the completion of the workshops, participants were able to design and analyze management scenarios with ArcFuels and FlamMap. Trainings have included personnel from several federal agencies, including the National Park Service and Bureau of Land Management, as well as the Nature Conservancy and other landowners.

“It’s not like we’ve been out knocking on doors either,” says Ager. “Word is spreading and people are contacting us to arrange trainings. We are also starting to see federal land managers include burn probabilities and the word “risk” into their planning documents, so we can tell that this approach is catching on.”

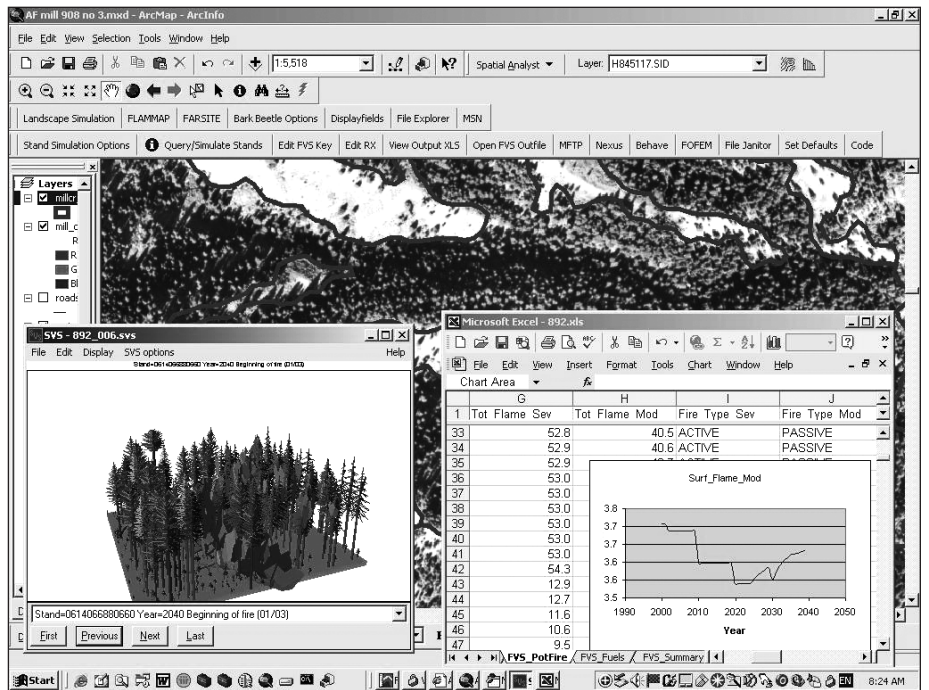
“Much of what we’ve accomplished was simply matching up the right data and the right models with the right people and showing them how to make it all work,” he adds.

The latest workshop was nicknamed “RapidSPOT” and was co-sponsored by the WO Fuels Planning Group. Last November, 11 fuel planning teams from around the country came to Portland, Oregon, with data in hand for their proposed fuel treatment projects. Over 3 days, the teams used ArcFuels and FlamMap to design landscape fuel treatment projects using the latest tools.

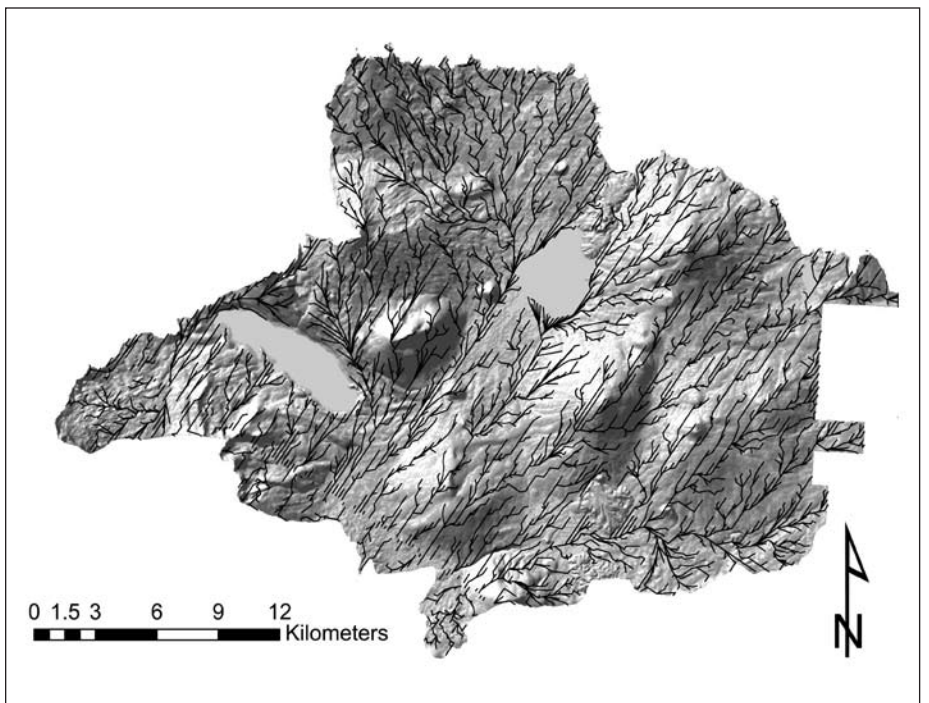
Not surprisingly, Fireshed Assessments are now being hailed by many as the balanced solution to mitigating fire risk where there are many stakeholders operating in a contentious environment—a situation that is increasingly common throughout the West.

“We shall never be able to escape from the ultimate dilemma that all our knowledge is about the past, and all our decisions are about the future.”

—Ian Wilson



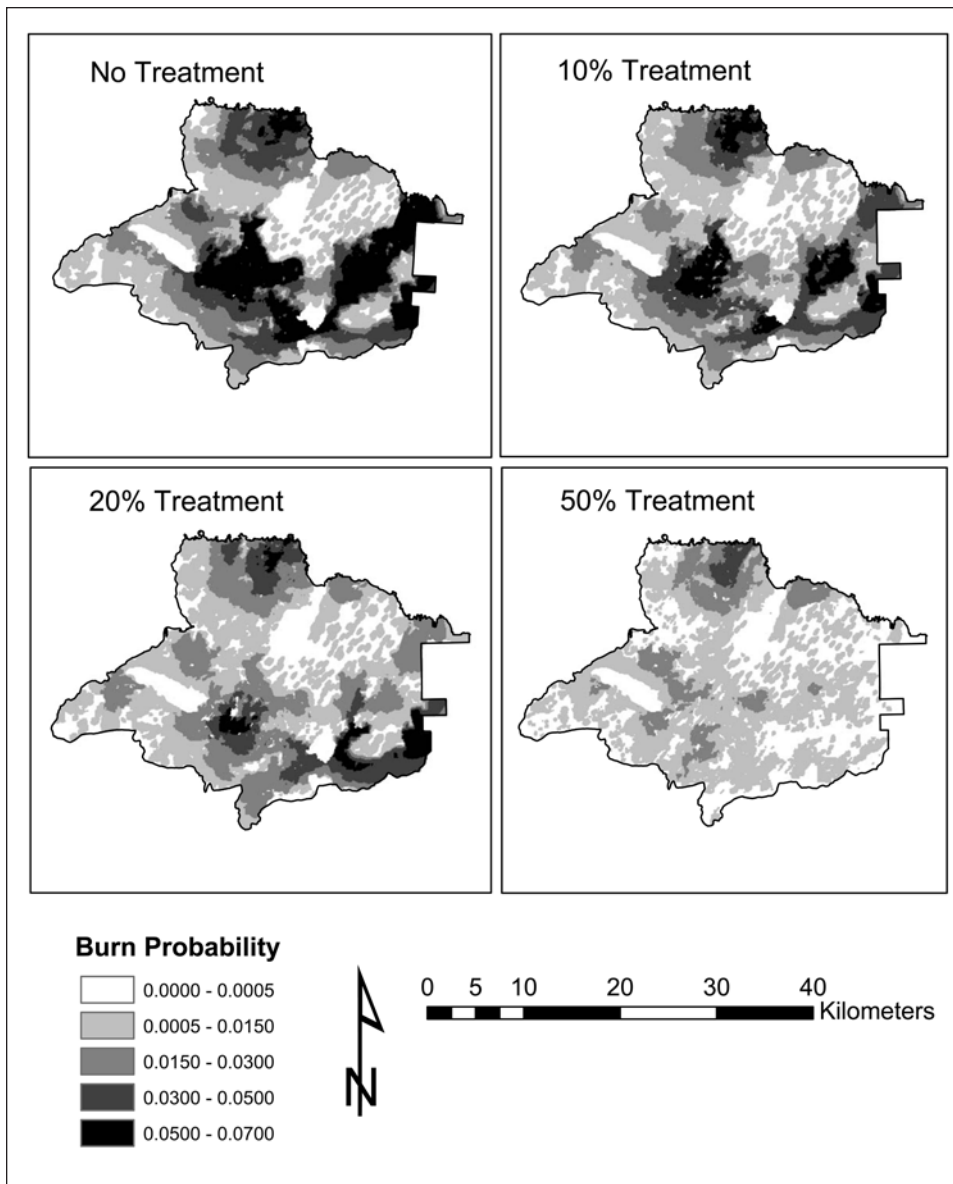
Ager and his colleagues integrated key wildfire and vegetation models with ArcGIS to create a GIS interface that automates the Fireshed process and streamlines forest landscape planning (see <http://www.fs.fed.us/wwetac/arcfuels>).



The FlamMap program developed by Mark Finney can be used to identify routes where fire will travel fastest across a landscape and show where fuel treatments might be most efficient at reducing wildfire risk.

WRITER'S PROFILE

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Burn probability can be used to calculate risk and evaluate different fuel treatment strategies. Shown here are burn probabilities if zero, 10, 20, or 50 percent of the landscape were treated on the Five Buttes planning area on the Deschutes National Forest.



LAND MANAGEMENT IMPLICATIONS



- Conservation planners can reexamine the threat of wildfire to habitat for key species using quantitative risk-based measures. The risk framework provides a method to quantify wildfire threats to habitat reserves and identify areas where wildfire impacts are minimized.
- Using tools developed in this project, managers can now rapidly analyze large landscape fuel treatment strategies with a variety of data sources and examine mitigation opportunities with a state-of-the-science risk approach.
- Six hands-on workshops in California and Oregon were conducted to demonstrate and apply the risk-analysis framework on specific fuel treatment projects. The workshops combined the mechanics of designing and analyzing landscape fuel treatment strategies with wildfire analysis and concepts from the risk framework.

FOR FURTHER READING

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