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ArcFuels: Integrating Wildfi re Models and Risk Analysis into Landscape Fuels Management

Lisa-Natalie Anjozian
US Forst Service, lisa@toeachhisownmedia.com

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RESEARCH SUPPORTING SOUND DECISIONS

(Left) In earlier times, fuel planners drew on mylar to design vegetation treatments.
(Right) Today, fuel planners use sophisticated computer-modeling tools that can predict post-treatment fire behavior on large landscapes in near real time. Credit: Berni Bahro.

ArcFuels: Integrating Wildfire Models and Risk Analysis into Landscape Fuels Management

Summary

That risk from wildfire continues to grow across the United States is not a new problem. Managing forest fuels in the real world—such as thinning and burning prescriptively—to reduce fuel loads have been used effectively to reduce the risk of severe wildfire. These actions have been helped by a variety of software tools that assist managers in planning and evaluating fuel treatments to ensure they are cost effective in terms of impeding the growth of future large, severe wildfires. While many landscape planning tools do a fine job within the scope of their capabilities, the process of fine tuning fuel management plans requires that users interact with large cumbersome databases and complex wildfire behavior models. The streamlined approach for modeling wildfire and planning fuel treatments on large landscapes developed in this study integrates fire behavior modeling and data processing tasks into a framework. This framework provides rapid assessment of wildfire risk and the potential effects of fuel management activities. The total picture of a particular scenario includes not only the predicted change in fire behavior, but also the change in likelihood of a fire, and resulting change in specific highly valued resources. Read further to learn about ArcFuels.

Key Findings

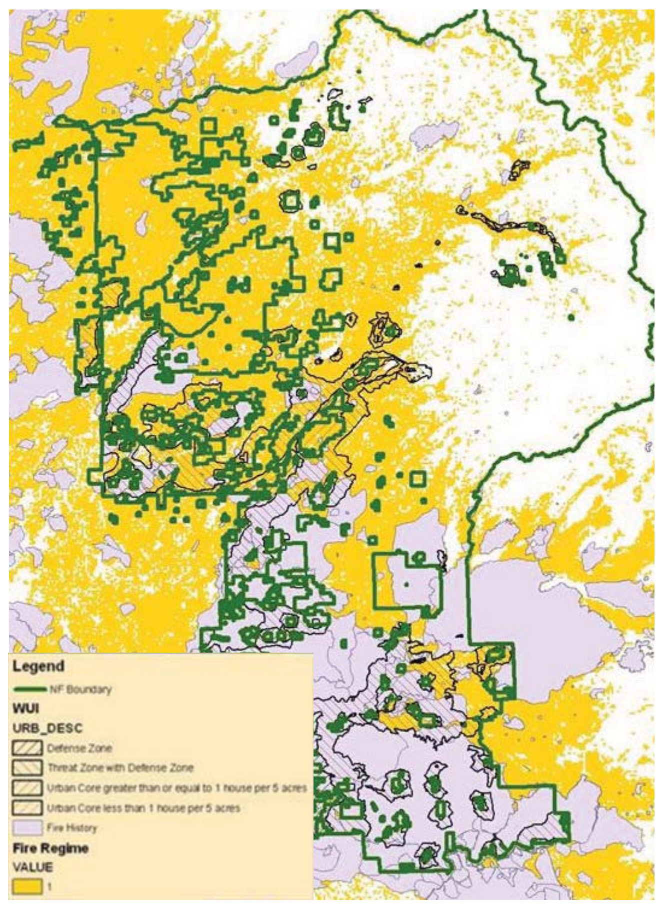
- ArcFuels, designed by the team, is a system that integrates a number of important fire behavior and vegetation models, geographic information systems, and desktop computer programs. It quickly and easily offers an approach for simulating, in real time, the effects of treatment plans.
- ArcFuels helps users enhance programs like FlamMap to calculate the potential effect of fuel treatments on burn probability and risk in terms of financial and ecologic value. This process offers a concrete measure of both wildfire benefits and damage that planners and landowners can use in fuels management plans.

Introduction

Where the sky is black and clean, and no urban lights pollute, you can see them. Bright points like stars—but moving—tracking steadily across the night. Wedded to us in orbit, they will emerge into day on the other side. They are satellites, looking at earth, acquiring data, sending us streams of information. Until relatively recently in the history of human instruments in space, many satellites were working efficiently, effectively, and independently. But understandings move forward, and thinkers and tinkerers developed a system to take advantage of the work the many satellites do, a system that connected the independent work being performed by diverse instruments and their individual systems. The global earth observation system of systems was born, an integration of efforts that can track weather events in real time, for example, and assist in predicting ramifications for people and lands in the path of a hurricane, or tornado, or storm.

The system of linked satellites that explores earth also helps scientists understand long-term weather trends, such as the melting ice sheets, rising sea levels, disappearing coastlines of our changing world. A user-friendly point of entry allows resource managers, decision makers, stakeholders to access the information that thousands of instruments produce in combined, understandable data sets. In less than fifty years, exploring earth moved from an era in which Shackleton's three-masted, wooden-hulled barquentine sailed to Antartica, to man-made instruments (that record the break-up of polar ice sheets) roving through the scrim of the sky.

In no less a breath-taking leap, land management planning on federal lands in the United States moved from paper maps on drafting tables, and black and white aerial photos to the sophisticated geographic information systems and fire modeling tools that can simulate forest succession, fuel treatments and thousands of wildfires—in a matter of minutes. And all this with amazingly fine spatial detail. While many software programs used in landscape planning and fuels management work efficiently to solve small sequential steps in the planning process, someone forgot to link them together to help planners create the finished product—a fuels treatment plan that can withstand the test of National Environmental Policy Act (NEPA) and public scrutiny. A complicating factor was the difficulty of balancing the myriad goals that various land management agencies, local jurisdictions, and private and public owners hold. Looking at large diverse landscapes and evaluating the many alternatives for reducing wildfire risk to economic, ecologic and cultural values while garnering support from various stakeholders proved a problem. A system to streamline this process to integrate the many systems was needed. A solution to the process was proposed to the Joint Fire Science Program by Alan Ager, operations research analyst with the Western Wildlands Environmental Threat Center in Prineville, Oregon. With collaborators in research and on national forests, Ager and the team explored all the contents of a fire world.



To plan treatment of lands, the space must be defined. The fireshed defines a unit of land, areas with similar fire regimes, fire history, and wildfire risk. Credit: Alan Ager.

Fire—In the tactile and worldly dimension

To begin effective planning, for any space, you need to know the boundaries of that space, whether it be the four walls of your home or the reaches of the entire planet. Like a watershed, a fireshed defines a certain space, a unit of land. The space embraced by a fireshed includes areas of land with similar fire regimes, fire history, wildfire risk, and potential for mitigation. Developed by the Forest Service's Berni Bahro and his team of planners in the California region, the fireshed assessment process uses input from different stakeholders to simulate fuel treatments on the land, and to observe the resulting change in wildfire behavior in that space. Treated sites are placed to lessen the effect of wildfire on a fireshed, and are located strategically to block fire paths using ideas and software developed by Mark Finney at the Rocky Mountain Research Station. "The fireshed process was developed by the region 5 team as a mechanism to build consensus among landowners and concerned publics about wildfire issues and mitigation strategies," Ager explains. This is especially important in the wildland-urban interface, where growing numbers of inhabitants, moving from urban centers, don't always recognize that the greatest risks are from large fires that spread long distances to arrive at the boundary between wildlands and their real estate.

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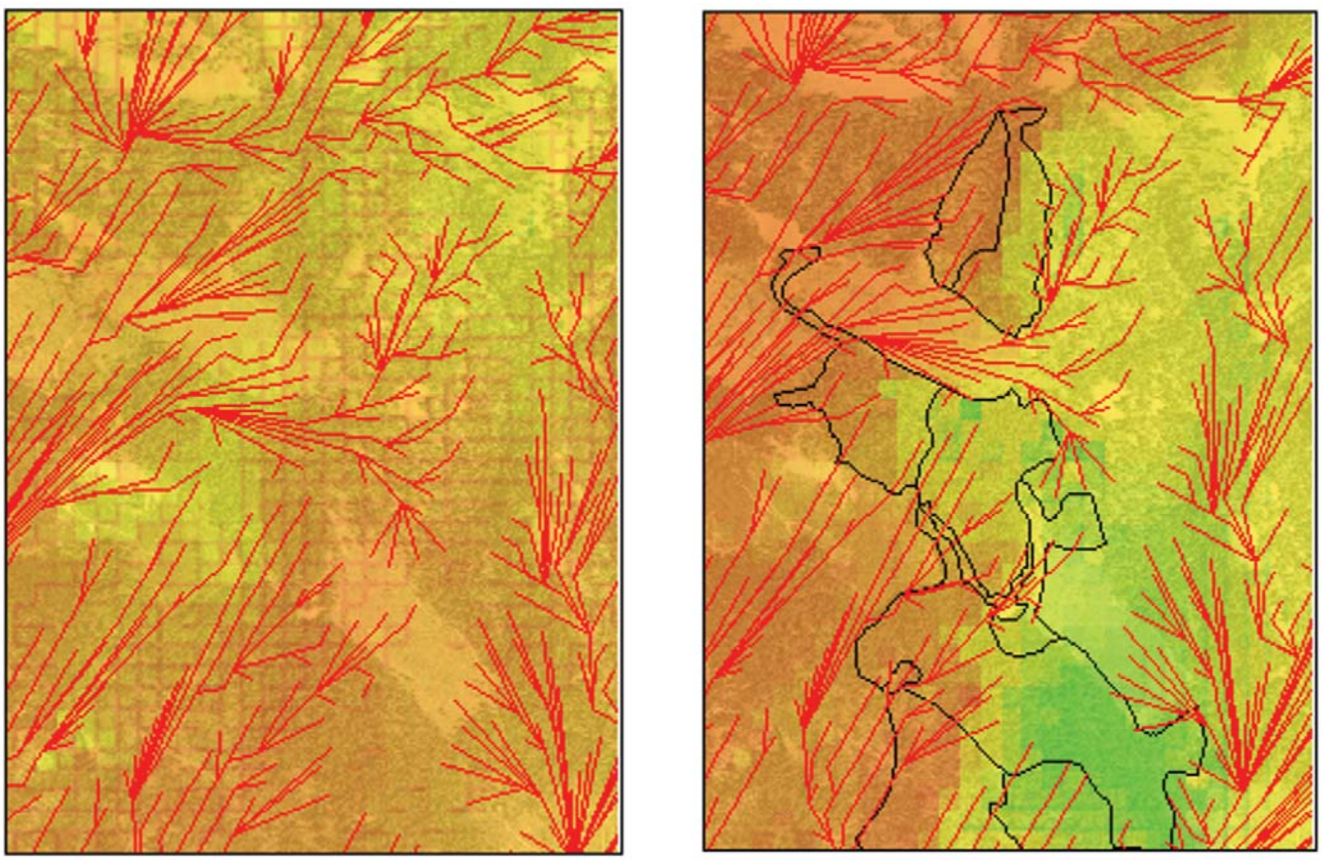
Burn models—Tinkering with the toolkit

To arrive at fireshed assessments, quick computing of multiple variables is critical. But problems occur when data sets can't easily move among the fire behavior models, or vegetation and fuels programs, or geographic information systems, and even basic desktop office programs. Ager and his team created ArcFuels to eliminate the headaches of moving data from one process to the next. This system moves the data in the background, and helps planners and analysts organize the landscape and the planning process. The result is that users can leverage key fire models and visualization software to easily and handily design complex landscape treatment alternatives and test them in near real time.

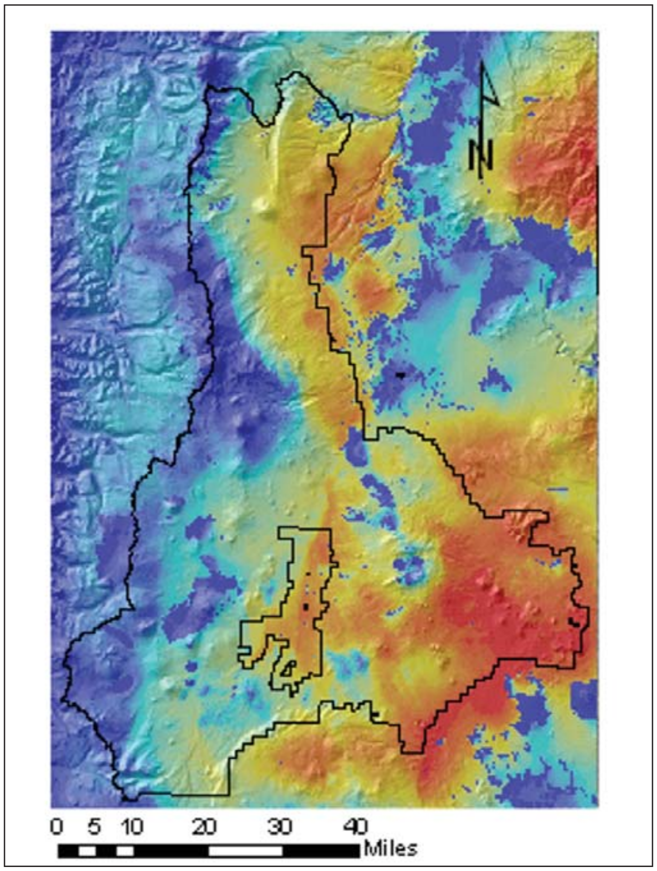
In a collaborative setting, stakeholders and planners can quickly look at a range of thinning intensities in a specific overgrown ponderosa pine forest, or the effects of burning under different weather conditions, for example. Zooming out to the landscape, planners can test the net effect of a battery of stand treatments on the pace of a



Because ArcFuels links together different software used in fuels management, users can quickly test many alternatives and visualize the change in wildfire behavior to the individual stand and the whole landscape. In the first simulation (left), treatments have been excluded. In the second simulation (right), treatments have been added (black outline), altering wildfire behavior. The images show FlamMap outputs of flow paths and fire arrival time. Credit: Alan Ager.

"ArcFuels," Ager notes, "automates the process of scaling up individual stand prescriptions to a fireshed, and simulating the landscape package of treatments with wildfire simulation models."

wildfire. Or the effect of omitting treatments on lands where the owner doesn't want to allow these management tools. "ArcFuels," Ager notes, "automates the process of scaling up individual stand prescriptions to a fireshed, and simulating the landscape package of treatments with wildfire simulation models." ArcFuels organizes management prescriptions for stands in a project area within a geographic information system, he explains, and this simplifies the process of modeling all the complex concerns, constraints, conditions, management goals that multiple landowners in a fireshed may have.



More complex probabilities can be calculated for the probability of different points in a landscape burning, and how hot or intense it will burn. This, along with the attendant change in financial and ecological values, can be arrived at with the wildfire risk formula—a calculation that offers the expected net value change. Pictured above is a burn probability map of the Deschutes National Forest. Credit: Alan Ager.

At play in the field of chance

With the space defined as a fireshed, and software tools integrated to help with assessing fuel management actions, quantifying the change in risk from treatments remains. But how do you define risk, and how can it be calculated for highly random event like a wildfire? How do we place

A fireshed. Credit: Miles Hemstrom.

monetary value on things that hold intangible value? For example, while determining solid measures of harm to a human life may seem callous, it is the best we've arrived at when calculating insurance compensations and awarding personal injury damages. While acknowledging the intangible value, it is a means of applying a monetary value to calculate what could, or has been lost. Similarly, a forest, a landscape holds intangible as well as tangible values, and a loss or change in those values requires some way of calculating that change.

Building on previous papers by Mark Finney at the Missoula fire lab, Ager devised a process to quickly calculate the expected net value change for many forest attributes like wildlife habitat, old growth, economic values and others. These calculations incorporate both likelihood, that is, the probability of fire at a specific intensity and location, and the net change in value as measured in financial or ecological terms. The expected net value change can include present and future, and positive and negative impacts from fire. Ager incorporated specific model linkages and code into the software to enable users to calculate the change in expected net value for fuel treatment scenarios. This achievement helped make it possible for fuel planners to use risk analysis in their fuels planning. In a central Oregon study of wildfire risk to northern spotted owl habitat, for example, the models were used to calculate the effects of fuel treatments on the probability of a fire with sufficient intensity to eliminate the key stand characteristics the endangered birds require.

By using ArcFuels to model different treatment options in real time, and see the possible outcomes of those treatments, managers and stakeholders can quickly find among many alternatives the best treatment placement and course of action. By using the risk framework, stakeholders can also quickly apprehend a hard sum of change in value associated with treatments.

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Like the satellites that can track that hurricane in real time today, and help in assessing the long term risks of more intense weather produced by a warming planet, the risk approach can show reluctant stakeholders the long-term hazards, with comparisons of suppressing wildfire or preventing wildfires through fuel treatment activities. With the virtual landscape shaped by using the tools, models and goals of wildfire risk, stakeholders can see a clear picture of what a "no action" decision really means in ten or twenty years. From sailing ships to space ships, from discrete specialties to integrated systems, our movements sometimes make giant leaps for mankind.

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Management Implications

- ArcFuels is a new approach for melding the key technology ingredients for landscape fuels planning—geographic information systems, corporate databases, stand and landscape fire behavior models, and a streamlined process for developing and testing fuel treatment alternatives using risk-based measures. The system makes it possible for the first time to bring stakeholders and different land managers to the table to analyze fuel treatment scenarios in near real time, focusing the debate on the holistic and long term solution to the wildfire risk problem.

Further Information: Publications and Web Resources

ArcFuels website: http://www.fs.fed.us/wwetac/arcfuels

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Scientist Profiles

Alan A. Ager is an Operations Research Analyst with the Western Wildlands Environmental Threat Center in Prineville Oregon. He received his Ph.D. at the University of Washington and has worked at the Forest Service for 20 years on a wide range of natural resource modeling problems.

Alan Ager can be reached at:
Western Wildlands Environmental Threat Assessment Center
Pacific Northwest Research Station
3160 NE 3rd Street
Prineville, OR 97754
Phone: 541-969-8683
Email: aager@fs.fed.us

Collaborators

Berni Bahro, **Ken Wright**, and **Klaus Barber**, USDA Forest Service Region 5

Mark Finney, **Rob Seli**, and **Chuck McHugh**, Missoula Fire Lab

Drew McMahan, Forest Health Enterprise Technology Team, Fort Collins, CO

Tom Burry and **Bob Clements**, Wallowa Whitman National Forest

Helen Maffei, Deschutes National Forest

Dave Owens, Ochoco National Forest

John Anderson, Balance Tech, Missoula, MT

Results presented in JFSP Final Reports may not have been peer-reviewed and should be interpreted as tentative until published in a peer-reviewed source.

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John Cissel
Program Manager
208-387-5349
National Interagency Fire Center
3833 S. Development Ave.
Boise, ID 83705-5354

Tim Swedberg
Communication Director
Timothy_Swedberg@nifc.blm.gov
208-387-5865

Writer
Lisa-Natalie Anjozian
lisa@toeachhisownmedia.com

Design and Layout
RED, Inc. Communications
red@redinc.com
208-528-0051

Joint Fire Science Program
Manager's Viewpoint
WRITTEN BY MANAGERS FOR MANAGERS
February 2009

Developing an Analysis and Planning Framework for District-Level Fuels Treatment Projects

Written By: Paige Houston

Purpose of this opinion piece

Manager's Viewpoint is an opinion piece written by a fire or land manager based on information in a JFSP final report and other supporting documents. This is our way of helping managers interpret science findings. If readers have differing viewpoints, we encourage further dialogue through additional opinions. Please contact Tim Swedberg to submit input (timothy_swedberg@nifc.blm.gov). Our intent is to start conversations about what works and what doesn't.

Problem

ArcFuels, a new computer modeling program developed to assist land managers in making rapid assessments, is designed to target district-level fuels projects by linking them to other programs. However, the problem is how to make this information exchange available to all fuel managers who implement these projects while accounting for fire behavior characteristics, probability, and risk.

Overall, this study intends to identify faster and more efficient ways for land managers to delineate fuels projects at the district level by linking vegetation and wildfire models as a means of influencing fire behavior to reduce potential fire threat. However, by linking computer modeling programs with corporate data programs, this study found that some of the corporate data are either missing or inaccurate. This underscores the real problem of how inefficiencies can stall-out great ideas.

Application by Land Managers: Underscoring What You Need to Know About ArcFuels

This study shows how ArcFuels is designed to allow for the rapid assessment during the planning phases of fuel reduction across large areas—providing quicker predictions for analyzing fire behavior based on weather conditions. This also relates to the stand visualization information that comes from the Forest Vegetation Simulator with the Fire and Fuels Extension (FVS of FFE), FlamMap, and FARSITE.

ArcFuels can query information through a direct link to FVS that provides the user a faster way to make changes to prescriptions also linked to GIS (Ager 2004). However, not all fuels managers and their supervisory fire program managers are aware of the latest computer modeling programs. Maintaining proficiency is the single-most unrealistic expectation that fuels managers are faced with daily.

For instance, FVS now has a new extension called Parallel Processing Extension (PPE) that can assist users in designing project priorities or look at ways to accomplish these priorities more efficiently (Ager 2004). This portion of the program can also streamline designing treatments that are compatible with programs such as Excel and Microsoft windows—as long as the user is aware of the updates.

Keeping Current with Computer Programs

New updates to these programs are constant. Therefore, staying current with all computer programs can be challenging—especially for fuels managers. These people already manage more than just the planning phases of district-level fuels projects. They also participate on fire assignments, incident management teams, NEPA teams, and must always be maintaining their fire qualifications. If the FVS program isn't used for a couple of years, it is highly probable that managers cannot pickup where they left off.

This FVS program can be linked to ArcFuels. It provides the stand visualization information in which certain key words are linked in a certain order that only the experienced user would know. Also, the user would need to know what information is required—in a specific order—before running the models that include terrain features, overlays of the area, and stand data that represent the area to produce outputs for a visual simulation (USDA 2004).

Furthermore, if corporate data that supposedly crossover to other computer modeling programs is inaccurate or does not reflect real time situations, the fuels manager would not necessarily be aware of this. And, most often, it is not the fuels manager who crosswalks that particular data. Therefore, when it is time to run computer models for rapid assessment for fire behavior, one might not be aware that "garbage in" could possibly become "garbage out."

Could Be Misleading

When considering fire behavior potential across a landscape, ArcFuels can also assist in developing fuel treatment options that encompass other disciplines. This concept builds on spatially organized treatment areas delineated across the landscape that would impact fire behavior enough to influence positive outcomes for all resources (Ager 2004).

Thus, when developing prescriptions, a fuels manager might interpret that ArcFuels contains the necessary information and that the program is easy enough to maneuver around in to make informed decisions about long-term impacts resulting from rapid assessment prescriptions. Unfortunately, this could be very misleading.

At this point in time, ArcFuels does not evaluate risk assessment during the development of prescriptions. However, efforts are underway to incorporate this capability into the program.

Risk Assessment

This study is still researching the impacts of risk assessment and trying to incorporate risk at the national planning level. Fuels managers understand that risk analysis must be completed for fuels projects and that it is a required, nationally-driven, very time-consuming process.

Coupled with this strong focus on risk, fuels and program managers are also confronted with tremendous accountability and responsibility. This reality could help encourage a reluctance to oversimplify for rapid assessment when making very complex decisions. This is especially true when fuel loadings exceed levels that might not be representative of the corporate data linked to such modeling programs, most likely because priority areas are the wildland-urban interface.

The study agrees that one views risk as any change in terms of cost resulting in a negative value that wildfires cause—both spatially and temporally—on a multitude of resources (Ager 2006). This further clarifies the complexity of risk associated with fire behavior and the probability that fire will occur on a particular landscape (Finney 2006). Once again, this underscores the complexity and risk that fuels managers must tackle when designing district-level fuels projects. Once it becomes clear how risk assessment fits into the ArcFuels modeling program, it will make the rapid assessment concept more conducive for fuels and land managers.

Stand Visualization Feature

Most computer models are one dimensional and assume that the landscape is homogenous. ArcFuels, however, provides a third dimensional view by utilizing and linking spatial features built into GIS layers. While this stand visualization feature is applicable to fuels managers for developing strategies, certain variables could contribute to overestimating or underestimating outcomes. For example, weather indices now reflect that many days of the summer season are in the 90th and above percentile conditions. Fires are burning hotter, longer, more severe, and more intense. Therefore, unless one ground-truths fuel loadings and arrangements, rapid assessments may underestimate fire potential. Even so, others still perceive the value of the rapid assessment to be identifying those problem areas that pose the most fire threat—and targeting those areas (Gercke 2006).

Another contributing factor that land managers must address when predicting the potential threat across a landscape includes the vast array of computer modeling programs available for assisting in the rapid assessment decision-making process. Knowing which program to use, its limitations, and how well its outputs reflect real-time situations adds complexity to an already challenging problem. Moreover, the data used within the programs are either outdated or have not been consolidated with other information-sharing systems for compatibility. When attempting to streamline processes for accomplishing projects, this type of data management creates barriers for both researchers and fuels managers when trying to adapt to the dynamic environment in which we all work.

Information Exchange

Finally, the study conducted numerous workshops, conferences, and published papers for transferring the latest technology to the fuels managers (located mostly in the Pacific Southwest Region). It appears that this region adopted the concepts from the ArcFuels computer modeling program for implementing fuels projects. At this time, it is unclear what other Forest Service regions are doing regarding the incorporation of ArcFuels into funded fuels management strategies—as well as how information is being transferred in those regions. An assumption could be made that the necessary costs for sending fuels managers to training may prevent further information exchange.

In addition, corporate databases are not being made available to the appropriate users (such as the FACTS database). Some forests prefer to maintain control and only allow access to a selected few data entry users. In my opinion, when these database managers refuse to relinquish control or access, they are preventing the appropriate users from ever becoming proficient with programs and knowing how or where to access information more readily and rapidly. While this might be understandable from a program oversight point of view to contain control measures, in my opinion, information is knowledge. Yet, unfortunately for the rest of us—and our programs—to some others, information is power.

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Manager Profile

Paige Houston is the Regional Aviation Training Specialist at the Northern Rockies Training Center in Missoula, MT. She has 22 years experience in fire management across several USDA Forest Service regions, and a few years with the USDI Bureau of Land Management. She currently serves as a primary Division Group Supervisor on the Northern Rockies Type 1 Incident Management Team and instructs a variety of fire and leadership courses in northwest Montana, at the Wildland Fire Apprentice Academy, and with the National Smokejumper Association. She spent eight years with the Bitterroot and Lolo hotshot crews and worked two seasons with the Alaska Smokejumpers.

She has several more years of experience in other primary firefighter and fuel management positions, including a season with the rappellers out of Chelan, WA. She's a graduate of the University of Montana where she received a degree in resource conservation.

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