When Things Get Busy: FSPro and RAVAR

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In late July, 2006 firefighting resources were stretched thin across the West, and more fires seemed to be starting every day. On July 23 and 24, 2006, the Shasta-Trinity National Forest in California was hit by a series of lightning strikes that started multiple ignitions across the Forest. Joe Millar, the fire management officer for the Forest, realized that a number of these fires had potential to become serious problems.

Millar was in touch with Bernie Bahro, the California geographic liaison for a new Rapid Response Decision Support Team that was supporting a set of fire assessment tools developed by the Rocky Mountain Research Station. Bahro quickly agreed to work with the Team, composed of highly skilled researchers led by Mark Finney from the Missoula Fire Lab, the Missoula Forest Science Lab, and the new Boise Wildland Fire Research, Development & Application unit to develop some Fire Spread Probability (FSPro) and Rapid Assessment Values at Risk (RAVAR) projections for the Shasta-Trinity to support prioritizing the fires and assessing long-term strategies.

FSPro is a spatial model that maps the probability of free burning fire spread for a set period of time. RAVAR is an economic model that provides dollar estimates of values (structures, infrastructure, etc.) threatened by a fire, as well as assessments of non-monetary values such as critical habitat.

Further below, Millar describes how the models assisted decision-making relative to the management of fires in a very complicated and high risk environment. His story, in many ways, captures the strength and potential of these two new tools. First, however, some background is necessary.

Initially, researchers at the Fire Lab planned a limited field testing of the models during the 2006 fire season. However, when National Preparedness Level unexpectedly moved to level 5 and there was a drawdown on resources across the country, the field testing took on a whole new life. As the models' decision support strengths were recognized, limited prototype testing turned into a full-fledged field implementation. One or a combination of the two models was used in decision support on 70 fires during the 2006 season.

This past season the models were primarily run by researchers using computers at the Missoula Fire Lab. The Lab researchers worked in conjunction with liaisons and fire personnel from the Geographic Area Coordination Centers (GACCs) to collect data, run the models, and provide maps and interpretation. The model outputs were used at different levels of fire management including:

- Forest or unit level (prioritization of fires, development of Wildland Fire Situation Analysis (WFSA), public communication)
- GACC level (allocation of resources, internal communication, strategy development)
- Incident level (containment strategy and long-term assessment)

In general, the programs were viewed as valuable supplements to other fire behavior modeling efforts, and as powerful communication tools, both internally within fire management teams and with members of the public. Inevitably, with such a rapid application of a new piece of technology there were a number of problems identified by sources, including: data availability, difficulty in interpretation, and limitations in long-term assessments.

This article will illustrate some of the potential uses of the two models, and highlight some of the directions that the programs will likely take as researchers incorporate the lessons learned from the 2006 fire season.

How the Models Work

According to Rob Seli of the Missoula Fire Lab, FSPro was developed in response to a recognized limitation of FARSITE in making long-term projections. Based on current weather forecasts, FARSITE is really only accurate in projecting fire behavior 2 to 3 days out.

Summary of Benefits

- Containment strategy & prioritizing fires
- GACC level - resource allocation decisions
- WFSA - economic impacts, worst-case scenarios
- Public communication
- Internal communication - strategy and tactics

Summary of Criticisms/Problems

- Data availability
- Assumption of no suppression action – not good for predicting final outcome – over predicted fire in some cases
- Need to incorporate atmospheric instability – Haines Index
- Difficult to interpret- legends could be improved
- Hand off needs to be refined

FSPro calculates the probability of fire spread from a current fire perimeter or ignition point for a specified time period. Combining the FARSITE or LANDFIRE data layers (crown base height, bulk density, etc.), current weather projections, historical weather scenarios, fuel moisture classifications, fire history, and wind speed and direction, FSPro can push fire projections out as far as 30 days. The model is designed for situations when managers do not have a high level of confidence in weather projections, or for periods when long-term weather projections are not available.

"The program starts with current weather projections –where are you at now?" says Seli. "If it is above average conditions, that is your starting point. Then you decide how far out you can accurately project weather. From that point, we integrate historical data from a nearby remote auto weather station with similar topography to create thousands of different weather scenarios. Then the fire is simulated using each of the potential weather scenarios."

RAVAR is also a spatial model, showing the primary resource values at risk by ongoing large fire events. The program can be directly integrated with the FSPro model to identify the likelihood of different resources being threatened.

The most important layer generated by the RAVAR model is the structure layer generated using local parcel records. However, RAVAR is not limited to the assessment of threatened structures. Any resource value that has been spatially mapped may be included within a RAVAR assessment. Some of the data layers that have been incorporated in the RAVAR assessments include: critical infrastructure (power lines, road networks, and gas pipelines), municipal water intakes, recreation facilities, sensitive wildlife habitat, cultural heritage sites, and ecological data from the LANDFIRE project.

Below are examples of how both models were used in the field as well as the benefits and limitations of the tools identified by fire managers who worked with them in the field.

Prioritizing Fires

One of the key benefits of FSPro and RAVAR identified by many of our sources was the assistance the programs provided in prioritizing fires once fire season ramped up on individual forests or units and at regional and Geographic Area levels.

The fires on the Shasta-Trinity National Forest, mentioned in the introduction, provide a clear example of this application.

Joe Millar, FMO for the Shasta-Trinity, says, “I realized from the beginning that FSPro was an experimental tool, but we were able to use it first to assist the unit in prioritization and then consider the long term implications. We had over 30 fires start across the Forest during the July lightning episode. We wanted to know which fires were likely to be problems, where the fires were likely to go and where we needed to make the appropriate response. FSPro, was just one of the tools we used, we also validated the information with the use of FBAN’s and LTAN’s. Over the course of the season, the fires generally played out like the models predicted, we gained more confidence in the program.”

For Millar, the FSPro maps showed that two of the fires (Lakin and Dog) on the Shasta-Trinity were in areas that were really not substantial long term threats. The Lakin threat was short term and significant to the entire State. It also showed that a few of the fires (Little, Bake and Oven) had potential to become serious long term problems.

When Millar first received the model projections, the Bake and Oven fires were at the time 25 and 18 acres respectively and the Little fire was approaching 200 acres. The FSPro projections showed the Bake and Oven fires combining and growing to 21,000 acres. Without a serious suppression effort, the fire could easily reach and impact the New River and Trinity River. Both are wild and scenic rivers with important anadramous fish habitat concerns. It would also threaten a number of communities and domestic watersheds in the Denny area and the Trinity River corridor and tribal issues were of concern if the fires were to expand to the west. Season ending rain events usually don’t occur until mid to late October and the Forest knew they would need lots of logistic support. An order for a Type 1 Team was made. Ordering a Type 1 team on three fires for a total of about 225 acres raised some eyebrows, but a few days later when the fire blew up (and became the Bar Complex), Millar felt the projections had assisted in making the Forest’s point of how serious the situation was going to become.

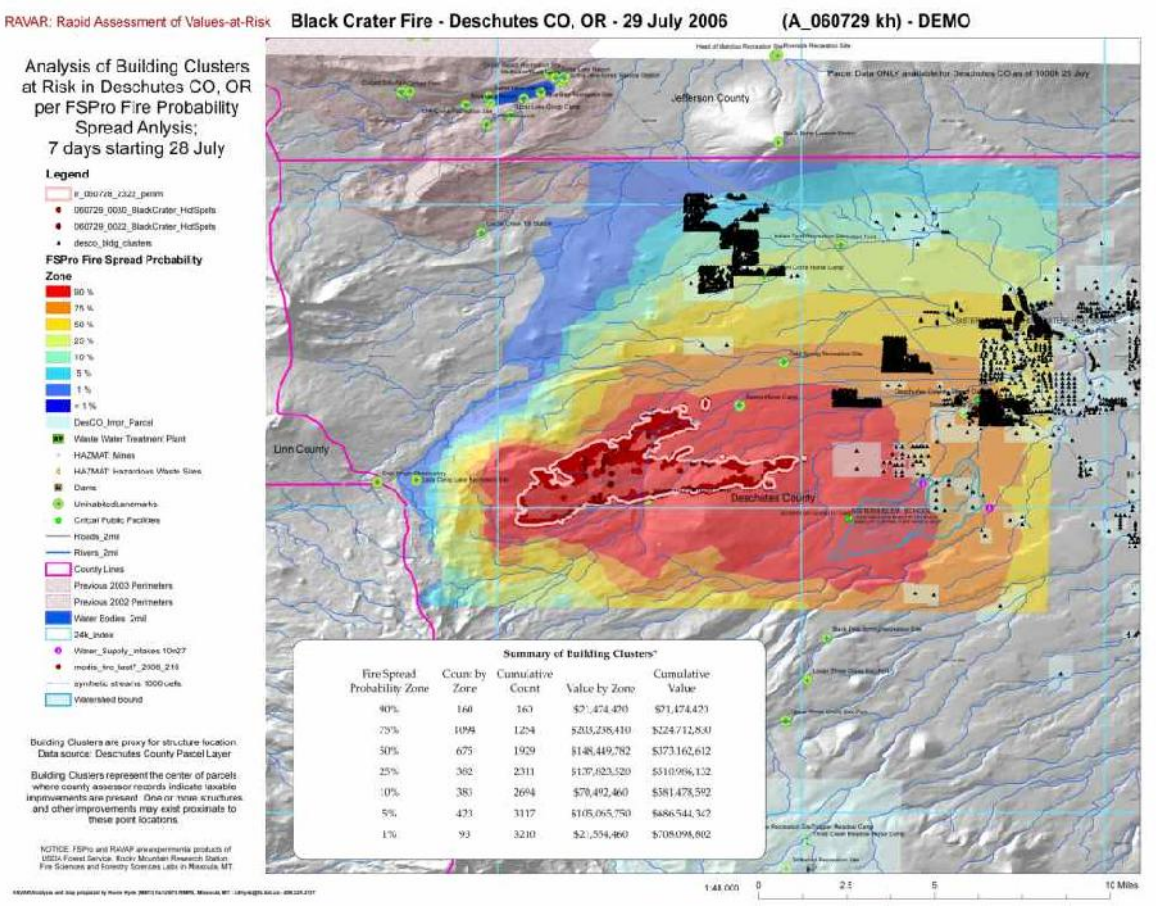
The Little Fire was a firefight in progress, and the FSPro maps were showing that with little to no suppression actions the fire could grow to 19,000 acres. This was one of the primary entry points into the Trinity Alps Wilderness; the Forest put an emphasis on it for control. Another fire - the Lakin Fire was threatening power and gas lines for California Power authorities. FSPro was showing this fire with the potential to grow to 9000 acres without a serious suppression effort. The Forest identified this as a key fire to control and focused suppression actions on this one as well.

RAVAR also played a role on the Shasta-Trinity. Millar says that the model showed that immediately after ignition the Pigeon Fire (which eventually burned into the Bake-Oven Fire and became a part of the Bar Complex) was directly threatening 199 residences valued over $13 million (RAVAR values). If the fire was to get into all of the structures threatened during the course of Pigeon Fire, RAVAR information was used to project that it could threaten up to 391 residences and 43 businesses valued at somewhere close to $30 million.

“The suppression efforts on the Pigeon Fire will end up being the most expensive fire we had,” says Millar. “If the fire wasn’t caught when and where it was, which was outside the communities, it would have likely doubled or tripled in cost-loss value. RAVAR was a tremendous tool from that standpoint as it provided additional information in developing and maintaining our situational awareness.”

Allocating Resources

FSPro was used extensively at the GACC level in prioritizing fires and allocating resources. According to Gerry Day, manager for the Pacific Northwest GACC, FSPro "helped with estimating how long fires would run. That became critical when we got busy."



Fire spread probability contours and Values at Risk produced by a combined FSPro and RAVAR model run for the Black Crater Fire.

In early August, 2006, the Pacific Northwest GACC began responding to a series of lighting strikes in the Cascade Mountains. Many of the ignitions were around popular campgrounds and relatively close to some mountain communities. The decision space was small, and prioritizing response was critical.

"When models and intuition are telling you the same thing, it gives you more confidence in the decisions you make," said Steve Dickinson, coordinator for the Pacific Northwest GACC.

FSPro was also used on the Tripod Complex, and Kim Kelly, GIS coordinator for the Pacific Northwest GACC says that every three or four days the fire perimeters that were sent in from the fireline got better and the model was relatively more accurate and effective. Gerry Days says that the FSPro runs really helped to analyze the positive and negative effects of different actions and scenarios. "The incident commanders were having a difficult time figuring out where to put the Type 1 firefighters. On the FSPro runs we could place control lines in different drainages and see where it stopped the branching of the fire. It really helped us to identify where we might pinch off the fire in some locations."

Dickinson found that FSPro is filling a void in decision-making. "At GACC level decisions are made by people sitting in different offices. They pull out maps and being mentally drawing the same strategies.

With the FSPro maps, everyone can look at the same thing. This replaces lengthy discussion to get on the same page. It enhances performance because everyone gets to the same point quicker."

WFSA Development

Line officers reported that both FSPro and RAVAR were used in the Wildland Fire Situation Analysis (WFSA) process at the incident level. According to the developers, WFSA development was one of the original motivations for creating the programs. "One of the primary applications of RAVAR is in the development of WFSA," says Dave Calkin of the Missoula Fire Lab. "especially in developing estimates of the economic impacts of different strategies."

According to Tom Caves, a fuels specialist on the Mendocino National Forest, FSPro was most useful for contingency planning. "We found the maps to be a good tool for worst case scenario planning in the WFSA process – finding out how everything goes to heck if you lose this thing. It is useful for thinking outside of the box and it gives you something to base your assumptions on."

Guy Pence, the fire and aviation staff officer for the Boise National Forest, found that FSPro helped his team draw lines for the WFSA boundary that were more accurate. By looking at the probability maps they were able tie lines in tighter to the fire perimeter in areas where there was less probability of spread and farther out where the maps were showing a greater chance of fire spread. "We found that we had to make far fewer adjustments to the lines because it is based on scientific probabilities. It also helped to make our WFSA maps more accurate from the beginning."

John Szymoniak Acting Project Manager at the new Rocky Mountain Research Station's Wildland Fire RD& A unit said, "Those were the kinds of issues that led to the development of the models. Over the years we have come to know where some of the difficulties lie in developing useful WFSA's. Two of those areas are in attempting to predict probabilities and values being protected. We believed that providing these applications might go along way in providing managers and IMT's with better decision support than what has existed in the past."

Communication

The Boise National Forest had an incredibly busy fire season in 2006 with two Type 1 incidents (Rattlesnake Complex and the Red Mountain Fire), as well as two Type 2 incidents (Burnt Fire and East Roaring Fire). Guy Pence found FSPro to be useful for communication. "We used FSPro to work directly with the incident commanders on the fires. For example, we might show them that there is only a 10% chance that the fire is going in a certain direction. With the scarce resources we had we would just say – let it hang and concentrate the resources on another fire or in another location."

He also found that the maps produced by FSPro were useful to explaining strategy and tactics to local officials and the general public. Using the maps to show the fire spread projections they were able to clearly explain why they were putting resource in some places and not others. "We would tell a county commissioner – 'I know this area is important to you, but there is only a 10% chance the fire is going to reach it. I am not going to send two hotshot crews out to defend it."

Long-Term Assessment

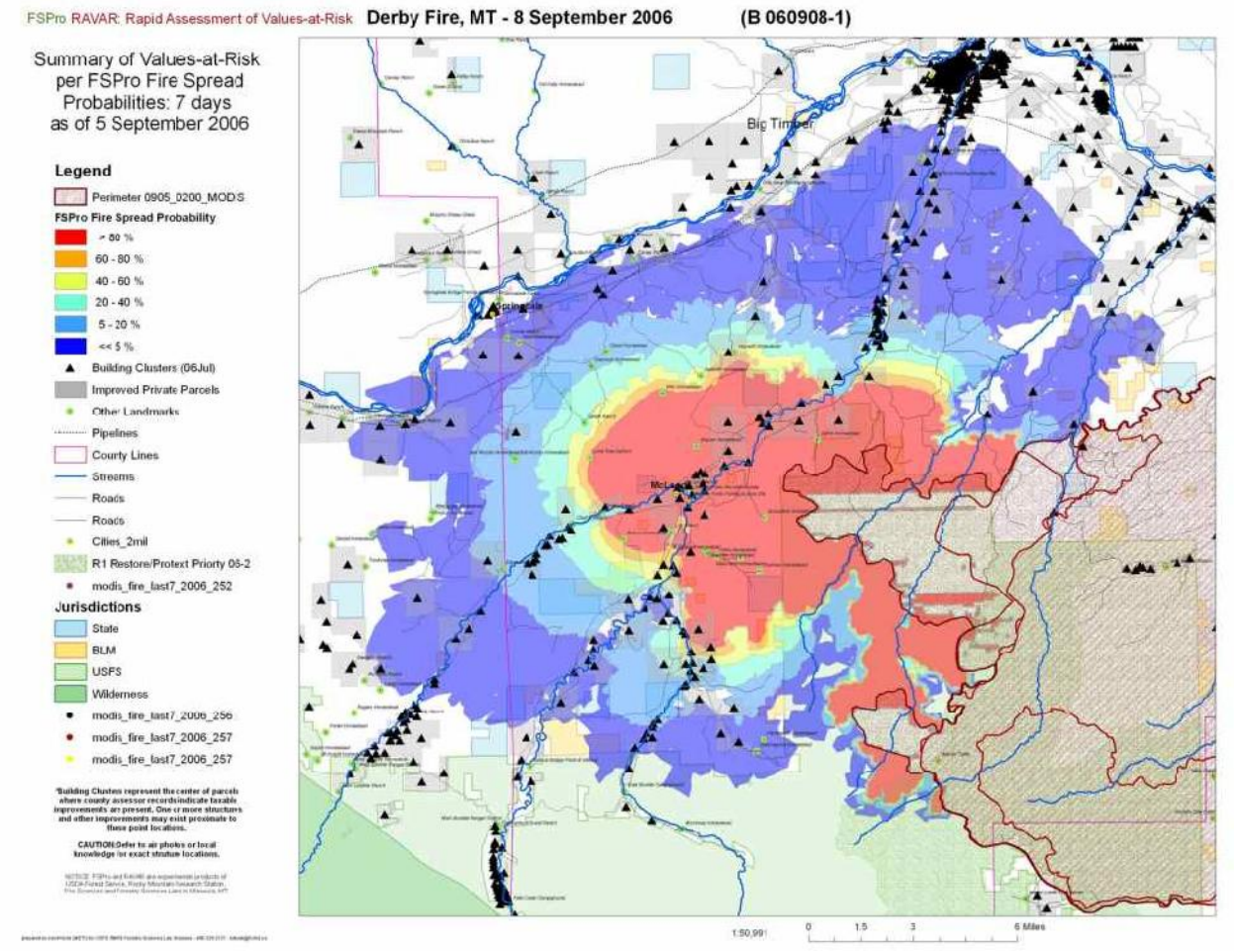
According to Kim Kelly, GIS coordinator for the Pacific Northwest GACC, "In the context of using the models for WFSA and for decision support at the GACC level, there was a high level of confidence in the use of the model. In regards to the models being used for long-term assessment at the incident level, the feedback we got from the field is 'the jury is still out.'" This sentiment was echoed by the overall response from interviewed sources, with many pleased with the accuracy in long-term assessment, and others still feeling skeptical.

The coordinators at the Pacific Northwest GACC were, overall, satisfied with the accuracy of the FSPro predictions. “There was never a time when we said that “it is not even close to what is happening on the ground,” says Dickinson.

Joe Millar echoes that sentiment. “The Bar Complex was a 102 day season long event. Through that time we became very comfortable with the maps because they were validated by what was going on with the fires.”

On the other hand, Bill Hahnenberg, incident commander for the Rocky Mountain Fire Use Management Team, said the he felt FSPro over predicted what would happen – larger fires and more fire spread. His team only used the maps as a secondary tool. In response, Szymoniak indicated that “this is not unusual since FSPro is dependent on how well the RAWS station can reflect the local weather influencing the fire and the detail of the fuel models used in the projects. Fire behavior modeling in general still has a long way to go towards improved predictions.”

Tom Caves also felt that the maps did not really predict the fires on the Mendocino well. The models did not pick up on the fact that their suppression actions held. “In some cases, we had to tell people that the fire is not running – quit the back-off approach and go direct. The maps gave false impressions in some instances.” Again this observation is understandable since FSPro models fire spread in the absence of any suppression actions. Unless a barrier file is imported – which can readily be done – the model doesn’t see the suppression actions.



Fire spread probability contours and Values at Risk produced by a combined FSPro and RAVAR model run for the Derby Fire.

Interpretation and Other Problems

Don Hall, deputy district ranger on the Klamath National Forest, had the most serious criticisms of both FSPro and RAVAR. “In the third week of July we had a lot of fires in northern California. I had just started on the WFSA process when I was handed an FSPro map. While I understood what the map was showing, I knew nothing about where it came from, the data that was used to develop it, or how to interpret it. These are all serious failings. If I am going to use it to make decisions I need to know what is behind it.”

This was part of a general criticism of the prototyping process voiced by a number of sources - the hand-off process needs to be refined. Bernie Bahro, liaison for both the Northern and Southern California Geographic Areas, says that when the team was able to work one-on-one with line officers and incident commanders things worked much more smoothly, but as soon as things got busy that became impossible. Sources suggested that the legends provided with the maps should be easier to interpret, and that their needs to be training on how to interpret probability contours.

The developers of the programs also identified some limitations with the programs and their application. “Data, data, data,” says Rob Seli of the Missoula Fire Lab. “That is the real headache and the main obstacle to making progress with these programs. The models need a FARSITE landscape and we spent 75% of our time putting the datasets together for individual areas." According to Seli, the development of the LANDFIRE fuel datasets is a potential solution. For the time being, the Lab is going to have to work with regions and individual forests to put datasets together.

Similarly, Kevin Hyde, a contractor with Meti Corp., who worked on the development of RAVAR, says the team spent the vast majority of their time pulling data together for the model. A core data set is a parcel layer, normally generated from cadastral surveys and tax records. The team had to go county by county obtaining parcel maps.

Seli also pointed out that FSPro does not pick up on atmospheric instability measured by the Haines index. This is often important predictor of extreme fire behavior.

What’s Next?

Prototyping these two models was undertaken for the objective of testing the utility of the models and to determine if they had value as decision support applications. According to Szymoniak “we think a business case was made in 2005 and 2006.” Apparently enough so that the U.S. Forest Service has authorized the development of a new application called Wildland Decision Support System (WFDSS). This new system will incorporate FSPro and RAVAR as a part of its decision support modules. It will be a web based system that will replace the WFSA and WFIP as they currently exist.

In response to the serious fire season of 2006 and the promise shown by these applications, the USFS is stepping up delivery of WFDSS. Components of it are intended to be up and running for the 2007 fire season. Szymoniak said that by hosting it on a single web site some of the concerns expressed regarding interpretation and understanding of these new tools can be effectively addressed. “We think we can deliver requested products to target audiences when they are needed and increase the understanding of the new applications. Hosting it on a web site will provide the opportunity to provide a users guide and answers to FAQ’s. The site is also planning to develop links between the model analysts and the requesting units via text messaging and other communication links. Adding the functionality of a web based system should address the problems and frustrations expressed in the AAR.”

The U.S Forest Service is working with IBM, Northrop Grumman, and Systems for Environmental Management to develop the website. These companies have staff that is working with fire managers to

get input on how information can be presented to help make decisions. According to Dave Calkin, “We want to describe values in ways that fit into the decision-making process. The last thing fire managers need is someone in a lab in Missoula telling them what they should care about.” Calkin and the other researchers are now working with the regions and the GACCs to identify priority data layers and get those pre-staged for the upcoming fire season.

The RMRS researchers recognize that it is easier to quantify the negative impacts of fires than it is to quantify the positive impacts of fires. They say that the next phase in the development of this software will be to work to incorporate benefits. Asking questions such as – Is this fire within the historical range for the area? Is it improving critical habitat? Is it improving Fire Regime Condition Class? What do we mean by values at risk? The initial phase of this investigation is underway.

Overall, sources were pleased with the performance of these two assessment tools, and are looking forward to utilizing them further in the upcoming fire seasons. For their part, the researchers are working on the programs to get them incorporated into the WFDSS project and are incorporating lessons learned from the past fire season.

Advances in Fire Practice is a sub-site of wildfirelessons.net and is focused on bringing efforts and ideas to the forefront that leaders in the fire management, practice, and research communities have identified as innovative and widely applicable. It provides access to critical and proven fire information and resources. Advances in Fire Practice section can be reached directly by going to http://www.wildfirelessons.net/AFP.aspx or through the main Wildland Fire Lessons Learned Center website at www.wildfirelessons.net.

The Wildland Fire Lessons Learned Center actively promotes a learning culture for the purpose of enhancing safe and effective work practices in the entire U.S. wildland Fire community. It is located at the National Advanced Fire & Resource Institute in Tucson, Arizona.