Wildland Fire Decision Support Tools

A Guide for Agency Administrators

March 2019

Integrating science, technology and fire management.
Wildland Fire Management RD&A

Introduction

A variety of tools are available to aid risk-informed decisions and safe, effective courses of action. This guide has three parts: Easily Accessible Tools, Tools that Require Pre-Planning, and Tools that Require a Request from a Specialized User.
If you see this symbol, it is an item found in the WFDSS interface:

When considering which tool to use to support a risk-informed decision, ask:

1. Are the decision support tool outputs needed to make a decision (use of tools is not required), or has a decision essentially been made?
2. Is your question about values at risk or relative costs?
3. Do you want information for a specific time period such as "the next 24 hours" or "the next 14 days"?
4. How much time to you have before the product is needed?

Easily Accessible Tools

The following tools are accessible to decision-makers immediately, if you know where to look.

Zone Weather Forecast

Zone forecasts are available every morning and afternoon to evaluate current and near-term weather. Go to www.weather.gov or the WFDSS incident Situation Map>Info Tab>Weather Forecast. The "Zone" numbers are found on the forecast and the Situation Map>Fire Weather and Danger. Unit fire personnel usually read these over the radio, or post to bulletin boards. Note the forecast conditions on the "Local Thresholds" of the Pocket Card for your unit.

Fire History

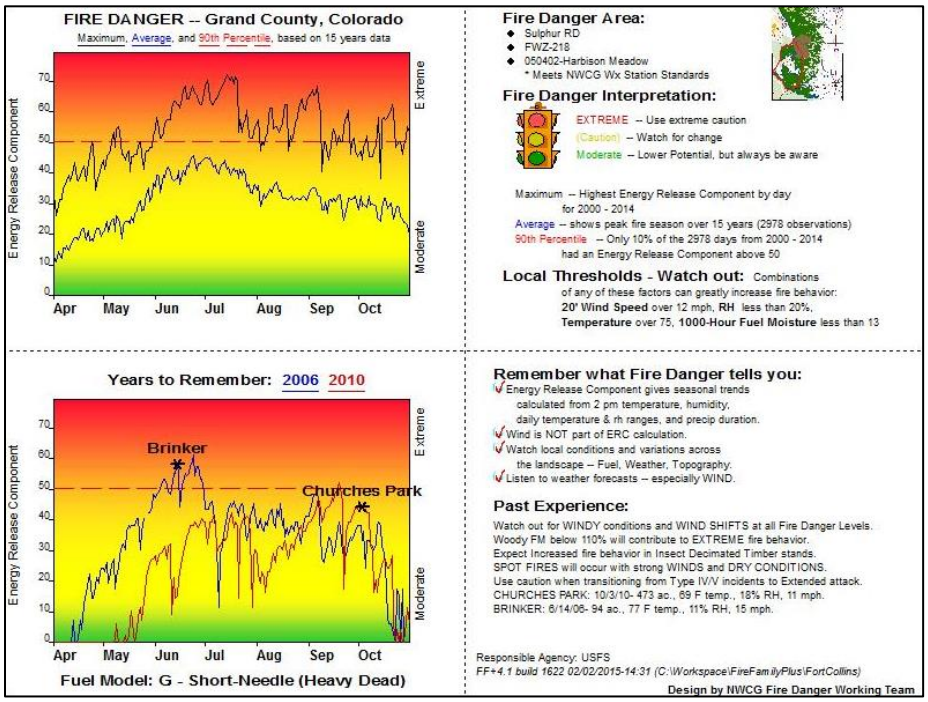
A fire history map can be useful to get an idea of fire size, shape, and direction of movement. In WFDSS, go to the incident Situation Map and click Disturbance History>Historical Wildfires. Zoom in/out on the map until you get the scale that makes sense. Talk with local fire personnel about how long a past fire might inhibit new fire growth, what stopped previous fires (fuel type? Aggressive action? Snowfall?).

Fire Effects Information System (FEIS)

If you want to take a deep dive in the fire ecology literature, this is a comprehensive database of annotated literature citations organized around individual plant and animal species. Navigating the site is easy: https://www.feis-crs.org/feis

Pocket Cards

The Pocket Card is a general indicator of fire danger, and used prior to an ignition to determine staffing needs and provide a comparison to historical worst and average conditions. Conditions around the country vary, but the Pocket Card can give everyone the same frame of reference, and is especially useful for new or visiting firefighters. Once created, the Pocket Card is used by firefighters for that season. Cards are found in your Dispatch office, and many are filed here:



1. Pocket Card from Colorado showing how to interpret local fire danger indices and local watch-out situations.

https://famit.nwcg.gov/applications/WIMS/PocketCards/PocketCards

SCI – Stratified Cost Index (SCI)

Developed as an interim performance measure for suppression expenditures, SCI provides "typical" fire suppression costs from historic data by geographic area and fuel type. SCI Results compares current expenditures with historic costs based on fire size, location (e.g. wilderness, WUI), ERC percentile, fuel model, and jurisdiction. Users enter up to four potential final fire sizes. The results are color coded costs per acre. Costs that are less than the 50th percentile are green, indicating near or below average costs. Yellow means costs are high and should be monitored and documented closely. Red means the costs are in the upper 10% for similar fires. See the WFDSS Help Topic Stratified Cost Index for information on Creating, Editing, and Accepting a Stratified Cost Index, and more, http://wfdss.usgs.gov/wfdss_help/index.htm

SCI Results

Stratified Cost Index by Percentage

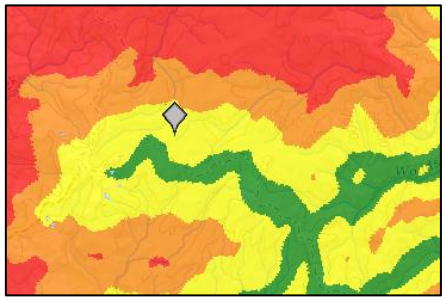
Acres Burned	25%	50%	75%	90%
19322	$226	$865	$3,317	$5,916
31840	$186	$715	$2,742	$4,891
59000	$147	$565	$2,167	$3,866
120000	$112	$431	$1,653	$2,949

Accept Reject

2. A 19,322-acre fire typically costs $865/acre. If your fire costs $5,916/acre then it is more expensive than 90% of fires of this size, in this fuel type, in this region. Find this on the WFDSS Cost tab.

Estimated Ground Evacuation Time

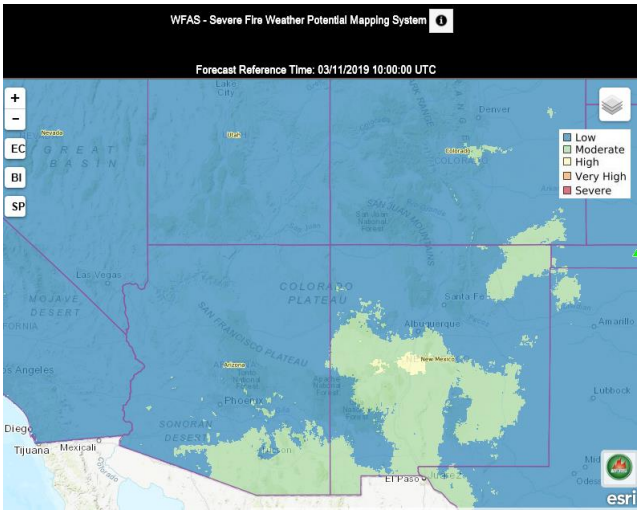
This layer is available for every WFDSS incident. Use it to see how long it would take to evacuate fire personnel in the event of an injury or threat if you commit them to an area. It is not a go/no-go decision tool, but rather *to initiate a dialogue* on the best course of action. Go to the Situation Map and click the "+" sign next to "Fire Environment and Safety," then turn on the "Est Ground Evac Time". See the legend by clicking the icon right after the layer title. Click the question mark to get more information about this layer. It is only available in the lower 48 states and can be downloaded for use in GIS.



3. The fire (grey diamond) is in an area of yellow, meaning evacuation tiem is 2-4 hours. Orange and red areas indicate more time; green takes less. Use this tool when considering deploying personnel.

WFAS

Go to https://www.wfas.net/ for a dynamic fire danger map, fuel moisture, and drought information. The "Severe Fire Weather Potential Mapping System" is a quick and easy way to see a spatial map of potential fire behavior across the Lower 48. Spatial representation of nation-wide indices (sorry Alaska and Hawaii) is handy and the color ramp is very intuitive.



4. In WFAS, you can see "Severe Fire Weather Potential" based on real-time monitoring of weather and fuels.

Values Inventory

If you want to quickly assess the values potentially impacted by the fire, go to the Situation Map and use the layer switcher on the left pane to click on the "+" signs next to Infrastructure, Natural and Cultural Resources, and Unit Fire Planning>Other Unit Shapes. All of these spatial layers can help you see what is near the fire. Not all of these values are negatively impacted by fire, and presence on the map doesn't mean there is a need to keep fire away from these values. Evaluate protection needs with fire personnel or resource specialists.

If you've drawn a Planning Area in WFDSS, you can view a table of the values that exist in the planning area. On the Situation Map, click the "+" sign next to Planning Areas, then the black "down arrow." A link to "Spatial Inventory" pops up national-level data. Be aware that it may NOT include "Other Unit Shapes" if they exist (see above), depending on how your WFDSS Data Manager entered the shapes. The inventory can be downloaded as an Excel spreadsheet using the icon in the upper left corner. For more information see the WFDSS Help section on Obtaining a Values Inventory http://wfdss.usgs.gov/wfdss_help/index.htm

Plan Ahead With Local Resources to Use These Tools

These tools are readily available, but some amount of coordination is needed among local staffs to gather intelligence and use them for decision-making.

Fire Behavior Observations

Responders on the fireline will have useful observations of current fire behavior and fuels conditions that should be considered in decision making. This is expressed in size-ups to Dispatch, radio or in-person

dialogue, or written observations/reports. It's never a bad idea to speak directly with the people who have been directly observing the fire.

Spot Weather Forecast

These are available within a few hours but must be requested through the National Weather Service local office. There is an online form to be filled out with the request for information and any weather observations from the site (https://www.weather.gov/spot/). Fire personnel know how to request this product if it is needed and can call the forecaster by phone to discuss further details or concerns.

Fuel Moisture Monitoring

Monitoring and tracking live and dead fuel moisture content on your unit provides daily, weekly, monthly, and seasonal tracking capabilities to support fire danger calculations and fire behavior predictions. Sampling provides valuable information related to fire potential, but is limited by data quality. The frequency of sampling is of highest value when used in combination with fire danger indices and fire behavior predictions. Fuels sampling helps calibrate analysis and determine seasonal severity. Plan ahead for the necessary equipment, personnel, and frequency. There is information available on the internet; one good guide is available here: https://www.wfas.net/nfmd/references/fmg.pdf

Cost Spreadsheet

When viewing your incident in WFDSS, the "Cost" tab has several estimation methods to choose from. A button below the comment box, "Download Cost Estimator" can help you assess daily expenses and estimate the final cost of the incident. Getting the spreadsheet is easy, but you should coordinate with the Incident Commander, planner, Incident Business Advisor, or fire staffs to fill it out realistically.

Tools Requiring Specialized Experience & (Usually) a Request for Products

The following tools are helpful in decision-making, but Agency Administrators typically have to request these products from a specialized user group that has been trained to use particular software. This might be a Fire Behavior Analyst (FBAN), Long Term Analyst (LTAN), Fire Planner/Ecologist, Finance/Cost person, or other technical specialist. If no one on your local unit can provide these products, you can contact your regional office or the National Fire Decision Support Center using information on the WFDSS Home Page.

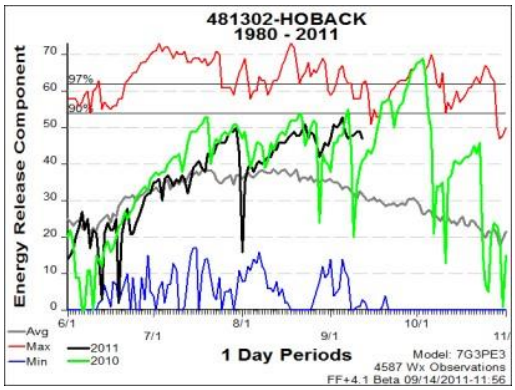
Non-Spatial Tools

Fire Family Plus

Fire Family Plus combines fire climatology and fire occurrence analysis capabilities with a graphical user interface. Users can summarize and analyze weather observations, link weather with local historic fire occurrence data, and compute fire danger indices based on the National Fire Danger Rating System (NFDRS) or the Canadian Forest Fire Danger Rating System (CFDRS). The Pocket Cards, ERC Graphs, and Term Graphs are all created in Fire Family Plus, which requires an experienced user who can access the Weather Information Management System (WIMS) for necessary data.

ERC Graphs

Most Dispatch or fire management offices post an "ERC Graph" to compare the current season's severity to previous years. It displays how current conditions are tracking relative to past "Maximum" and "Average" fire seasons. There may be different graphs for different parts of the unit, such as high/low-elevation, or timber/shrub. The graph is made by people experienced in using the Fire Family Plus software, and with an understanding of how to create graphs that define the fire season and the percentiles. An ERC graph from the weather station closest to the fire is available in WFDSS: Situation Map>Info tab> Fire Danger Rating Graph. Note that the WFDSS graph is automated and is not likely to use the same station or years of data as the graph deemed best by the local fire staffs to assess Fire Danger.



5. This graph shows that 2011 (black line) was tracking similar to the 2010 fire season (green line) for this area. ERC approched the red line, indicating fire behavior on new and existing fires may exhibit above-average fire behavior.

Term Graphs

A Term Graph is created in Fire Family Plus software by an experienced user with an understanding of "season-ending events" in a particular area. The graph can be made at the start of the fire season, but is not typically requested until there is a fire on the unit. The graph can be updated annually as there is only one season-ending event per fire season. The graphs display waiting time probabilities of a season ending event, or, in other words, "how long will this fire persist if we do nothing?"

BehavePlus

BehavePlus is a fire modeling system to predict fire behavior for a specific slope, fuel type, wind speed, and fuel moisture. It does not project "growth" since there is no map, but the quick simulations can assist ground-level tactical decisions such as line construction, safety zones, and point protection activities. Outputs include: surface fire spread, crown fire, fire size, containment success, spotting distance, scorch height, tree mortality, and probability of ignition. Fire Behavior Analysts typically use this software to write the Fire Behavior Forecast in the Incident Action Plan (IAP) for the following day. This software requires an experienced user.

I-Suite Cost Projection

I-Suite software helps track Resources, Costs, Time, Incident Action Plans, and Supply Units supporting an incident. This information can be used as "real" time information for the management of an incident, or it can be used to help build a historical financial database for a specific unit. I-Suite requires an experienced user.

First Order Fire Effect Model (FOFEM)

A software program used to model vegetation mortality, fuel consumption, and smoke production. This is often used when writing compliance documents with planned prescribed fires to compare scenarios. This software requires an experienced user.

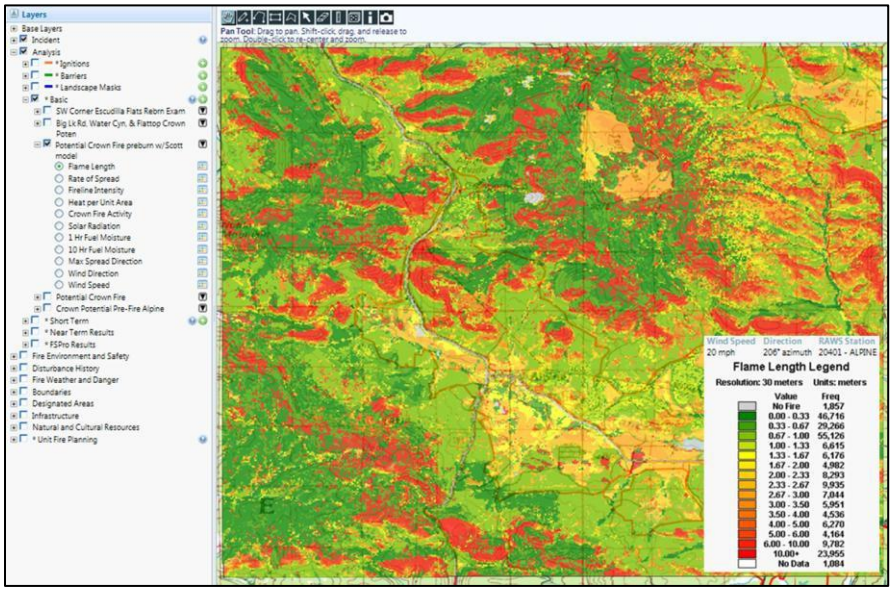
Geospatial Tools

These tools are run in WFDSS or desktop software by trained users with fire behavior modeling experience. Those users know how to access these tools. It is important to describe the question you have or the problem you are trying to solve, as the analyst can often choose the tool that best suits your needs. Also, ask the analyst for a good briefing on the limitations and assumptions of his/her modeling efforts, and confidence in the outputs.

WFDSS Basic Fire Behavior

Basic Fire Behavior (BFB) is:

1. Run by an experienced user in WFDSS by request, but can be run in "automated" mode. Automatic results are often less accurate than analyst-assisted results due to fewer user inputs.
2. Described as "Spatial Behave Plus," computing fire behavior for each pixel on a landscape under a single wind speed and direction.
3. Gives outputs including flame length, rate of spread, crown fire activity, and fire line intensity.
4. Does not address the probability of the cell burning; it only provides fire behavior outputs that would occur on the landscape if it burns under the specified conditions.



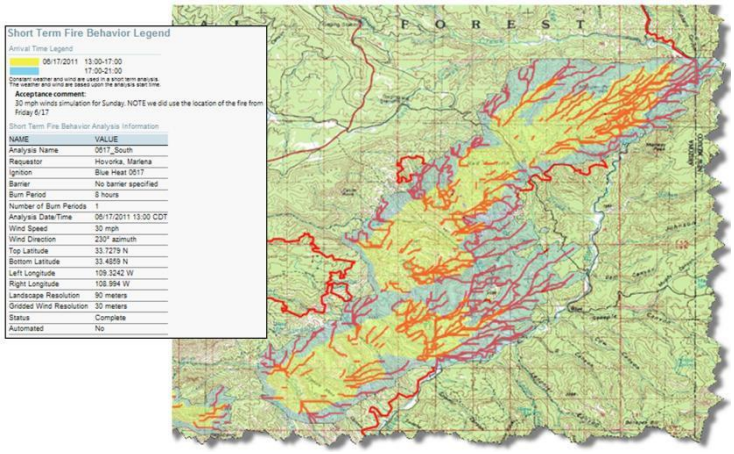
6. Basic Fire Behavior (BFB) gives you a snapshot of fire behavior on each pixel if it burns with the wind speed, wind direction, fuel moisture that is entered. This is an example of flame length. Answers the question: What is expected fire behavior in a certain location tomorrow?

Ask the analyst how weather and fuel moisture scenarios were chosen, if the model was calibrated to observed fire behavior, and if the landscape data is up-to-date. Use it to get a short-term (1 day), "big-picture" idea of potential fire behavior (not growth) across the landscape to inform the fire strategy.

WFDSS Short Term Fire Behavior

Short-Term Fire Behavior (STFB):

1. Provides the same gridded outputs (flame length, rate of spread) as BFB.
2. Adds paths representing "minimum travel time" to show the most likely path a fire will take from the current fire edge when driven by fuels, weather, and topography, which can help plan fire strategies.
3. Shows a different color for each day of fire growth under this single, static wind scenario (e.g. one wind direction and one wind speed).
4. STFB is best in predicting short-term fire behavior over 1 to 3 days since inputs are static.
5. The pathways and colored polygons can give an idea of potential spread or growth of the fire under the given scenario. For example, entering a 12mph SW wind for three 8-hour burn periods will show spread with a steady 12mph SW wind for 8 hours for 3 days.
6. It can be used for scenarios, such as a wind speed and direction associated with a frontal passage.
7. It does not indicate probability.



7. Short Term Fire Behavior (STFB) helps you see where the fire wants to travel, displaying lines that progress outward from the fire edge. It can help with assessments over the next 1-3 days. Answers questions like, "Which drainage has the most potential to funnel the fire toward values?"

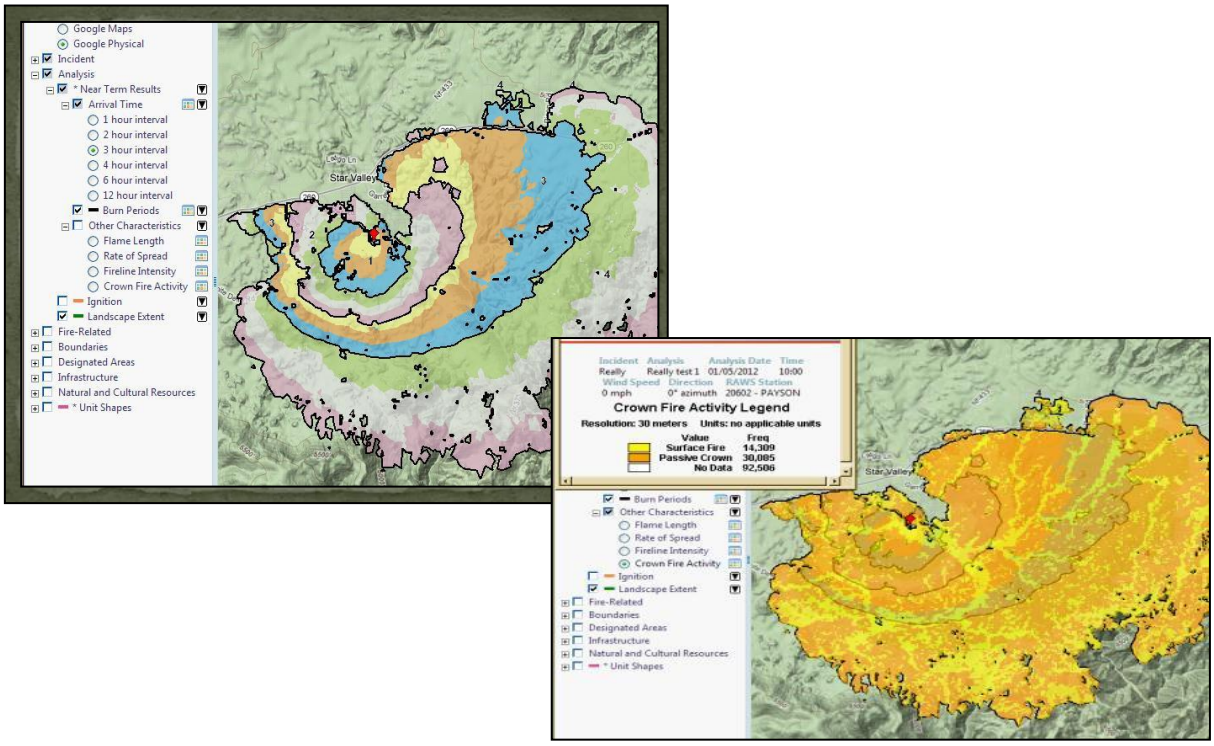
Ask the analyst how weather and fuel moisture scenarios were chosen, if the model was calibrated to observed fire behavior, and if the landscape data is up-to-date. Use it to get a short-term (1-3 day), "big-picture" idea of potential fire behavior and growth across the landscape to inform the fire strategy.

WFDSS Near-Term Fire Behavior

Near Term Fire Behavior (NTFB):

1. Models fire growth in the form of a fire progression using inputs for weather and wind that change hourly over the duration of the simulation.
2. It is more sophisticated than BFB or STFB and takes longer to calibrate and run.
3. Can model fire growth and behavior for up to 7 days, depending on confidence in the weather forecast.
4. Simulates where and when a fire could grow, and predicts fire behavior characteristics on the landscape where it does burn.
5. Scenarios, such as forecast wind events, can be modeled.
6. Does not address probability.

Ask the analyst how weather and fuel moisture scenarios were chosen, if the model was calibrated to observed fire behavior, and if the landscape data is up-to-date. Use it to get an idea of potential fire behavior and growth across the landscape for the next 2-7 days to inform the fire strategy. NTFB can tell you when a fire is expected to reach a point of interest and the type of fire behavior at a location if it burns.



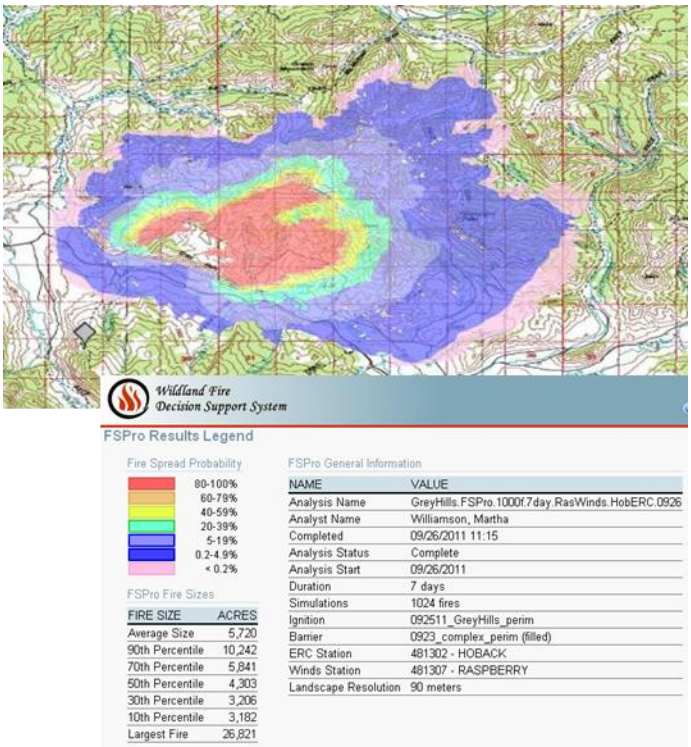
8. In this example of Near Term Fire Behavior (NTFB) output (top), each color represents a 3-hour interval and the black lines represent daily burn periods. The bottom box shows the amount of surface, passive, and active crown fire in the modeled area. Answers questions like, "How will the fire spread based on the forecast?"

WFDSS Fire Spread Probability (FSPro)

FSPro:

1. Predicts fire growth, and is designed to support long-term decision-making (more than 5 days).
2. FSPro uses historic climatological data to "grow" the same fire under thousands of real, historic scenarios in the weather database for a weather station near the fire.
3. The result is not a fire perimeter, as in NTFB, but a *probability surface*, where red is most likely and pink is a rare event.

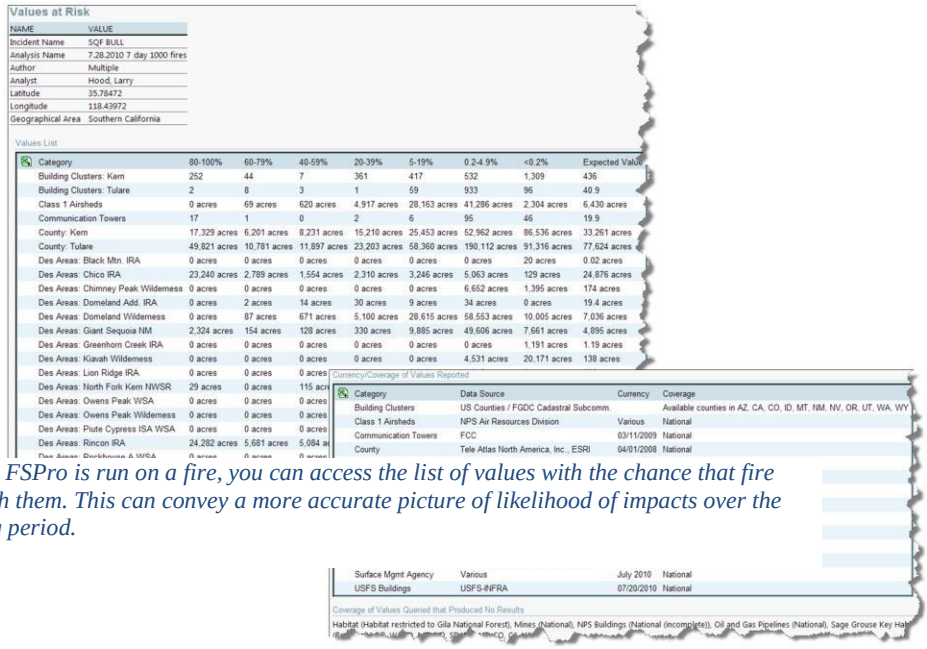
Ask the analyst how weather, wind, and fuel moisture scenarios were chosen, if the model was calibrated to observed fire behavior, and if the landscape data is up-to-date. Most FSPro outputs should show pink for a rare event; if not, it usually means too few iterations were run. Use it to get an idea of potential, probabilistic fire growth across the landscape for the next 5-14 days to inform the long-term fire strategy.



9. Here, FSPro simulated 1024 fires for 7 days. Red represents a high probability of being burned in this timeframe, while pink is showing the "rare event" under modeled conditions. This output is used to answer the question, "How likely is it that the fire will reach a point of interest in a certain time period (usually 5-14 days)?"

FSPro Values at Risk

Values at Risk was covered earlier, but after FSPro has been run, an additional table is available to tell you how likely each value might burn (remember, it is not likelihood of "loss" since not all values are negatively impacted by fire). FSPro Values at Risk (VAR) combines FSPro output with national and preloaded local value data (again, talk to your WFDSS Data Manager if local shapes are not showing up



10. Once FSPro is run on a fire, you can access the list of values with the chance that fire will reach them. This can convey a more accurate picture of likelihood of impacts over the modeling period.

since this setting is locally controlled) to calculate the "expected value (EV)" for each resource by multiplying the probability by the "count" of that resource in that probability area, and tallying them. EV

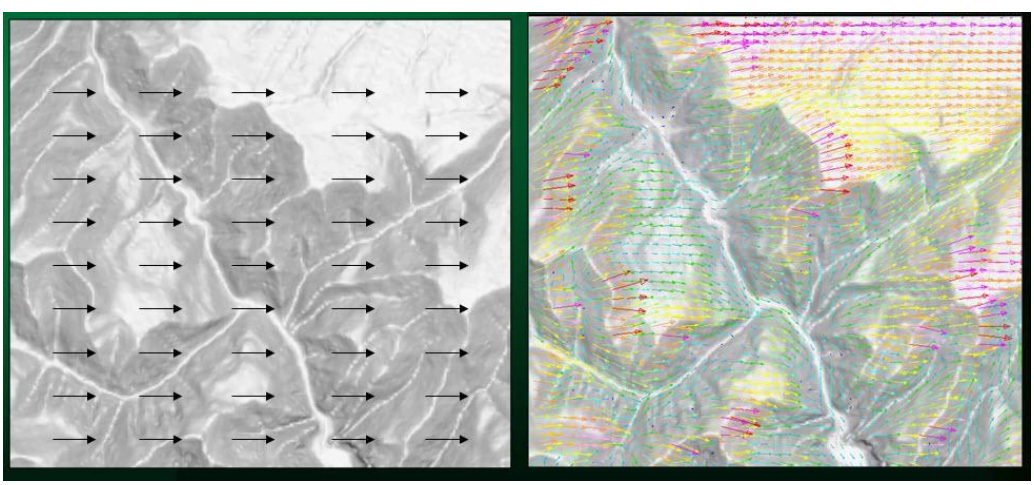
is displayed in the far right column and is used as one way to represent risk. This product is accessible from the Results tab of the FSPro Run by going to the "Values at Risk" link; it may be necessary to ask the analyst to access it and provide a briefing on assumptions and limitations of this output. For more information, go to the WFDSS Help section Values at Risk Information, https://wfdss.usgs.gov/wfdss_help/WFDSSHelp_values_at_risk_info.html

FlamMap & FARSITE

FlamMap is a desktop two-dimensional fire growth simulation modeling system that now includes a tab to also run FARSITE. These desktop versions were used by analysts before WFDSS made these modeling systems available online. BFB/STFB is very similar to FlamMap and NTFB is very similar to FARSITE. There is no desktop version to run FSPro. At times, analysts can use these models if WFDSS is unavailable. There are ways to download landscape data and weather inputs from WFDSS and other sources to facilitate analyses in FlamMap. If WFDSS is unavailable, finding an analyst who can run FlamMap may be helpful, though not every analyst has these skills. GIS skills are helpful to create useful products from the outputs. Tutorials are expected to be available during the summer of 2019. More information is available here: https://www.firelab.org/project/flammap

Wind Ninja- Gridded Wind Model

WindWizard produces "gridded" wind data that can be used to visualize how a single wind speed and direction will be funneled as it is pushed across terrain. The output can be used as an input to fire behavior models to better represent the winds expected to influence fire spread and behavior. Users can download desktop software (https://www.firelab.org/project/windninja), run scenarios on a smartphone app (https://www.firelab.org/project/windninja-mobile), or use WFDSS with gridded winds in BFB and STFB. Wind information at this detail is not available from the weather service. The shape files produced can be used for review of the channeling and checking effects of local topography on wind flow – useful for operational, planning and educational purposes. The high resolution wind information is useful in identifying areas and/or conditions that may produce high fire intensity and spread rates and for identifying locations where fire spotting might occur.



11. Westerly winds are interpreted by some models to be very uniform, as indicated in the left picture. The right picture shows westerly winds influenced by terrain. Winds speed up, slow down, and eddy. This tool can help understand local fire behavior.