The Wildland Fire Decision Support System: Integrating Science, Technology, and Fire Management

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Federal agency policy requires documentation and analysis of all wildland fire response decisions. In the past, planning and decision documentation for fires were completed using multiple unconnected processes, yielding many limitations. In response, interagency fire management executives chartered the development of the Wildland Fire Decision Support System (WFDSS).

WFDSS is a Web-based system for comprehensive, risk-informed decisionmaking and implementation planning. WFDSS is linear, scalable, and responsive to changing fire situations, provides a documentation system that is applicable to all unplanned fires, and integrates the best available science into fire management in an efficient and practical manner. It provides access to a suite of weather analysis and fire behavior prediction tools that provide managers information on season-ending event timeframes, fire size probabilities, fire spread pathways and short-term arrival times, fire weather forecasts, and historical weather trends. Economic assessment tools describe values at risk, historical fire costs, and total fire cost estimates.

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Documenting Decisions and Tracking Analysis

Prior to WFDSS, fire managers used different decision and documentation processes depending on the driving management strategy and the estimated duration of an incident. Wildland fires managed with suppression objectives required a wildland fire situation analysis (WFSA) to be completed,

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while fires managed for resource benefits needed a wildland fire implementation plan (WFIP). Additionally, suppression incidents expected to be of long duration also required a long-term implementation plan (LTIP).

These processes had many limitations, including preparation of data, tool access, timeliness, and quality of the final product. Often, there was pressure to complete these processes while fire managers were busy with urgent fire management tasks. These processes were completed on paper or through desktop software and often did not document all critical information in an easily usable and viewable format. WFSAs were frequently prepared quickly, late at night, after an unintended outcome.

The quality of the final product varied and sometimes contained redundant decisions or recommended actions that had a low probability of success. Sometimes, unrealistic alternatives were created, analyzed, and then abandoned. There was often little input from specialists and resource managers. Standards and guidelines from agency land and resource management plans were not always well linked and documented. Incident size was sometimes poorly estimated and planning areas were incorrectly drawn, resulting in costly revisions. These limitations of past processes warranted change.

A Changing Fire Environment

The fire environment has changed over the past century. Dramatic shifts in the overall fire management situation, specfic strategies and management capability have occurred throughout the history of fire management (fig. 1). Fire management complexity continues to rise as a result of altered vegetative conditions and fuel complexes, combined with recent trends in seasonal weather and fire danger. Meanwhile, operational capacity has remained unchanged for years—although it saw a small increase after the fire season of 2000, when more resources were made avail-

able by national legislation. Since the middle of the last century, use of prescribed fire and fires managed for resource benefits has expanded, science and technology has improved steadily, and decision support has expanded rapidly. To match current and projected trends in fire complexity (in terms of its nature and our responses), all of these factors will bring about an increased reliance on decisionmaking, including development of a new decision support methodology to advance decision documentation and analysis.

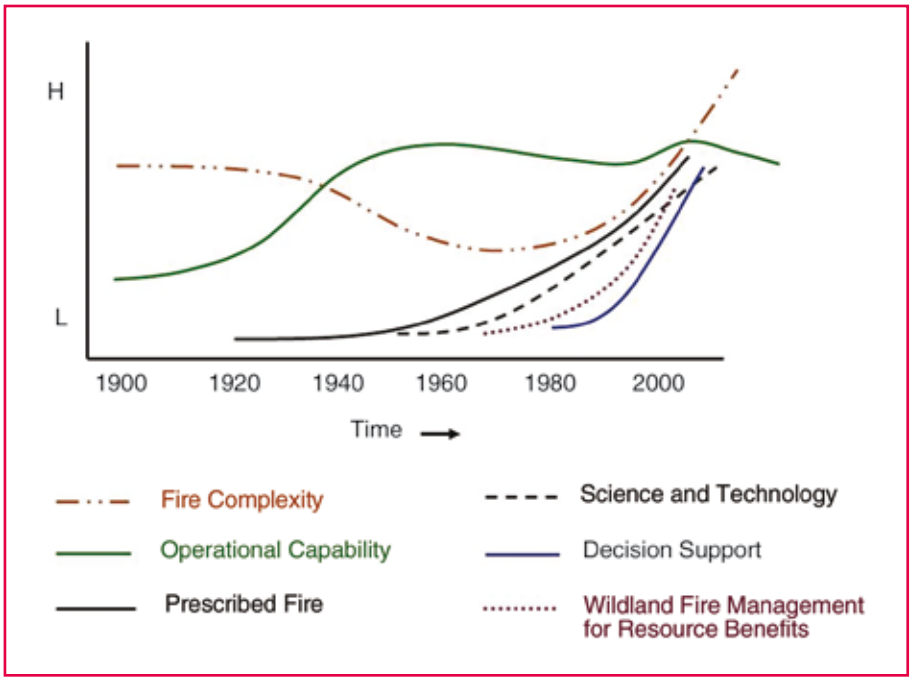

Figure 1—*The changing wildland fire management situation emphasizes the need for new decision support methodology.*

In response to increased wildland fire complexity, the need for standardization, and improved efficiency, the National Fire and Aviation Executive Board (NFAEB) chartered WFDSS in 2005. WFDSS supports and documents wildland fire decisions through a host of risk assessment and economic analysis tools. When existing strategies are not sufficient to address a fire situation, WFDSS allows for the creation of courses of action and implementation plans to address increasingly complex wildland fires. WFDSS replaces and consolidates the WFSA, WFIP, and LTIP processes within a single process that is intuitive and easy to use. Line officers, fire managers, and analysts can use WFDSS to plan, manage, and support decisionmaking on wildland fires.

What Makes WFDSS Different?

WFDSS is uniquely different from other decision systems that have been used in wildland fire management. The advantages of WFDSS are that it:

- Is a comprehensive, Web-based system useful for decisionmaking on all wildland fires;
- Does not require a comparison of multiple alternatives but does accommodate this if desired;
- Utilizes spatial displays as its foundation, reducing the need for large text inputs;
- Allows for incorporation of multiple unit objectives and requirements and provides space to create incident-specific objectives and requirements;
- Does not dictate a course of action but provides a framework and information for decisionmaking and process documentation;
- Allows fire managers and line officers to view the parameters of past and current incidents in an area in order to consider combined and adjacent effects;
- Provides immediate availability of products;
- Produces outputs from fire behavior and economic tools much more quickly than previously possible;
- Allows managers and line officers to use tool outputs to better communicate fire information to cooperators and non-fire individuals and agencies;
- Provides for risk-based decisionmaking while matching the process to the decisions; and
- Is linear, scalable, and customizable according to need.

WFDSS Attributes

Beyond meeting the documentation needs of fire managers and line officers, WFDSS has attributes that address the limitations of the previous decision documentation methods. These attributes include:

- Accessibility: WFDSS is a Web-based system and does not require users to install and update desktop programs or share paper copies. Users need only an Internet connection and login identification to access WFDSS. This provides for easy and quick access to the tools and information within the system.
- Consistency: WFDSS is consistent with accepted models of risk-informed decisionmaking.
- Flexibility: WFDSS matches different types of analyses with different kinds of risk characterizations and decisions. It makes risk characterization intuitive, logical, relevant, and understandable.
- Information assembly and consolidation: Data that already exist from different sites are consolidated to present concise information.
- Adaptability: WFDSS provides a decision framework that is linear, scalable, progressive, and responsive to changing fire complexity. As incidents progress in size and complexity, WFDSS provides decision and documentation support to match fire management needs. Specific analysis tools can be accessed to address changes in fire conditions.
- Geospatial capability: Geospatial displays in WFDSS reduce the amount of text needed by presenting the information spatially. Geospatial display of preloaded landscape layers allows for a quick situational analysis and displays of potential fire behavior, resource values, and management action points. These layers can be viewed at varying resolutions and multiple scales (fig.2).
- Safety and resource availability assessments: WFDSS provides information for the consideration of safety, risk, and the availability of resources as part of the decision process.

WFDSS allows for the creation of courses of action and implementation plans to address increasingly complex wildland fires.

WFDSS User Roles

Access to WFDSS is gained through user role assignments. Role assignments match individual responsibility and expertise to the job duty and tools in WFDSS needed to make decisions. User roles include viewer, dispatcher, author, geographic area editor, national editor, fire behavior specialist, rapid assessment of values-at-risk (RAVAR) analyst, and super analyst.

WFDSS Structure

The decision support structure in WFDSS is linear with the following organization: information, situation, objectives, course of action, validation, decision, periodic assessment, and reports. The function of each is as follows:

- The information section is used to obtain and review incident information, such as area jurisdiction, fire size, and fire location.
- The situation section is used to view maps, reference data layers, and applicable fire behavior and economic assessments (fig. 3).
- The objectives section displays individual land and fire management plan strategic objectives and management requirements; it also provides space to create incident-specific objectives and requirements.

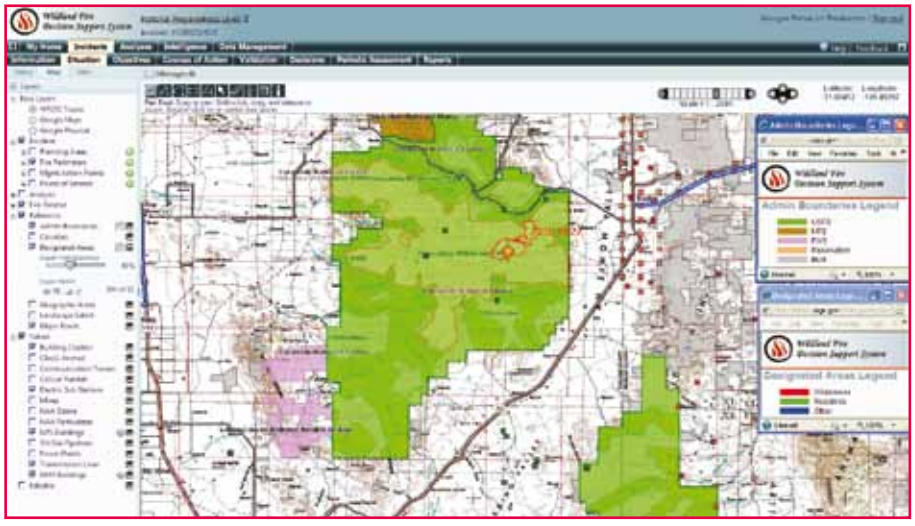

Figure 2—*The 2010 Horseshoe fire (Arizona) with a backdrop of administrative boundaries and designated areas, building clusters, Forest Service buildings, major roads, transmission lines and electric substations displayed in the WFDSS's situation map page. WFDSS's spatial displays can quickly convey such critical information.*

- Within the course-of-action section, users can define a specific course of action for an incident. These can range from following a predefined initial response to a detailed incident-specific description that includes management action points, resource commitments, and predicted costs.
- The validation section provides a review of the situation, objectives, and course of action parameters to ensure that the unit and incident objectives can be met. If they cannot be met, the validation section guides the development of a new course of action.
- The decision section allows the appropriate line officer to approve the decision and provide a rationale.
- The periodic assessment section provides a process for periodic review of the current decision, responses, and accomplishments in order to evaluate effectiveness, confirm accuracy, and continue or adjust associated planning activities.

Users can consolidate information into different documentation reports for viewing on screen or printing from the reports section. Reports can be generated for each of the WFDSS sections or for the entire WFDSS planning and analysis process.

Fire Behavior Prediction, Weather Analysis, and Economic Assessment

WFDSS provides access to a host of fire behavior prediction, weather analyses, and economic assessment tools to gain better situational awareness and fire potential. These tools aid in determining fire size probabilities, season-ending event timeframes, historical weather trends, fire spread pathways and short-term arrival times, fire behavior characteristics, fire weather/fire danger forecasts, information on values at risk, historical fire costs, and estimated total fire costs.

WFDSS includes the fire spread probability (FSPro), basic fire behavior and short-term and near-term fire behavior prediction tools. Fire size probabilities can be modeled with FSPro. FSPro calculates two-dimensional fire growth and maps the probability that fire will visit each point on a landscape of interest within a specified time, based on the current fire perimeter or ignition points and in the absence of suppression. FSPro uses current weather forecasts and historical climate data along with landscape and fuel characteristic layers to calculate these probabilities. Within the FSPro options, users can also view season-ending event timeframes and historical weather trends (fig.4).

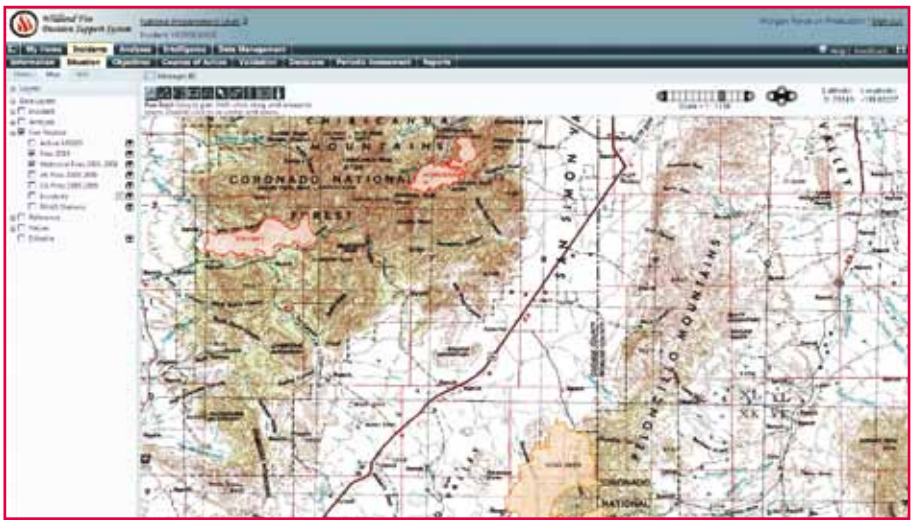

Figure 3—*To-date 2010 fires in red and historical fires (2001–2009) in orange displayed on WFDSS's situation map page.*

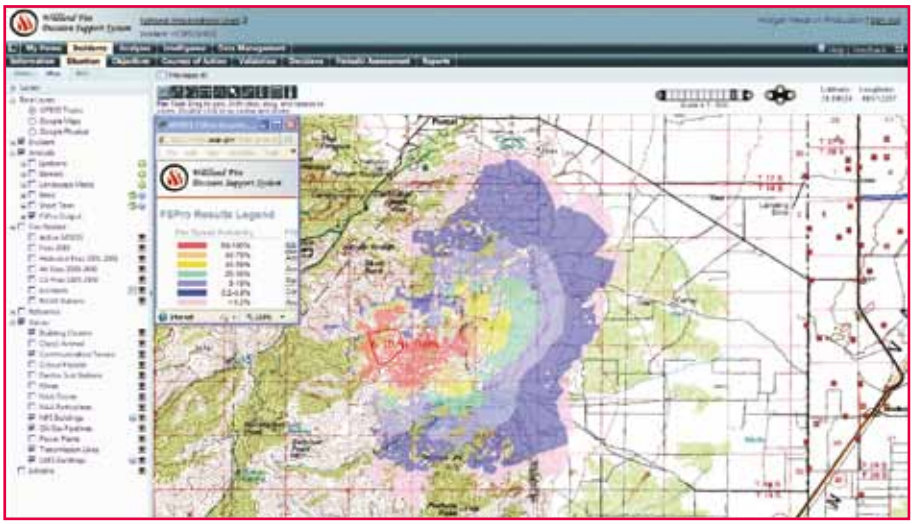

Figure 4—*Fire spread probability (FSPro) results displayed on the WFDSS situation map page. These results can easily be displayed and reviewed by fire managers and included as part of a decision document.*

Fire spread pathways and arrival times can be modeled in WFDSS using the short-term fire behavior tool. Outputs include the arrival time of a fire to reach a given area and the major pathways the fire will follow over a landscape given a consistent wind speed and direction. The basic fire behavior tool in WFDSS can be used to determine fire behavior characteristics such as flame length, rate of spread, and fireline intensity across an entire landscape for one moment in time and under specific weather conditions. The near-term tool uses hourly forecast weather data to produce sub-daily perimeter projections and fire behavior characteristics such as flame length and rate of spread.

In addition to these fire behavior prediction tools, fire weather and fire danger forecasts are readily available in WFDSS. To access the most current weather and fire danger forecasts, users click on a location of interest on a map, and the most up-to-date forecasts appear on screen. These fire behavior and fire weather/fire danger tools provide valuable information to fire managers and line officers to aid in strategic planning and formulating courses of action.

The economic assessment tools in WFDSS provide information on resource values at risk, historical fire costs, and estimated total fire costs. The Stratified Cost Index (SCI) tool calculates the expected costs of a large fire given its characteristics, based on past fire costs. Users can quickly view historical fire costs and include these values in their decision documentation.

Another available economic assessment tool is the RAVAR tool. RAVAR identifies primary resource values-at-risk on large incidents and is integrated with an FSPro model output to identify the likelihood of different resources being affected. RAVAR can aid in developing strategies by identifying and quantifying the significant resource values most likely to be at risk.

Additional Resources

In addition to the WFDSS production site (used for decision support and documentation for actual wildland fire events), there is also a separate WFDSS training site. The training site can be used by fire managers and line officers to practice using the system, become familiar with the decision documentation process, and use the analysis and assessment tools without disrupting or affecting actual incidents. To obtain a WFDSS user account, visit the WFDSS homepage <http://wfdss.usgs.gov>, the source for information on WFDSS training, related resources, frequently asked questions, and more. Many products are complete within WFDSS while others are still under development, and some will continue to evolve as modeling and display technology improve. WFDSS will be updated as improvements are made to integrate the best science and technology with fire management to assist effective decisionmaking. ■