

LESSONS LEARNED FROM RAPID RESPONSE RESEARCH ON WILDLAND FIRES



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In recent years, more researchers are collecting data either on active wildfires or immediately after wildfire occurrence. Known as Rapid Response Research, this important undertaking provides real-time information, useful data, and improved tools for managers.

Rapid Response Research can encompass fire ecology, burn severity, fire behavior, firefighter safety, emissions, erosion, vegetation response, remote sensing, and a multitude of various fire-related topics.

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This article is a synthesis of informal discussions and a panel review held at the 2005 Joint Fire Sciences Principal Investigators Meeting. These discussions concentrated on what has been learned from Rapid Response Research, including insights from managers who provided recommendations on how to improve coordination between research and fire management teams.

Researchers must understand and work closely with fire management organizations *without* compromising these managers' primary tasks.

By using this Rapid Response Research, we have the potential to link fire effects to conditions before, during, and after fires. This information is critical to building the next generation of tools for

forecasting the consequences of fire and fuels management.

In this way, Rapid Response Research products are also helping fire managers and local land



Monitoring Active Fire Behavior—Rapid Response Researcher Jim Reddering, remote sensing program manager with the National Center for Landscape Fire Analysis, University of Montana, Missoula, MT, monitors the 2003 Cooney Ridge Fire near Missoula. Photo: Andrew Hudak, research forester and landscape ecologist, Forest Service, Rocky Mountain Research Station, 2003.

managers make informed decisions about the ecological and social consequences of fire.

At the same time, however, Rapid Response Researchers can complicate resource and personnel management for managers during critical emergency periods on wildfires. Researchers must therefore be constantly aware of the challenges of conducting research on active wildfires (see sidebar). They must understand and work closely with fire management organizations without compromising these managers' primary tasks.

The Joint Fire Science Program funding agency requires these scientist–manager partnerships to place a strong emphasis on transferring research findings to the field.

Fire scientists and fire managers have long worked closely together, but if they are to successfully address today's complex wildland fire challenges, they must now work together even *more* closely.

Teams of research scientists and technicians have an increasing presence in today's fire camps. Demands for information and accountability from the media and general public also peak during large fire incidents.

The added safety and logistical requirements required for Rapid Response Research are justifiable only if the research data can be effectively collected—and we learn information that we cannot ascertain by any other means.

Recommendations for Successful Rapid Response Research

Researchers must understand the fire organizations and their objectives. The fire managers' primary responsibility is to manage the fire safely—not to support research. When arriving to do research on a fire, researchers must therefore be prepared, have the necessary “red card” credentials that indicate sufficient training, fitness, and the appropriate knowledge.

Researchers must also have—and follow—an operations plan. We recommend using a liaison and building strong relationships with fire managers. Just as importantly, researchers must always share what was learned with these fire managers.

Science, guided by questions that are important to managers, is essential to improve the understanding of wildland fire dynamics and to develop strategies that

address fire risk, rehabilitation, and restoration. To ensure that this occurs, researchers must be constantly aware of the potential challenges that face them while conducting research on active wildfires.

Researchers must understand that fire management organizations adhere to a strict code and follow a chain-of-command. Researchers must respect this chain-of-command by:

- Attending daily fire management meetings and briefings,
- Communicating clearly and regularly with incident management teams,
- Following the protocols established on each fire,
- Checking-in with division supervisors and fire crews working near them, and
- Following *all* safety guidelines.

The work done to nurture relationships between management and research communities outside of the actual fire season is equally important for successful Rapid Response Research on actively burning fires. This includes engaging with fire managers through workshops and trainings.

Remember, the “goodwill” built through 10 years of successful Rapid Response Research can be threatened by safety violations and poor communication. More information—including the 9 recommendations for any research team considering Rapid Response Research on wildland fire or other incidents—is available at <http://www.cnrhome.uidaho.edu/default.aspx?pid=70495>.

What Is Rapid Response Research? How Is it Different From Other Fire Research?

Certain types of information or data that are essential to our understanding of wildland fire can only be obtained during, or immediately after, a fire. Large fires can provide unique opportunities for assessing fire behavior, fire effects, fuel treatments, and social responses on a landscape scale.

Rapid, well-organized, and pre-planned responses from the science community must therefore be organized to gather data on actively burning fires.

If advance planning and funding for a timely research response is not in place, critical data could be lost.

Rapid Response Teams must coordinate with fire management teams to quantify conditions immediately before, during, and after wildfires and prescribed burns.

By the time funding is obtained, the research opportunity has often passed, or other factors—precipitation, faded memories, changing seasons—have masked or destroyed important information.

In the past, research on active fires has been hampered by:

- Lack of funding,
- Inadequate preseason planning and coordination,
- Poor adoption or adherence by researchers to the incident command system, and
- Lack of acceptance or tolerance of research by incident management teams (IMTs).

The governing board of the USDA/USDOJ Joint Fire Science Program (JFSP), a partnership of six Federal wildland fire management and research organizations, has provided financial support for teams of research scientists and technical specialists that can mobilize quickly to investigate fire behavior or fire effects on active fire incidents.

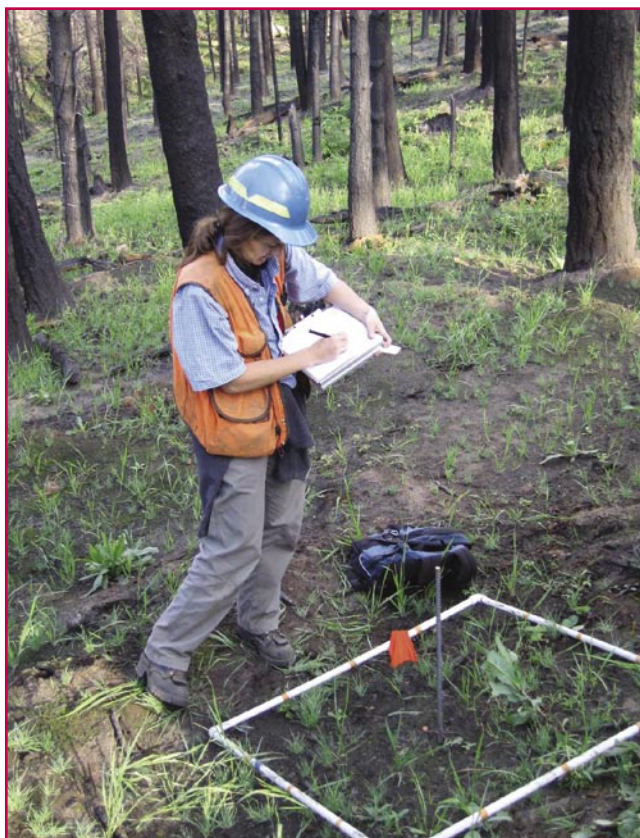
The JFSP funding agency provides scientific information and support for fuel and fire management programs. The JFSP funding agency also requires scientist–manager partnerships that place a strong emphasis on transferring research findings to the field.

How Is Rapid Response Research Conducted?

Advance Planning Proves to be Crucial

Rapid Response Research teams must coordinate with fire management teams to quantify conditions immediately before, during, and after wildfires and prescribed burns. Rapid Response projects are expected to take advantage of opportunities to obtain information on large fires.

Traditionally, researchers conceived research questions and designed experiments beforehand and submitted competitive research proposals. If awarded, they then developed operations' plans, participated in training sessions, and purchased



Post Fire Data—Leigh Lentile, post-doctoral research scientist with the Department of Forest Resources, University of Idaho, Moscow, ID, collects data on post-fire ground cover and vegetation response one year after the Umatilla National Forest's School Fire. Photo: Pete Robichaud, research engineer, Forest Service, Rocky Mountain Research Station, 2006.

equipment. With Rapid Response Research, however, the study area is not defined until after a fire ignites and various research criteria are met.

Researchers must therefore be ready to decide—within days—whether a given fire will be sampled and travel to the fire on short notice, strategize data collection, and coordinate with IMTs to ensure safe operations. Rapid Response Research teams must always be prepared for efficient mobilization, be flexible, and be cognizant of management concerns.

A Rapid Response Research team led by Elaine Kennedy Sutherland, Forest Service research biologist, performed Rapid Response Research on seven fires around Missoula, MT, in 2003. Sutherland's team focused on fire effects on fish and fish habitat.

Coordinating with local land management decisionmakers and IMTs, a crew of six researchers located small streams with known native trout populations or potential trout habitat. They then established sample sites near actively burning fires—locations likely to burn in a day or two—taking measurements, setting up instruments, and surveying fish populations.

In some of these locations, fires burned the study sites, or areas immediately upstream from the sites. Some of the sampled sites were never reached by fire. After the fires, fish populations were resurveyed and measurements were retaken. For some data, the sites were monitored for days or weeks.

While the data collected during this project addressed research



Measuring Water Infiltration Rate—Sarah Lewis, civil engineer with the Soil and Water Engineering Research Work Unit, Forestry Sciences Laboratory, Moscow, ID, measures relative water infiltration rate to assess the degree of post-soil water repellency after the Hot Creek Fire on the Boise National Forest. Photo: Pete Robichaud, research engineer, Forest Service, Rocky Mountain Research Station, 2005.

Some fire management teams more readily welcome researchers on fires than others.

objectives, it was also useful for the IMT, as well as the resource specialist and fish biologists. This information proved instrumental in developing post-fire rehabilitation objectives. Presentations were made to fire management teams during incident briefings, and the data were made available immediately post-fire.

Applied Research

Applied research that provides real-time data and information builds credibility, increases the likelihood of application, and fosters opportunities for future collaboration between scientists and managers.

Familiarity with the fire management program and its science needs increases the potential for meaningful data collection and interpretation. Some fire management teams more readily welcome researchers on fires than others. This acceptance often depends on fire conditions and objectives, as well as the prior nurturing of personal relationships and credibility between researchers and team members.

For example, Peter Robichaud, Forest Service research engineer, conducts Rapid Response Research on post-fire hydrological response

and soil erosion mitigation. Robichaud has provided erosion control measures information such as the effectiveness of felling trees and snags on the contour. This, in turn, has allowed Burned Area Emergency Response (BAER) teams to immediately change contract specifications, alter treatments, and improve effectiveness (Robichaud 2005).

Often times on these fire incidents, a unique window of opportunity exists to extend preliminary research results directly to end-users. For instance, when Robichaud arrives on a fire, he provides a brief justification of why his research is necessary and useful, and also provides a followup closeout presentation. Although analysis is usually incomplete before this closeout briefing, Robichaud can still share:

- Anticipated results;
- Benefits of the research; and
- How these results can enhance adaptive management, thereby improving the managers' decisionmaking and support.

Research Findings During 2003 Fires

The 2003 Montana fire season brought many opportunities for several newly funded Rapid Response Research projects. Teams led by Forest Service researchers Colin Hardy, Phil Riggan, and Andy Hudak—in collaboration with University of Montana and University of Idaho faculty members—explored alternative image acquisition and analysis methods for remote sensing of burn severity.

Mutual research objectives were to improve the predictive capabilities for fire risk, the real-time assessment of fire behavior, and the

Rapid Response Research provides a venue for scientists to obtain information and knowledge that is not otherwise available.

post-fire mapping and description of fire effects—thus, improving the strategic effectiveness of post-fire rehabilitation efforts.

Under the supervision of Ed Mathews, the research team's IMT research liaison, small crews of research technicians were sent into areas *before* they burned to collect prefire measurements of soil and vegetation condition and to install instruments to collect heat flux, as well as other fire behavior information.

These instruments then autonomously recorded or reported observations to field personnel working in a safe zone located outside the fire perimeter. As fires burned through these field sites, a ground-based thermal infrared radiometer measured radiant heat flux emitted from points within or near the sample sites.

Additionally, the multispectral FireMapper™* image acquisition system installed on the Pacific Southwest Research Station's airborne sciences aircraft collected multiple images of the sample site at 4-minute time steps (Riggan and Hoffman 2003; Riggan and others 2003). These missions were

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Feel the Heat—Fire-protected video systems and instrumentation for measuring heat flux, fire behavior, and local weather are installed on the Dragon Complex Wildland Fire Use Incident on the North Rim of the Grand Canyon, AZ, by mechanical engineer Jason Forthofer (sitting) and project leader Colin Hardy. Both men are from the Fire Behavior Research Work Unit, Missoula Fire Sciences Laboratory, Missoula, MT. Photo: Dan Jimenez, Forest Service, Rocky Mountain Research Station, 2005.



Thermal Infrared—Patrick Freeborn, physical scientist with the Fire Chemistry Research Work Unit, Missoula Fire Sciences Laboratory, Missoula, MT, operates both mid- and short-wave thermal infrared cameras to monitor radiant heat flux and temperatures on the Dragon Complex Wildland Fire Use Incident on the North Rim of the Grand Canyon, AZ. Freeborn installed these cameras inside the Rapid Response Research plots. Photo: Colin Hardy, Forest Service, Rocky Mountain Research Station, 2005.

planned, executed, and monitored in full compliance with local incident aviation safety protocols, including pilot briefings, coordination with air attack, and post-mission debriefings.

These technology-produced multi-band (visible and thermal) images were used to remotely determine the heat intensity of the fire. These data were merged onto a digital topographical map which was then accessed by fire commanders for potential decisionmaking on the ground.

What Is the Value of Rapid Response Research?

Rapid Response Research has great potential to promote mutual understanding between the land management and science communities. Scientists doing Rapid Response Research have a responsibility to provide land managers with defensible information and the useful tools necessary to expedite and strengthen fire management.

Researchers learn from observing fires firsthand. They become more aware of the total management context, as well as the broader decisionmaking process.

Today, a critical need exists for researchers to evaluate the effectiveness of management actions to reduce the hazard of severe wildfire and to mitigate fire effects on human, floral, and faunal populations. To do this, scientists must understand the logistical and temporal constraints and the sociopolitical environment in which managers make most of their decisions.

One of the primary goals of Rapid Response Research on wildfires is to facilitate the interpretation and utility of research results to enable land managers to make challenging, timely decisions. Researchers learn from observing fires firsthand. They become more aware of the total management context, as well as the broader decisionmaking process.

Rapid Response Research provides a venue for scientists to obtain information and knowledge that is not otherwise available. This research allows scientists to collect real-time measurements and observations that are normally modeled or reconstructed.

Rapid Response Research on fire behavior can play a critical role in furthering our evaluation of assumptions underlying existing models, as well as providing key information for the evolution and development of new models. Rapid Response Research can assist with model calibration, provide accuracy assessments for many commonly used predictive models, and increase user confidence in these tools.

Furthermore, Rapid Response Research can provide data to test new equipment. Information from the duff moisture meter, for example, adds a new level of accuracy

to predictions of duff consumption and smoke emissions (Robichaud and others 2004). Such equipment can also be used to determine the best and safest time for a prescribed burn. Improved tools to detect soil water repellency and areas at risk to erosion can help to identify hazardous situations, streamline treatments, and reduce costs.

Sharing Results

Results and recommendations from Rapid Response Research projects are being shared with many different users. Roger Ottmar has been conducting Rapid Response Research for most of his career as a Forest Service research forester. In the early 1990s, Ottmar's Rapid Response Research involved attaching instruments to interagency hotshot crew members as part of a smoke exposure study.

This ongoing research has provided important information about fuel flammability and smoke emissions—critical for both short- and long-term firefighter safety and health.

Forest Service research scientists Bret Butler and Jack Cohen's Rapid Response Research work has provided firefighters with valuable information about safety zones (Butler and Cohen 1998a, b). Due to their efforts, a combination of trainings, publications, and Web sites now provide information on how and why safety zones are used on fire incidents. In fact, their safety zone guidelines are now included in the Incident Response Pocket Guide carried by every wildland firefighter.

In Alaska, during the summer of 2004, the Rapid Response Research team led by Roger Ottmar and

David Sandberg collaborated with research teams from the Forest Service, University of Idaho, Colorado State University, and Yale University to jointly sample and characterize fuels, vegetation, fire consumption, and smoke production from the same sample points before, during, and after the burn.

Their data will help to develop improved, practical indicators of burn severity that will complement existing indicators such as the "normalized burn ratio" used by BAER teams and others. Additionally, this joint effort complements ongoing research to:

- Assess the Alaska black spruce and white spruce fuel type photoseries (Ottmar and Vihnanek 1998);
- Provide calibration (Rorig and others 2003) for Canadian Forest Fire Danger Rating System (Turner and Lawson 1978), National Fire Danger Rating System (Deeming and others 1978), Consume (Ottmar and others 1993), and fuel models (Scott and Burgan 2005), and
- Evaluate duff consumption elements of predictive models (Ottmar and Sandberg 2003).

Successful field operations would not have been possible without the cooperation of the Alaska Fire Service, State of Alaska, and IMTs who tactically and logistically supported this Rapid Response Research.

Unique Opportunity

Rapid Response Research provides a unique opportunity to pursue questions important to managers tasked to integrate the best available science in their decisionmaking about fire risk, rehabilitation, and restoration.

Rapid Response Research links post-fire effects, fire behavior during the fire, and prefire conditions. In this way, Rapid Response Research can build and help propel the necessary understanding for improving fire and fuels management.

Lessons learned from the pioneers of Rapid Response Research have demonstrated that the potential benefits outweigh the costs and—if researchers and managers continue to work together effectively—the challenges *are* manageable.

Thus, Rapid Response Research can continue its vital role of advancing science that is both relevant and immediately useful to all of us.

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ACCESS TO CRITICAL FIRE INFORMATION AND RESOURCES

The Wildland Fire Lessons Learned Center has added a new feature to its popular Web site, <<http://www.wildfirelessons.net>>. Called “Advances in Fire Practice,” it highlights the ideas and efforts that leaders in the fire management and research communities have identified as widely applicable and innovative.

In doing so, this special area of the Web site now provides easy access to critical fire information and resources, including:

- Summaries of research articles, tools, and fire science findings.
- Synopses of many of the fire resources available from Forest Service research stations and labs.
- Fire-centered indexes of science journal articles that allow readers to scan recent abstracts and fire science titles in major journals.
- A growing collection of case studies of innovative projects that tackle the myriad challenges that continue to face fire professionals.
- Current articles on the fireshed assessments that are dramatically reshaping the California land managers’ approach to fuels management.
- Articles that explore the links between forest restoration and bioenergy production—spurred by a stewardship contract in Arizona’s White Mountains.
- An “Instructor’s Corner” that provides resources for fire science class instructors and students, including a curriculum “swap corner” and an article review platform.

This new Advances in Fire Practice section can be accessed at <<http://www.wildfirelessons.net/AFP.aspx>> or through the main Wildland Fire Lessons Learned Center Web site at <<http://www.wildfirelessons.net>>. ■