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Value and Challenges of Conducting Rapid Response Research on Wildland Fires

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Abstract

Rapid Response Research is conducted during and immediately after wildland fires, in coordination with fire management teams, in order to collect information that can best be garnered in situ and in real-time. This information often includes fire behavior and fire effects data, which can be used to generate practical tools such as predictive fire models for managers. Drawing upon lessons learned from fire managers and researchers working on active wildland fires, we identify challenges including high costs, logistics, and safety; understanding and fitting into the fire management organization; building relationships with managers and other researchers; and science delivery. Our recommendations for safer and more effective Rapid Response Research are that researchers must understand the fire organizations and their objectives because a fire manager's primary responsibility is to manage the fire safely, not support research. In addition, researchers must be prepared with equipment, a "red card" signifying sufficient training and fitness, and appropriate knowledge when arriving to do research on a fire. Further, researchers must have and follow an operations plan. We recommend using a liaison to build strong relationships with managers and sharing what was learned. Science guided by questions that are important to managers is essential to improving both the understanding of wildland fire dynamics and developing strategies to address fire risk, rehabilitation, and restoration, yet researchers must be aware of the challenges of conducting research on active wildland fires.

Keywords: Rapid Response Research, wildland fire, Incident Management Teams, Joint Fire Science Program, burn severity

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Cover Photos:

Top: *Colin Hardy presents the Rapid Response Research operations plan to the Incident Management Team on the Dragon Complex Wildland Fire Use Incident, North Rim of the Grand Canyon, AZ. Photo by: Sharon Hood (USDA FS), 2005.*

Second from top: *Fire-proofed video systems and instrumentation for measuring heat flux, fire behavior, and local weather are being installed by Jason Forthofer (sitting at left) and Colin Hardy (right), on the Dragon Complex Wildland Fire Use Incident, North Rim of the Grand Canyon, AZ. Photo by: Dan Jimenez (USDA FS), 2005.*

Third from top: *Steve Baker and Emily Lincoln are sampling smoke from smoldering duff following the passage of the wildfire flaming front in Alaska. Photograph by: Cyle Wold (USDA FS), 2004.*

Bottom: (*From left to right) Researchers Alistair Smith, Carter Stone, Jonathan Sandquist, Andrew Hudak, and Sarah Lewis assess fire effects shortly after the 2003 Wedge Canyon Fire, north of Glacier National Park, MT. Photo by: Don Shipton (USDA FS), 2003.*

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Value and Challenges of Conducting Rapid Response Research on Wildland Fires

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Introduction

Rapid Response Research provides scientists an opportunity to interact with fire management teams on active fires and to observe, quantify, and collect data that might otherwise be unavailable. Data relating to fire behavior, fire effects, fuel treatments, or social responses are often more reliable, accurate, and valuable if measured *in situ* during an active wildland fire or in the recent aftermath. A well-organized and pre-planned Rapid Response study can provide real-time information and practical data that can be used to link fire effects to conditions before, during, and after fires—information critical to building the next generation of tools for forecasting the consequences of fire and fuels management (Lentile and others 2007). The products of Rapid Response Research help fire managers and local land managers make more informed decisions about the ecological and social consequences of fire. However, Rapid Response Research complicates resource and personnel management for incident managers during critical emergency periods on wildland fires. Science driven by the management issues and guided by questions that are important to managers is essential to improving both the understanding of wildland fire dynamics and developing strategies to address fire risk, rehabilitation, and restoration, yet researchers must be aware of the challenges of conducting research on active wildland fires.

Increasingly, scientists are tasked with seeing their science used, yet effective science delivery is challenging (Landry and Amara 2001, Rogers 2002). Fire science is shaped by the needs and expectations of fire managers, just as science is shaped by institutions and needs in other fields (Gieryn 2000). With the recent focus on federal government accountability, there is an urgent need to demonstrate the tangible benefits from research and effectively address challenging fire management issues that are grounded in science. Fire scientists and fire managers have long worked closely together, but they must work together even more closely if they are to address these challenges.

In this paper, we discuss the value, challenges, and what has been collectively learned from many researchers, some of whom have been doing Rapid Response Research on fires long before it was formally named. Teams of research scientists and technicians have an increasing presence within fire camps. Demands for information and accountability from the media and general public also peak during large fires burning in forests and rangelands, especially those fires that border the wildland urban interface. The added safety and logistical requirements needed for Rapid Response Research are justifiable only if the research data can be effectively collected, and we learn information that we cannot learn any other way. We will also share research successes and failures and feedback that we have received. Lastly, we reflect on the lessons learned from both fire scientists and fire managers and make recommendations for safer and more effective Rapid Response Research.

How Does Rapid Response Research Differ 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 (http://jfsp.nifc.gov/AFPs/2006_1_AFP.doc). For example, in situ measures of active fire characteristics, such as flame length or rate of spread, are more informative than estimates based on inference or models. Rapid, well organized, and pre-planned responses from the science community are required to take advantage of opportunities to gather data on actively burning fires and improve understanding of how first-order fire effects relate to pre-fire forest structure and condition and fire behavior.

Similarly, Rapid Response Research may provide the critical link in developing tools for predicting and mapping the degree of ecosystem change induced by the fire process and the post-fire residual ecosystem structures that dictate second-order fire effects. This information can lead to improved understanding of the role of fire in creating conditions that drive post-wildfire ecosystem processes, structures, and functions.

Critical data may be lost if advanced planning and funding for a timely research response are not in place. Often, by the time funding is obtained, the research opportunity has passed or precipitation, faded memories, changing seasons, and other factors have masked or destroyed important information. In the past, lack of funding, inadequate pre-season 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) have hampered research on active fires. The Governing Board of the

Figure 1. *Carter Stone (sitting at left), Jim Hedgecock (center), and Andrew Hudak (right), assess fire effects on soil and vegetation after the Black Mountain Fire, near Missoula, MT.*
Photo by: Don Shipton, (USDA FS), 2003.

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. JFSP funding provides scientific information and support for fuel and fire management programs and requires scientist-manager partnerships along with strong emphasis on transferring research findings to managers in the field.

How is Rapid Response Research Conducted?

Advance planning is crucial. Rapid Response teams must coordinate with fire management teams to quantify conditions *immediately before, during, and after wildfires and prescribed fires*. Rapid Response projects are expected to take advantage of opportunities to obtain information on large fires. Traditionally, researchers conceive research questions and design experiments beforehand, submit competitive research proposals, and if awarded, develop operations plans, participate in training sessions, and purchase equipment. However, with Rapid Response Research, the study area is not defined until after a fire ignites and various research criteria are met. Researchers must be ready to decide within days or hours whether or not a given fire will be sampled and then travel to the fire on short notice, strategize data collection, and coordinate with IMTs to ensure safe operations. Rapid Response Research teams must be prepared for efficient mobilization, be flexible, and be cognizant of management concerns.

Researchers are engaged with teams managing active fires. Researchers must understand the fire management organizations because they must work closely with them without compromising the managers' primary tasks.

Fish and Stream Resources

One example of Rapid Response Research comes from a team led by Elaine Kennedy Sutherland, research biologist with the Rocky Mountain Research Station's Forestry Sciences Laboratory in Missoula, MT. Sutherland's team performed Rapid Response Research on seven fires around Missoula in 2003, focusing on fire effects on fish and fish habitat. The specific objectives of Sutherland's research included: 1) collect pre- and post-fire data on riparian vegetation, stream channel morphology, and fish habitat; 2) quantify the magnitude of fish kill; and 3) monitor long-term system recovery. Coordinating with land management decision-makers and IMTs, a crew of six researchers located small streams with known native trout populations or potential trout habitat and established sample sites near actively burning fires. They chose locations likely to burn in a day or two and took measurements, set up instruments, and surveyed fish populations. In some cases, fires burned the sites or areas immediately upstream, and sometimes fire never reached the sites sampled. After the fires, fish populations were resurveyed and measurements re-taken. For some data, the sites were monitored for days or weeks. The data collected during this project addressed the research objectives but were also useful for the IMT—particularly the resource specialist and fish biologists—in developing Burned Area Emergency Response (BAER) team objectives. Presentations were made to fire management teams during incident briefings and the data were made available immediately post-fire. This work would not have been possible without the long-term planning of many individuals, and the need for this organized planning must be understood before undertaking Rapid Response Research.

Figure 2. *Damien Cremins, fire technician, measuring and counting pebble size in a tributary of Fish Creek in the Lolo National Forest, MT. Photo by: Matt Burbank (USDA FS), 2003.*

Figure 3. *Dead westslope cutthroat trout found in a tributary of Fish Creek in the Lolo National Forest, MT. Photo by: Ethan Mace (USDA FS), 2003.*

There are multiple types of wildland fire IMTs, some national and some local, that manage wildland fires and other "all-risk" incidents such as hurricanes. Local land managers request the support of teams when fire management exceeds local capacity. Fire Use Management Teams (FUMT) are specifically organized for wildland fire use incidents (wildland fire for resource benefit). There are currently 7 of these teams nationally. They may also be used to implement other appropriate management responses, including the full-range of suppression responses according to pre-determined fire and resource criteria. These teams each consist of seven to 10 people responsible for managing from 10 to more than 200 other people. Their primary objective is to complete a plan for long-term management of the fire, then implement strategies and tactics in the plan. IMTs range from Type 1, the most highly trained national teams, to Type 5. Type 1 teams are used primarily for the most complex wildfires. These teams consist of 33+ personnel plus a large support staff and on-the-ground firefighters. Their primary objective is to develop and implement the short-term strategies and tactics needed to meet agency objectives. Typically, these teams manage 500 to 1,500+ people. There are currently 17 of these teams nationally. Type 2 IMTs are regionally organized and supported teams used primarily for wildfire incidents whose complexity has exceeded local unit capabilities. These teams consist of 33 people plus additional support and on-the-ground firefighters. Typically, they manage 150 to more than 500 people and related resources. Their primary objectives are to develop and implement the short-term strategies and tactics needed to meet local land management objectives. There are approximately 56 of these teams nationally. Both the IMT Type 1 and 2 teams can be assigned to "all-risk" incidents. Type 3, 4, and 5 IMTs are local teams responsible for initial and extended attack (after the fire escapes initial attack capabilities). Their primary objectives are to develop and implement the tactics to suppress a wildland fire. Area Command Teams are occasionally assigned to coordinate and prioritize multiple IMTs within a specific area. These teams consist of four to five people with no tactical responsibilities. When fires burn for weeks, they are managed by multiple teams. One team replaces another as fire conditions change or as each team completes the maximum number of days they are allowed to work.

Applied research that provides real time data and information builds credibility, increases the likelihood of science application, and fosters opportunity 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 do others. This depends on fire conditions and objectives, but also on building personal relationships and credibility between researchers and team members.

Monitoring Erosion and Effectiveness of Post-fire Rehabilitation Measures

Figure 4. *Sarah Lewis installs a transect line for ground cover measurement plots within a paired watershed research site after the Hayman Fire, Pike and San Isabel National Forests CO, 2002. Photo by: Peter Robichaud (USDA FS), 2002.*

Figure 5. *Sarah Lewis uses a mini-disk Infiltrometer (Decagon Devices, Pullman, WA) to measure a relative water infiltration rate to assess the degree of post-fire soil water repellency after the Robert Fire, Flathead National Forest MT. Photo by: Andrew Hudak (USDA FS), 2003*

Peter Robichaud, research engineer with the Rocky Mountain Research Station Forestry Sciences Lab in Moscow, ID, conducts Rapid Response Research on post-fire hydrological response and soil erosion mitigation. Robichaud's research teams have installed eight paired watersheds and five hillslope-plot sites on large fires in six western U.S. states (ID, WA, MT, CA, AZ, CO). Immediate post-fire and annual monitoring of soil infiltration and erosion rates on these sites has provided data on emergency stabilization treatment effectiveness and initial recovery. These data have been used to expand the current suite of web-based erosion prediction tools and to develop a new model, Erosion Risk Management Tool (ERMiT). Information about prescribed erosion control measures, such as seeding, mulching, and contour-felled logs, has allowed BAER teams to change contract specifications, alter treatments, and improve effectiveness (Robichaud 2005).

Robichaud's research has provided data to test equipment such as the DMM 600 duff moisture meter (Campbell Scientific, Logan, UT) and the mini-disk infiltrometer (Decagon Devices, Pullman, WA), which may help to identify potential high erosion areas, streamline treatments, and reduce costs. Often there is a unique window of opportunity to extend preliminary results to end-users. Researchers need to take advantage of such opportunities to work with those who will use their findings. Robichaud provides an up-front and rapid justification of why his research is necessary and useful, and then provides a close-out briefing and/or presentation. Although analysis is incomplete during the close-out briefing, Robichaud shares anticipated results, benefits of the research, and reasons why managers should care about these results.

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. Like many other natural resources-related research efforts, scientists doing Rapid Response Research have a responsibility to provide land managers with defensible information and useful tools that expedite and strengthen fire management. There is a critical need to evaluate the effectiveness of management actions to reduce the potential for severe wildfire, as well as to mitigate fire behavior and post-fire effects on human, floral, and faunal populations. In order to do this, scientists must understand the logistical and temporal constraints and socio-political environment in which managers make most of their decisions. One of the primary goals of Rapid Response Research on wildland fires is to facilitate interpretation and utility of research results to land managers making challenging, timely decisions. Researchers learn from observing fires first-hand and becoming more aware of management context and the decision-making process.

Rapid Response Research can assist with model calibration, provide accuracy assessments for many commonly used predictive models, and increase user confidence in these tools. This research allows scientists to collect real-time measurements and observations that are normally modeled or reconstructed. However, these models are central to predictions for tactics during wildfires, and for designing successful fuel treatments around communities or elsewhere. Rapid Response Research provides a venue for scientists to obtain information and knowledge that is not otherwise available.

Thermal Imagery and Burn Severity

Figure 6. *Ed Mathews serves as an IMT research liaison to ensure that rapid response research is conducted safely and efficiently on the Cooney Ridge Fire, near Missoula, MT. Photo by: Andrew Hudak (USDA FS), 2003.*

Figure 7. *Patrick Freeborn installs and operates mid- and short-wave thermal infrared cameras to monitor radiant heat flux and temperatures within the Rapid Response Research plots on the Dragon Complex Wildland Fire Use Incident, North Rim of the Grand Canyon, AZ. Photo by: Colin Hardy (USDA FS), 2005.*

The 2003 fire season in Montana brought many opportunities for several newly-funded Rapid Response Research projects. Teams led by researchers Andrew Hudak and Colin Hardy from the Rocky Mountain Research Station and Phil Riggan from the Pacific Southwest Research Station collaborated with faculty from the University of Montana and the University of Idaho to explore alternative image acquisition and analysis methods for remote sensing of burn severity on the 2003 Cooney Ridge Fire, MT. Mutual research objectives were to improve (1) the predictive capabilities for fire risk, (2) the real-time assessment of fire behavior, (3) the post-fire mapping and description of fire effects, and (4) the strategic effectiveness of post-fire rehabilitation efforts. Under the supervision of Ed Mathews, the research team's IMT liaison, small crews of research technicians were sent into areas before they burned to collect pre-fire measurements of soil and vegetation condition and to install fire-proofed video systems and instrumentation for measuring heat flux, fire behavior, and local weather. Instruments autonomously recorded or reported observations to field personnel working in a safe zone 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 multi-spectral FireMapper™ image acquisition system installed on the Pacific Southwest Research Station 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 planned, executed, and monitored in full compliance with local/area incident aviation safety protocols that included pilot briefings, coordination with air attack, and post-mission debriefings. This technology produced multi-band (visible and thermal) images that were used to remotely determine the heat intensity of the fire. These data were merged onto a digital topographical map that was then assessed by fire managers. As a component of this research, a common geodatabase was assembled to facilitate data sharing and analysis. More information about this project is available at http://forestry.umt.edu/firecenter/.

Figure 8. *Fred Way (left), and Colin Hardy (right), discuss the Rapid Response Research plan on the Dragon Complex Wildland Fire Use Incident, North Rim of the Grand Canyon, AZ. Photo by: Sharon Hood (USDA FS), 2005.*

Furthermore, Rapid Response Research can provide data to test new equipment. Information from the DMM 600 duff moisture meter (Campbell Scientific, Logan, UT), 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.

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 research forester with the Pacific Northwest Research Station. In the early 1990s, Ottmar's Rapid Response Research involved attaching instruments to hotshot crew members as part of a smoke exposure study. This ongoing research has provided important information about smoke emissions critical for both short- and long-term firefighter safety and health. Bret Butler's and Jack Cohen's Rapid Response Research efforts have provided firefighters with valuable information about safety zones (Butler and Cohen 1998a, b). A combination of trainings, publications, and websites provides information on how and why safety zones are used in the everyday activities on a fire incident. The safety zone guidelines are now included in the Incident Response Pocket Guide carried by every firefighter on wildland fire incidents, and are an integral part of the new S-390 Introduction to Fire Behavior Calculations class.

Post-fire assessment teams may be particularly interested in research that seeks to develop a rapid yet consistent burn severity mapping approach that is applicable to different types of imagery. Several Rapid Response projects involve collaboration with the U.S. Department of Agriculture, Forest Service, Remote Sensing Applications Center (RSAC) and the U.S. Department of the Interior, Earth Resources Observation and Science (EROS) Data Center. RSAC and EROS provide satellite imagery and image-derived products for managing and monitoring wildland fires. RSAC produces Burned Area Reflectance Classification (BARC) maps for use by post-fire rehabilitation teams to identify post-fire burn severity. Many current measures of burn severity are interpreted from satellite and airborne imagery, including the normalized burn ratio, NBR (Key and Benson 2006). These and other indices correlate more highly to vegetation attributes rather than ground and soil attributes because the vegetation occludes the ground, especially in a forest environment (Patterson and Yool 1998; Hudak and others 2004a, b). In addition to their intended use, burn severity maps may be used to guide other management activities such as post-fire timber harvest and replanting strategies. Research that provides decision-support, such as the identification of appropriate spatial and spectral resolutions necessary for mapping and mitigation efforts, may help to streamline approaches and costs associated with post-fire rehabilitation.

Researchers need to improve internal coordination and fully exploit opportunities to gather many different kinds of data on shared research plots. Significant cost savings and data quality improvements have been realized by investing in research that uses existing logistical field arrangements to optimize data collection, including plans for data-sharing and complementary analyses.

Emissions, Firefighter Safety, and Fuels

During the summer of 2004 in Alaska, research teams led by Roger Ottmar and David Sandberg of the Pacific Northwest Research Station collaborated with teams from the Rocky Mountain Research Stations in Moscow, ID, and Missoula, MT, and the University of Idaho, Colorado State University, and Yale University to jointly sample and characterize fuels, vegetation, fire consumption, and smoke production on the same points before, during, and after they burned. Researchers targeted existing plots and coordinated to establish new plots to increase the efficiency of study design and JFSP support. Ground-based sampling and high resolution hyperspectral imagery were collected to explore patterning in vegetation and soil burn severity at multiple temporal and spatial scales. Airborne hyperspectral imagery has higher spectral and spatial resolution than Landsat and may be more appropriate than other satellite imagery for mapping burn severity. These data will help to develop improved, practical indicators of burn severity that will complement existing indicators such as the Normalized Burn Ratio (Key and Benson 2006) used by BAER teams and others. Additionally, this joint effort complements ongoing research to assess the black spruce (*Picea mariana*) and white spruce (*Picea glauca*) fuel type Alaska photo series (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 (Prichard and others 2006), and recently updated 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 Alaska Fire Service, State of Alaska, and IMTs who tactically and logistically supported this Rapid Response Research.

Figure 9. *Roger Ottmar is briefing an Alaska fire crew on forest floor consumption and smoke emissions on the 2004 Chicken Fire in Alaska. Photo by: Mary Huffman (Colorado State University), 2004.*

Indicators of Burn Severity

Researchers Penelope Morgan and Leigh Lentile of the University of Idaho teamed up with Andrew Hudak, Peter Robichaud, Sarah Lewis, and Kevin Ryan of the Rocky Mountain Research Station to sample eight fires burning in Montana, California, Alaska, and Idaho between 2003 and 2005, and more recently, in Washington in 2006. They sought to identify indicators of burn severity that were mappable, interpretable, and scalable from the ground to airborne and satellite imagery. Ground-based field data and remotely sensed moderate-resolution satellite imagery and high-resolution hyperspectral imagery were collected from all eight fires. These data were used to map and predict char fraction of the soil surface, the degree to which soils are water repellent, tree mortality, and native and non-native vegetation response. Their initial findings were that areas burned at high severity were relatively spatially uniform compared to the high spatial heterogeneity of fire effects in areas classified as either low or moderate burn severity. When their ground data were compared to satellite derived indices, such as the delta Normalized Burn Ratio (dNBR), they found significant correlations between the two, indicating the dNBR was effective at differentiating fire effects. The high resolution hyperspectral imagery allows mapping post-fire ground cover and soil conditions at a much finer scale (5 m) than is available with Landsat data (30 m) that are used to create most post-fire burn severity maps. Initial results suggest that a post-fire map derived from airborne hyperspectral imagery more accurately represents the immediate post-fire conditions than a classified burn severity map derived from satellite imagery (Robichaud and others 2007). These post-fire maps can be used by managers to support post-fire rehabilitation planning. At the present time, using hyperspectral imagery to evaluate burned areas has great potential, but further research is needed to make these products available for post-fire assessment.

Figure 10. *Rapid response researchers monitor active fire behavior during the Cooney Ridge Fire, near Missoula, MT. Photo by: Andrew Hudak (USDA FS), 2003*

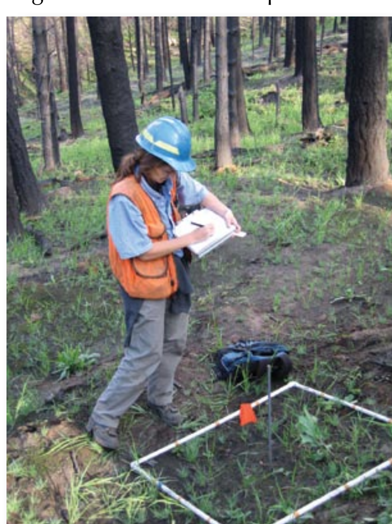

Figure 11. *Leigh Lentile collects data on post-fire ground cover and vegetation response one year after the School Fire, Umatilla National Forest WA. Photo by: Peter Robichaud (USDA FS), 2006.*

Challenges

The Rapid Response researcher must have the desire to pursue research objectives in a non-traditional setting, and must demonstrate the creativity and communication skills required to meet the challenges. The effort and dollars invested in wildland fire management, and concern for safety and protection of people and property, gives active fire suppression efforts greater priority than research. Rapid Response researchers face uncertainties and high costs, and the value of the information gained through this research must outweigh these costs. For instance, it is difficult to financially justify the support of highly-trained field crews that may spend considerable time participating in day-to-day research activities while waiting and preparing for fires to happen. While not entirely unique to Rapid Response Research, other challenges include logistics and safety, understanding and fitting into the fire management organization, building relationships with managers and other researchers, and science delivery. Three specific examples are given here, followed by nine recommendations for successful Rapid Response Research.

1. Logistics and Safety

Safety is critical. Where fires burn intensely and spread rapidly, it can be difficult to safely sample in advance of the fire front. Once on a fire, researchers must have radios programmed to incident frequencies (and listen to them) to stay informed of potential changes in fire behavior and other safety hazards. Participation by university and nongovernmental organizations, even with federal funding, can complicate logistics, safety, and other requirements. Academics and researchers outside of federal agencies and the western U.S. have found it especially challenging to get the necessary training and certification (the interagency “red card”). Enrollment in trainings is often limited and priority is given to firefighters and managers. Nevertheless, researchers must persevere through such bureaucratic hurdles and meet the same physical fitness and fire safety standards expected of others working within active fire perimeters.

2. Greater Costs and Uncertainties

There are several additional costs that are not widely acknowledged. First, there are the direct costs of preparing scientific/technical staff for work on fires. This includes purchase of personal protective equipment (PPE); additional training to meet fireline “red card” requirements; and maintenance, testing, and documentation of required fitness levels. Second, there are additional expenses incurred for having experienced and appropriately qualified firefighters leading the technical crews on fires. This level of experience is required to provide for adequate safety and to interface with fire management teams. Third, there are extra expenses from long hours and extended tours that are most often necessary to conduct research on wildland fires under a short timeframe. Fourth, obtaining some types of data on wildland fires can be difficult, resulting in less data collected for a given amount of money than in other research where the probability of data capture is higher.

Fires are variable and changeable by the hour—few other research environments are as dynamic. Considerable effort may have gone into setting up equipment and collecting data on a prospective site, a safe distance from the active fire front, only to find that conditions change. Often the most useful fire behavior data on a wildland fire is collected out ahead of the active front, particularly if the more active behavior is targeted. Sometimes, the best sites for research are too unsafe at a given time and must be abandoned. It may be that the most desirable location to collect information is on a portion of the fire where there is limited access and a high number of firefighting resources. Careful coordination will be needed to avoid infringement on fire suppression activities.

3. Understanding and Fitting into the Fire Management Organization

Decisions to dispatch research teams must be made quickly and are often based on limited information. Research team leaders need to identify study sites that can be accessed reasonably and safely ahead of the fire. It can be difficult to get the necessary information about the candidate fires without speaking with people on the fire. Often, local or incident-dedicated resources and personnel are unavailable to provide first-hand information about an incident, particularly during the first days of a fire.

On actively burning fires, researchers are required to obtain permission from IMTs to conduct research on the fire or even visit the fire. Researchers must work with IMTs to determine where and how they will work without jeopardizing the safety and effectiveness of fire management operations. Research must integrate the IMTs daily shift protocols into every aspect of their activities—communications, transportation, staging of resources, and safety. Coordination with the IMT is critical. Air operations must be planned, implemented, and monitored in full compliance with agency and incident aviation safety policies and procedures. This coordination involves not only the IMT, but also the local administrative unit as well as the appropriate Geographic Area Coordinating Center (GACC).

Considerable variation in management’s willingness to incorporate Rapid Response Research may depend on pre-conceived notions, previous experience, and personalities. Differences in philosophy and attitudes toward Rapid Response Research exist. Type 1 and 2 IMTs are usually more traditional and geared toward suppression, while FUMTs tend to be more open to Rapid Response Research. Dispatch of field research technicians and aircraft is contingent on IMT acceptance of the request to mobilize. Furthermore, management strategies may shift considerably during a large incident due to fire behavior and growth and available resources. Identifying which managers will welcome researchers depends on building personal relationships and establishing credibility.

If we are to continue conducting Rapid Response Research, agencies are encouraged to find a way to fund and reward researchers and managers who overcome these challenges. For example, specific requirements for conducting Rapid Response Research, as well as deliverables produced by JFSP-funded projects, are provided in announcements for proposals and in an electronic database (http://jfsp.nifc.gov). It is important for funding agencies and researchers to recognize that Rapid Response Research can be expensive and impose additional safety considerations, yet produce few results. But when Rapid Response Research succeeds, the potential benefits can be high because the research opportunity and knowledge gained and applied may not otherwise have been possible.

Recommendations

Researchers must understand the fire organizations and their objectives. Fire management organizations adhere to a strict code and follow a chain of command. Researchers on active fires must respect this chain of command by attending daily fire management meetings and briefings, communicating clearly and regularly, following the protocols established on each fire, checking in with Division Supervisors and fire crews working near them, and following all safety guidelines. Understanding the chain of command and operational procedures is important, as researchers must be willing to be a self-sufficient part of the IMT. Researchers can be formally "rostered" on the Incident Action Plan (the daily shift plan), possibly as a "Monitoring Group." 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 "good will" built through 10 years of successful Rapid Response Research can be threatened by safety violations and poor communication. We make the following nine recommendations for consideration by any research team.

1. Be aware that the IMT's primary responsibility is to manage the fire safely and not to support research.

Researchers must remember that they are working in an environment that is task driven and oriented toward on-the-ground results. The IMT's responsibility is to the line officer and the effective management of the incident, not to support Rapid Response Research. Do not make demands on the fire management team that compromise their ability to do their primary jobs. It is also imperative that researchers or their liaison contact the local management agency before arriving on a fire or conducting any post-fire assessments. In some instances (for example, the National Parks), research permits or other special protocols are required.

2. Be prepared when arriving at fire camp. Do not depend on the fire organization to provide the necessary equipment or data.

Researchers must provide their own equipment, tools, PPE, and vehicles so that they are not dependent on fire managers. Approved wildland fire PPE must be procured well in advance of fire season as it may become scarce as fire season approaches. Field teams must physically remain together and carry, at all times, a handleld radio with the appropriate frequencies and possess the skills to use it. It is imperative that radios and other equipment are compatible with those used by fire managers. Field teams must carry hand tools appropriate for the fuel type and topography as determined by the IMT. If any GIS data will be needed for subsequent analyses, it is advisable to bring a portable computer hard drive to which data can be transferred, as it is much more difficult to obtain such data later.

3. Have a current red card and demonstrate the knowledge and language of safe operations.

All Rapid Response Research team members must have their "red card" that reflects sufficient current training and physical fitness qualifications. Additional training in radio use and communications, fire safety, and first aid is required. Teams should have their "red cards" together when they arrive on a fire, as these will be "passports" to the fire. Although Rapid Response Research team members without a "red card" may request visitor status and the required escort, it is unlikely that a single resource boss qualified individual will be available and willing to do this task. Rapid Response Research team(s) must have briefings both prior to, and following, each daily operational period. All aspects of situational awareness will be emphasized in the pre-shift briefing. The end-of-shift briefing will assess and review both safety and operational issues.

4. Develop and follow an operations plan.

During the incident, the Incident Commander or Fire Use Manager must grant permission to conduct research on the fire and approve all fireline visits. Research liaisons must check in regularly and communicate with IMTs to determine where and how teams can conduct research without jeopardizing safety and effectiveness of fire management operations. Bring a one-page synopsis (in layman's term) of project goals and objectives—explain why this particular fire was chosen for research, and potential benefit for managers.

Provide a copy of your operations plan to fire managers upon arrival at a fire. Make sure it includes contact information and qualifications for all crew members. In particular, the safety officer on the fire management team will want to see that safety protocols including "Lookouts, Communications, Escape Routes, and Safety Zones (LCES)" are being followed.

5. Use a liaison.

Many research teams have used a liaison to bridge the communication gap between the research and fire management teams. An effective liaison helps research teams fit into the fire management system and allows research team leaders to focus on ongoing and time-sensitive research with full confidence that the operations side is under control. The liaison should attend daily briefings and be responsible for fireline oversight and safety of the field team. The liaison should have local fire experience and know the language, routine, and objectives of fire management teams. For example, in Alaska, an Alaska Fire Service smoke jumper acted as a liaison to help coordinate fire activities and on-the-ground research logistics with Incident Commanders and support teams. Liaisons help to build trust. It is difficult to find a good liaison possessing hard-earned and invaluable credentials. Because of the difficulty in finding a good liaison, it is imperative to start searching well in advance of fire season. Fire managers have suggested that individuals who have recently retired from fire management or who have experience as a safety officer on fires would function effectively as IMT research liaisons.

6. Build relationships.

Effectiveness depends on communicating early and often with fire managers. Careful pre-work before the fire season and coordination with the local land management unit is essential. A good pre-season objective is to attend fire management meetings and talk to the IMTs. Discuss objectives and operation plans, ask for advice, and use the input to revise protocols and increase feasibility. Researchers must seek advice and be open without demanding support, resources, and fire manager time. Researchers are likely to be more accepted when they attend meetings, briefings, and live in the fire camp where (1) firefighters assemble for mobilization to the firelines, (2) operational plans are made, and (3) information among crews and individuals is exchanged. One of the most powerful ways to build relationships is to repeatedly help fire managers solve practical problems, often through active participation in field reviews and training, but also informally. Address concerns and questions from the fire managers at all levels.

7. Share what was learned.

Rapid Response Research can provide valuable information, but it must be communicated. Technology transfer should be synonymous with a good communications plan. Brief the fire managers, firefighters, and local agency administrators on what was accomplished prior to leaving—emphasize the practical, immediate value of the research. Answer questions. Immediate delivery of preliminary results can sometimes allow managers to alter their recommendations for treatments and help them understand the purpose of the research. Some Rapid Response Research teams provide a close-out package for the IMT documentation unit and present their project and results at IMT evening briefings. Seek feedback on how to work more effectively with fire managers. When researchers demonstrate the value of research, it becomes easier to get out on the next fire.

8. Work together to take advantage of research opportunities, as appropriate.

When researchers collaborate, they can more fully exploit opportunities to gather many different kinds of data on shared research plots. Sharing research plots and data will allow multiple users to benefit from shared databases and will decrease the overall risks and costs of conducting the research. In 2004, research teams coordinated to collect data from the same points before, during, and after wildfires in Alaska. For the 2003 Montana fires, the data, observations, and measurements collected by several Rapid Response Research teams are being managed in a shared geodatabase designed by the University of Montana's National Center for Landscape Fire Analysis (http://www.forestry.umt.edu/firecenter/). All investigators can access, edit, and analyze these data. Fire managers have also suggested development of an additional database to provide more information about specific Rapid Response Research teams. The database could include Rapid Response Research team rosters, contact information, past and current assignments, and areas of research expertise. The availability of this information could encourage partnerships and sharing among researchers and between researchers and managers.

9. Be fluid because flexible is entirely too rigid.

Rapid Response team leaders must acknowledge that they likely will have limited control over where and when their crews can sample during actively burning fires. Research teams that focus on strategic operations and pre-season organization are more likely to integrate and effectively coordinate with fire management teams. Remember, there are places and times that research teams may not be able to sample on the ground or from the air.

Conclusions

Rapid Response Research provides a unique opportunity to pursue questions important to managers tasked with integrating the best available science in their decision-making about fire risk, rehabilitation, and restoration. Rapid Response Research holds promise to link post-fire effects, active-fire behavior, and pre-fire conditions. In this and other ways, Rapid Response Research can build the understanding needed to improve fire and fuels management. Lessons learned from the pioneers of Rapid Response Research demonstrate that the potential benefits outweigh the costs, and the challenges are manageable if researchers and managers work effectively together. Thus, Rapid Response Research can advance science that is relevant and immediately useful.

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