Fire Management today

Volume 62 • No. 4 • Fall 2002

Dude Fire Staff Ride

United States Department of Agriculture
Forest Service

Fire Management Today is published by the Forest Service of the U.S. Department of Agriculture, Washington, DC. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Fire Management Today is for sale by the Superintendent of Documents, U.S. Government Printing Office, at:
Internet: bookstore.gpo.gov Phone: 202-512-1800 Fax: 202-512-2250
Mail: Stop SSOP, Washington, DC 20402-0001

Fire Management Today is available on the World Wide Web at <http://www.fs.fed.us/fire/fire_new/fmt/>.

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On the Cover:

Site of the 1990 Dude Fire on the Mogollon Rim in Arizona, where six firefighters died in a blowup. A participant reflects upon his feelings and experiences following the Dude Fire Staff Ride in 1999. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

The FIRE 21 symbol (shown below and on the cover) stands for the safe and effective use of wildland fire, now and throughout the 21st century. Its shape represents the fire triangle (oxygen, heat, and fuel). The three outer red triangles represent the basic functions of wildland fire organizations (planning, operations, and aviation management), and the three critical aspects of wildland fire management (prevention, suppression, and prescription). The black interior represents land affected by fire; the emerging green points symbolize the growth, restoration, and sustainability associated with fire-adapted ecosystems. The flame represents fire itself as an ever-present force in nature. For more information on FIRE 21 and the science, research, and innovative thinking behind it, contact Mike Apicello, National Interagency Fire Center, 208-387-5460.

Firefighter and public safety is our first priority.

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Dude Fire Staff Ride

Dave Thomas and Wayne Cook

The theme of this issue of *Fire Management Today* is the staff ride, a concept of organizational learning used for over a century by the U.S. military, and how it was applied to the 1990 Dude Fire, a 24,174-acre (9,783-ha) fatal forest fire that burned near the Mogollon Rim in Arizona.

Staff Ride

At its simplest level, a staff ride brings soldiers back to the scene of old battles, whether won or lost, to directly reexperience the strategy and tactics used on the battlefield. Custer's defeat at the Little Big Horn, Chief Joseph's skirmish at the Big Hole River in Montana, and the Civil War battles at Gettysburg and Antietam are staff rides regularly conducted today to train soldiers.

With the Dude Fire Staff Ride, we applied the framework of the military staff ride to a plume-dominated wildland fire that blew up outside of Payson, AZ, in June 1990, killing six firefighters. This staff ride was part of a national interagency fire behavior workshop in Phoenix, AZ, in March 1999.

The staff ride is not a lecture or field trip. The basic assumptions used in developing the Dude Fire Staff Ride were:

- There may be no one correct answer or chain of events leading up to the fatalities;
- Wildland fires are complex natural events that commonly defy honest attempts to think through and understand them;
- Hindsight often creates misperceptions of what actually occurred on a fire; and
- The root cause of the Dude Fire tragedy may never be fully known.

A staff ride brings soldiers back to the scene of old battles, whether won or lost, to directly reexperience the strategy and tactics used on the battlefield.

The lessons learned by participants in a staff ride are usually individual, personal, not easily categorized, and filled with emotion. The expectation is that individuals will form their own conclusions and then, after talking and listening to other participants, form a shared vision of what happened.

Before walking the old brushed-in firelines of the Dude Fire, staff ride participants were given the raw materials of the fire's history—shift plans, weather forecasts, fire behavior and fire danger predictions, maps, video footage, and photographs. The night before going to the actual fire site, students heard talks on the history of the staff ride from Glenn Robinson, author of *The Staff Ride*, a booklet that describes what a staff ride is and how it is put together. Dr. Dave Cleaves, of the USDA Forest Service's Washington Office fire research branch, spoke on decisionmaking. Dr. Karl Weick, an organizational psychologist at the University of Michigan who has studied how firefighters behaved during blowups on the Mann Gulch and South Canyon Fires, cautioned the participants not to come too quickly to conclusions about the causes of the fatalities. From the fire's historical artifacts and the talks, each individual began framing a mental picture of the reasons for the Dude Fire fatalities.

In This Issue

The essays, articles, and book reviews that follow all derived from the experience of attending the Dude Fire Staff Ride. Dr. Marty Alexander, a fire behavior research scientist for the Canadian Forest Service, provides a timely critique of the concept of the staff ride, including a discussion of both its strong and its weak points. Dr. Karl Weick's talk on the evening before the staff ride is included. Paul Keller, formerly with the Zigzag Hotshot Crew and the official writer/editor for the Dude Fire Staff Ride, captured many of the conversations and speeches on both the fire site and during the final closing dialogue in Phoenix. Thankfully, he was able to record the closing talk of the fire behavior workshop, Bob Mutch's heartfelt personal account of what the Dude Fire Staff Ride meant to him.

Dave Thomas is the regional fuels specialist for the USDA Forest Service, Intermountain Region, Ogden, UT; and Wayne Cook is a technology transfer specialist for the Forest Service, Missoula Fire Sciences Laboratory, Missoula, MT.

We have also included two book reviews, though not directly about staff rides or fire suppression, that discuss organizational learning and the prevention of accidents. Dr. Jim Saveland, a research scientist at the Forest Service's Rocky Mountain Research Station in Fort Collins, CO, reviews Harvard professors Robert Kegan and Lisa Laskow Lahey's *Seven Languages for Transformation: How the Way We Talk Can Change the Way We Work*; and Dave Iverson, a social scientist with the Forest Service's Intermountain Region in Ogden, UT, reviews University of Michigan professors Karl Weick and Kathleen Sutcliffe's *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. These books have much to teach both firefighters and the organizations that manage them about increasing the level of firefighting safety. Jerry Williams, Director of Fire and Aviation Management for the Forest Service's Washington Office, used *Managing the Unexpected* as a building block for a speech on professionalism delivered in Scottsdale, AZ, in March 2002. In the version of his speech reprinted here, Williams notes that firefighting agencies must make a cultural change, shifting "the weight of accountability before an accident takes shape."

What's Next?

Following the Dude Fire Staff Ride, we evaluated this attempt to apply a military concept to wildland fire training, and we concluded that it was a success. We find support in the wildland fire community for utilizing this learning tool in the future. Staff rides are now being used by all agencies at local and regional levels throughout the country.

The next staff ride is being planned in conjunction with an international fire use conference for winter/spring 2003. Staff rides fit the concept of "lessons learned." We believe that the wildland fire community should consider fully integrating this concept into training, whether outside the classroom, hands-on, or performance based.

Acknowledgements

The success of the Dude Fire Staff Ride was due to the hard work and determination of organizers and participants, and to their willingness to try a new method of organizational learning. Something clicked for everyone who participated, and the whole event—motivated by a team spirit—magically came together.

The hundred-odd participants represented a diversity of occupations—hotshot superintendents, fire behavior researchers, staff ride experts, fire management officers, grunt firefighters, fatality investigators, meteorologists, claims adjusters, attorneys from the Office of General Counsel, survivors of the blowup, and more. That was another major reason for success.

However, one group of people must be singled out for special thanks: the personnel of the Payson Ranger District on the Tonto National Forest. Without their support and interest, the Dude Fire Staff Ride would not have gotten off the ground. ■

Dude Fire memorial erected by the local community. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

Fatality site on the Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

What's a Staff Ride?

Paul Keller

Could a Civil War historian really help wildland firefighter safety today? You better believe it. Case in point: the Dude Fire Staff Ride.

Yes, it's true. In a quest to better ensure firefighter safety on wildland fires, the USDA Forest Service contacted noted Civil War and military historian Glenn Robertson. The result: a quantum leap forward for wildland fire safety and training.

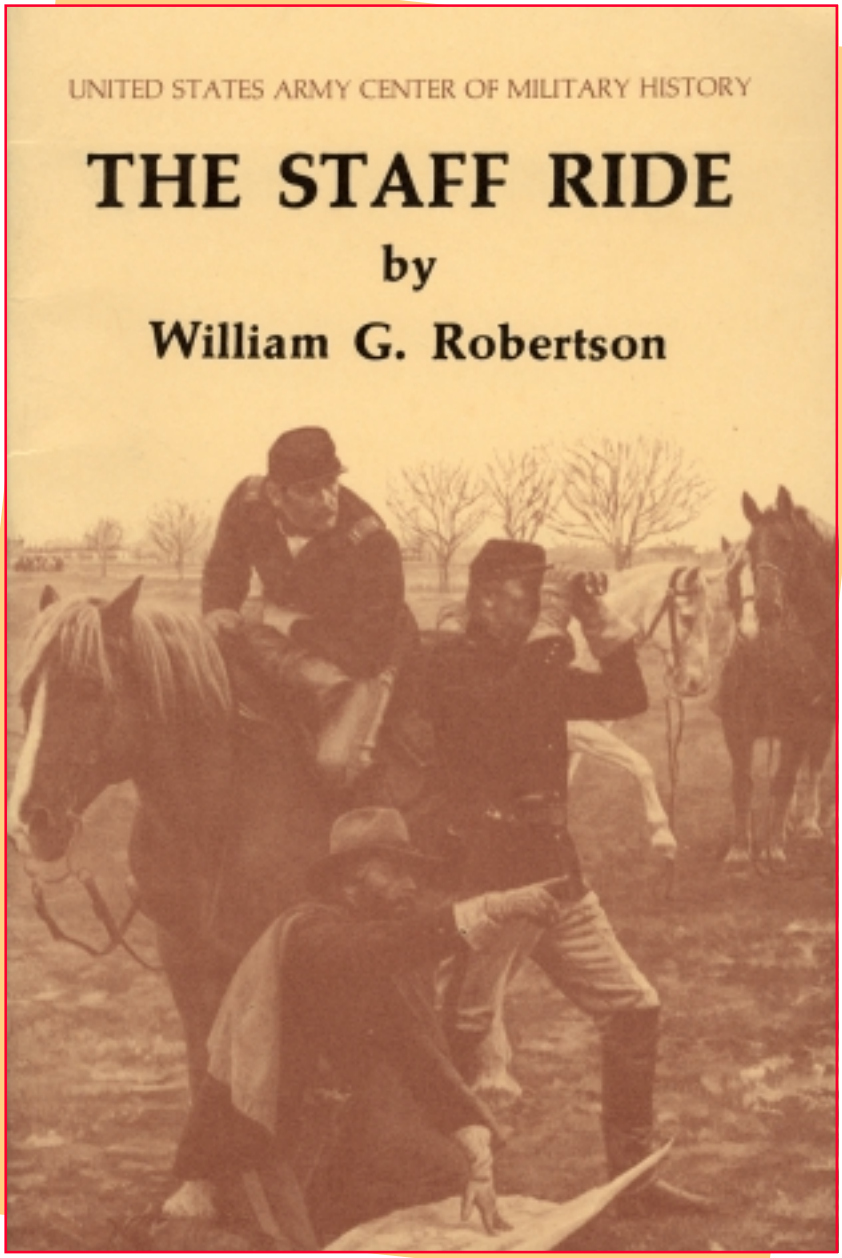
A professor of military history at the U.S. Army's Command and General Staff College, Robertson literally revived and rewrote the book on military staff rides—a unique and highly successful approach to gaining valuable insights from past military encounters. The initial staff ride idea was implemented as a training tool after the Civil War. Robertson developed the staff ride concept into a three-phase process:

1. Prior to the actual staff ride, study the incident in detail;
2. Make an extensive, preplanned onsite visit; and
3. Combine the first two phases into the all-important "integration phase"—a discussion to identify lessons learned for future incidents.

A Golden Opportunity

"I was fascinated to first learn how—through the staff ride process—war colleges still use such

The staff ride is a unique and highly successful approach to gaining valuable insights from past military encounters.



William "Glenn" Robertson's guide, used to develop the Dude Fire Staff Ride.

Paul Keller, a former hotshot and journalist, is a contract writer/editor for the USDA Forest Service's Fire and Aviation Management Staff, Washington Office, Washington, DC.

"The staff ride concept seemed a perfect vehicle for learning about what happened that day on the Dude Fire."

–Dave Thomas, fuels specialist

historical battles such as Gettysburg, the Normandy Invasion, and Little Big Horn to train in leadership, strategy, and tactics," noted Dave Thomas, the fuels specialist for the Forest Service's Intermountain Region, Ogden, UT.

Thomas helped plan a 1-week National Interagency Fire Behavior Workshop for fire behavior analysts in Phoenix, AZ. He and his fellow steering team members for the March 1999 workshop realized that the 1990 Dude Fire fatality blowup that entrapped 11 firefighters and claimed 6 lives had occurred in the nearby mountains. They knew that vital and valuable lessons could still be learned from this tragedy fire. But how?

"The staff ride concept seemed a perfect vehicle for learning about what happened that day on the Dude Fire," Thomas recalled. So he contacted Robertson, the staff ride guru. Robertson had never before been asked to apply his staff ride process to a wildfire incident. But he immediately saw the potential. He agreed to volunteer his time as a consultant to help plan the Dude Fire Staff Ride. "It was a golden opportunity," Thomas remembered, "a wildland fire learning first."

Robert W. Mutch, fire ecology consultant and Dude Fire Staff Ride participant, said that the staff ride's lessons will stay with him forever (see his article beginning on page 22). "I truly believe that the staff ride concept produced an environment for an unprecedented learning experience."

Mutch pointed out that even though the staff ride evolved from a military concept, it has nothing to do with war. He underscored that people who have never experienced a staff ride should not mistakenly assume that it equates the business of firefighting with the business of war. In fact, it does no such thing. "There is a major difference between the two," stressed Mutch. "In our business, the loss of life is totally unacceptable."

Huge Success

The event was a huge success. The organizers were Dave Thomas and Wayne Cook, a technology transfer specialist for the Forest Service's Rocky Mountain Research Station, Missoula, MT. Robertson, the staff ride authority, experienced the Dude Fire Staff Ride in the same way as his fellow workshop participants. "You achieved 95 percent of 100 percent—you almost had it perfect," Robertson told the steering committee members. ■

Human Factors in Fire Behavior Analysis: Reconstructing the Dude Fire*

Karl E. Weick

On the Dude Fire Staff Ride tomorrow, we will retrace the steps of people who were under pressure. Some of those people handled pressure well. Some didn't. For a richer understanding of the Dude Fire, we should focus on what happens when people are overcome by events; then we might be in a better position to prevent similar tragedies in the future.

Making Sense

One key to safety in fire suppression is how easy it is for people to make sense of what they are facing. A good example is Caroline Paul, one of the first women firefighters in the San Francisco Fire Department (Paul 1998). The first time she was allowed to take the nozzle of a firehose and lead a crew into a burning building, the rooms were so filled with smoke that visibility was near zero. Paul nudged against what she thought was the first step of a narrow stairway leading into an attic. Again and again, she tried to find the second step and push her way into the attic, only to bump into something hard. Finally, a hand pulled her away and steered her into an unseen hallway. Later, when visibility was better, she realized that what she had thought was an attic stairway was in fact a chair standing against a wall. She had been lunging against the wall, refusing to believe it was anything but a stairway leading to the source of the fire.

> When the world is unpredictable, as is often the case on a fire, it is important to hold one's meanings lightly and to update one's sense of what is happening.

What Caroline Paul stumbled onto is key to how we create the world around us. As Stephen Batchelor (1997) puts it, "Meaning and its absence are given to life by language and imagination. We are linguistic beings who inhabit a reality in which it makes sense to make sense." Meaning is a product of language, imagination, and action. The language of tables, chairs, beds, and staircases can be a constraint on the imagination and on action. The mind stays more supple and pliable, the body more flexible, when people deal with general directions rather than the specifics of mistakenly named objects. Sometimes the constraints imposed by specifics are necessary and helpful. But when the world is unknowable and unpredictable, as is often the case on a fire—with its difficult terrain, changing weather, and uneven heating—then it is important to hold one's meanings

Aerial view of "corner house" above Walk Moore Canyon, showing wildland/urban interface conditions on the Dude Fire. Photo: USDA Forest Service, 1990.

Karl Weick is the Rensis Likert Distinguished University Professor of Organizational Behavior and Psychology, School of Business Administration, University of Michigan, Ann Arbor, MI.

* This article is based on a presentation by the author at the March 1999 National Interagency Fire Behavior Workshop in Phoenix, AZ. The author spoke on the day before the infield phase of the Dude Fire Staff Ride.

When people are under pressure, they fall back on habitual, first-learned, overlearned responses.

lightly and to update one's sense of what is happening. This is the world of sensemaking.

Caroline Paul, under the pressures of the moment, was unable to change her first sense that she was crawling into a narrow attic. Nor was she able to notice enough of the context around her to update her label for what she faced. The more resistance she encountered, the more convinced she became and the harder it was for her to disengage from her aggressive attack and try something else. Fortunately, someone else had a different view of the situation, and Paul had enough presence of mind to heed the tug on her coat, retreat, and alter the attack.

Human Factors

Paul's case illustrates many of the human factors we will see on a much larger scale at Walk Moore Canyon. They include regression, tunnel vision, and misunderstanding.

Regression. When people are under pressure, they fall back on habitual, first-learned, overlearned responses. In Paul's case, she was more accustomed to meeting resistance head-on, with intensified force, than to circumvent it. So that's what she did.

The best example of regression I've ever seen involves F–104 fighter plane pilots. The planes stationed in Europe were the same as those in the United States, with one important difference: The European planes ejected pilots from the bottom instead of the top. In a European plane, if you got into trouble at a low altitude, you turned the plane over so it would eject you upward. Several pilots who learned to fly European F–104s were transferred to a U.S. squadron of F–104s. For the transferred pilots, the first fatalities all involved turning the plane over at low altitudes and ejecting themselves into the ground. Again, people regress under pressure to first-learned, overlearned responses.

Hotshots and engine near "corner house" on the day of the Dude Fire blowup as the fire in the background backs into Walk Moore Canyon. Photo: USDA Forest Service, 1990.

Regression occurred on the South Canyon Fire when Don Mackey, under pressure, went from acting like a crew leader with his head up to a crew member with his head down, digging line.* For example, he offered to help Quentin Rhoades sharpen his saw. Butch Blanco, under pressure, went from acting like the incident commander to acting like a crew boss. He collected his own crew members and kept them around him, monitoring their whereabouts more closely than the fire or the other crews. Both cases illustrate the general principle that, under pressure, administrators tend to function at one level below the level to which they are assigned. They regress to first-learned responses.

To guard against regression, you need to practice; but make sure to practice the newer, more complex routines. Also, don't take processes for granted: they unravel and constantly need to be rebuilt, for two reasons:

1. Safety is not bankable (Schulman 1993). A history of failure-free performances does not insure against the next error, and the organization is only as reliable as its next error.
2. If safety is not bankable, there is no stable resting place for an

* For a summary of events on the 1994 South Canyon Fire in Colorado, see Bret Butler and others, "The South Canyon Fire Revisited: Lessons in Fire Behavior," *Fire Management Today* 61(1): 14–20.

organization. As P.R. Schulman (1993) observes, "Unless continual reinvestments are made in improving technical systems, procedures, reporting processes, and employee attentiveness, those performance standards that have already been attained are likely to degrade."

Tunnel Vision. In Caroline Paul's case, we see another common behavioral pattern for people under pressure: The more frustrated people get, the less they notice. The pattern here is robust (Wickens 1996). As stress, pressure, or arousal increases, the breadth of attention decreases. We tend to ignore peripheral events; in the case of small spot fires in fine materials, that could be a lethal oversight.

Tunnel vision is especially important for people performing complex tasks, because they have to pay attention to a relatively large number of salient cues. In performing a complex task, the minute you begin to ignore any cue whatsoever, you immediately lose relevant information and your performance immediately suffers. This is what happened at Three Mile Island, the nuclear power plant in Pennsylvania where an accident occurred in 1979. According to Christopher Wickens (1996), "… under the high stress caused by the initial failure, the operators appeared to be fixated on a single faulty indicator, supporting an incorrect belief that the water level in the reactor was too high, thereby preventing their attention from focusing on more reliable indicators that supported the opposite (and correct) hypothesis."

The safeguard against tunnel vision, interestingly, is similar to the safeguard against regression:

The more frustrated people get, the less they notice—a potentially lethal oversight in the case of small spot fires and fine materials.

practice, practice, practice. Routine, well-rehearsed, well-learned performances place a smaller demand on active attention than does the performance of tasks that are less well learned. Furthermore, a good model of task demands and "a well-developed skill in discriminating sources of useful (versus trivial) information" (Wickens 1996) can slow the degradation of performance.

However, it is difficult to perform novel, complex, and variable tasks on automatic pilot. In Caroline Paul's case, it was the first time she was allowed to lead a crew into a burning building. She was under enormous self-imposed pressure not to foul up. Under this intense pressure, she became preoccupied with a single cue—the unyielding wall that she supposed to be a stairway.

Similar fixations might have developed on the Dude Fire. The more novel the tasks that people on the fire were required to perform, the more cues they might have missed. For example, the incoming type 1 incident command team "shadowed" the onsite type 2 team for 6 hours to get a good feel for the fire. If shadowing involved unfamiliar activities, then the incoming people might have paid more attention to the onsite team members than to the fire itself, thereby missing crucial information.

Misunderstanding. Caroline Paul's case shows that we are slow to ask for help and often even slower to understand that others might see the world differently. People under pressure often fail to listen, pool information, and spell out their reasoning.

Fire approaches "corner house" on the Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1990.

When people interact with respect, they are better able to update their understanding of what is taking place.

Respectful interaction is fundamental. We are all ready to profit from the experience of others until it seems to conflict with our own. Then we face the problem of how to weigh our own vantage point against that of others. Since our knowledge is indirect and fallible and our frame of reference limited, we cannot afford to ignore completely what others think is happening. To pool our observations with theirs for maximum adaptability, we must live by three imperatives (Campbell 1990):

1. ***Trust.*** We must respect the reports of others and be willing to base our beliefs and actions on them.
2. ***Honesty.*** We must report honestly so that others can use our observations in coming to valid beliefs.
3. ***Self-respect.*** We must respect our own perceptions and beliefs, seeking to integrate them with the reports of others without deprecating them or ourselves.

Wherever tragedy occurs, it is likely that there has been a breakdown in one or more of these three imperatives. The Mann Gulch Fire saw a breakdown in trust when Wagner Dodge's crew failed to believe that his escape fire would save them.* The South Canyon Fire saw a breakdown in honesty when people had serious, unexpressed doubts about who was in charge, where the escape zones were, and why they were digging line downhill. The Battlement Creek Fire saw a breakdown in self-respect when people allowed the division supervisor's assessment to dominate their own reservations.**

It is interesting that the preferred handoff and briefing procedures in wildland firefighting tend to incorporate all three imperatives. For example, some crew bosses follow this protocol: Here's what I think we face; here's what I think we should do; here's why; and here's what we should keep an eye on. Now talk to me! In this example, there is trust (the crew boss invites observations from others and listens), honesty (the crew boss gives his or her own candid appraisal), and self-respect (the crew boss sets the stage for resolving differences without either dismissing his or her own observations or deprecating the observations of others). When people interact with respect, they are better able to do what Caroline Paul could not do—update their understanding of what is taking place.

Context of the Dude Fire

The case of Caroline Paul suggests that something similar might have happened on the Dude Fire: Unfolding events created problems for sensemaking by producing pressures of various sorts and making it difficult to integrate resources. Specifically:

- Several agencies responded to an escalating event, so information was not disseminated widely, even though several crews were jammed into the same area.
- The crews were just settling in and were strangers to one another.
- Some crews had new people.
- The environment consisted of discontinuous fuels in complex terrain, including a wildland–urban interface setting.
- Communication was difficult because 25 radios using 5 frequencies were distributed among 150 people (Whitney 1999).
- Some crews were sleep deprived, a source of stress (Wickens 1996).
- Everyone was potentially subject to heat stress, an influence that has been shown to produce cognitive confusion and to impair attention, memory, and situational judgment (Wickens 1996). What is especially tricky about heat stress is that people who are suffering from it are unable to assess their own condition or to convince others of their needs.

These features translated into specific problems for overhead teams and crews. For fire behavior analysts, the circumstances affecting other members of the fire overhead team and the people under them determine whether their analyses will be persuasive. Robert McDonald (1979) puts it well: "While it is important for you to spend time tapping calculators, conferring with fire weather people, and making long-range calculations of probabilities, it is most important for you to be involved in what's happening in the trenches. Know specifically who is on the line. Know the critical points, and, whenever possible, be close to the action, with close communication with key line personnel. They

* For a summary of events on the 1949 Mann Gulch Fire in Montana, see Richard C. Rothermel and Hutch Brown, "A Race That Couldn't Be Won," *Fire Management Today* 60(2): 8–9.

** On the 1976 Battlement Creek Fire in Colorado, three firefighters were killed and another severely burned on a ridgetop when a burnout fire lit below swept over the crew's position. For a brief discussion, see Bret W. Butler and Jack D. Cohen, "Firefighter Safety Zones: How Big Is Big Enough?", *Fire Management Today* 58(1): 14.

should feel a kinship with you and a reliability on you—that you are always at hand for consultation. They are your people—your personal responsibility. You may well have to be the most organized individual in the entire fire organization." As a fire behavior analyst, if you nourish the relationships that McDonald describes, then you can frame your analyses in ways that will help people make more sense of their confusion, be less vulnerable to pressure, and take fewer excessively risky actions.

The confusing situation that the overhead team faces can be described as a continuous organizing of resources and fire. "The question of organization is never really solved because the fire constantly changes," note Pyne and others (1996). "Nearly all suppression efforts are either building up or building down, and the organization they exhibit is the product of these evolutions." Rhona Flin (1996), who has summarized a large number of incident command studies, argues that incident commanders face situations that are surprisingly similar:

- Extremely difficult decisions,
- Ambiguous and conflicting information,
- Shifting goals,
- Time pressure,
- Dynamic conditions,
- Complex operational team structures,
- Poor communication, and
- Significant risk accompanying every course of action.

Fire behavior analysts should keep this list in mind in formulating their forecasts for incident commanders. The question is, "Can I present my forecast so that it is taken seriously by somebody in this situation?"

Firefighters congregate in burned area on the Dude Fire. Photo: USDA Forest Service, 1990.

Something similar goes for crews. Crew bosses have told me that when they attend an early-morning briefing ("the variety hour," as they call it), their priorities are to find out the weather and the radio channels and to get enough maps for their crews. They do not always register the fire behavior analysis, depending on whether they are sure they have the weather, maps, and radio channels. These crew leaders are reaching for tools that directly help them make sense of what they will face. To them, the fire behavior forecast is a more indirect tool. Fire behavior analysts might want to make weather, topography, and vantage points—which crew bosses consider crucial for their sensemaking—more salient in their forecasts.

Fire Behavior Forecasts

Fire behavior analysis unfolds in the context of sensemaking, pressure, and complex environments. According to the fuels specialist Dave Thomas (1999), "The fire behavior forecast is the official record of what is supposed to happen on the fire. It is a summation of all the fire behavior rumor, gossip, science, and fire behavior modeling. A good FBAN's [fire behavior analyst's] job is to 'make sense' of all this fire behavior information from various sources." The fire behavior analyst talks about how fast the fire will spread, how hot it will be, and what size it will be when it stops spreading. For firefighters, that imposes a structure of regions, valences, and paths on what was previously unstructured terrain. In other words, fire behavior analyis imposes order that reduces confusion. It calms people down, helping them notice more and be more aware, which in turn helps them feel more in control. Done well, fire behavior analysis helps people know what they might be facing. It enables them to form expectancies, establish plausible goals, know what cues to look for, and understand what actions might be appropriate. It substantially boosts their sensemaking.

Some fire behavior analyses are surprisingly sensitive to the situation of the people who have to act on them (see the sidebar). Some

forecasts, however, make it harder for people to make sense. One fire behavior analyst put it this way: "It is my personal view that most fire behavior forecasts are not worth the paper they are written on—they are too general, and the FBAN has not risked putting his/her name to a forecast that is very specific. We tend to use opaque words like 'extreme,' 'erratic,' etc., maybe even hiding under the fact that the numbers generated by Rothermel's model are only accurate within a factor of 2."

It should be possible to use the language of lookouts, communications, escape routes, and safety zones (LCES) to help relate the forecast to user needs. Forecasts of long-range spotting could mean potential difficulty in maintaining escape routes and safety zones, whereas forecasts of smoky conditions or fire movement into flatter terrain could portend difficulties for lookouts. Translating fire behavior predictions into their possible implications for LCES could be a form of respectful interaction, adding to the pool of information crews use in making sense of their operations. The LCES formula has a lot more flexibility than sometimes believed, something I learned from the way Paul Gleason uses LCES in deploying his Zigzag Hotshots. The L in LCES can mean more than just one or two lookouts. Paul told me of situations, for example in case of a possible rock slide, where he deployed as many as 16 lookouts, with only 4 people digging line. Thus, the ambiguous phrase "Fire behavior will be erratic" might be underscored in a forecast by adding, "which will warrant multiple lookouts."

I am not encouraging fire behavior analysts to take work away from the incident commander or crew boss. But they should be mindful of the difficulties that overhead and crews have with sensemaking. Fire behavior maps can help. If crew bosses are eager to take a fistful of topographical maps back to their crews to give them their spatial bearings, then fire behavior analysts should do what they can to make crews equally eager for maps that give them their temporal bearings. That will depend on how well the maps fit their style of sensemaking and help reduce their uncertainty.

Learning

On the Dude Fire Staff Ride, our learning might be limited because we all have the benefit of hindsight. We already know that six people died on the Dude Fire and that five survived the entrapment, two with serious and three with minor burns. Therefore, we have a strong tendency to look for incorrect actions, flawed analyses, and inaccurate perceptions that produced the tragic outcome (Starbuck and Milliken 1988). We will tend to put perceptions at the beginning of our sequences and argue that perceptual accuracy makes all the difference and that the perceptions on the Dude Fire were inaccurate. We will be less likely to look for correct actions that had no effects or unclear effects, good analyses that led to incorrect actions, and accurate perceptions that got lost in bad analyses.

However, foresight is ultimately more important—and more difficult—than hindsight. As fire behavior analysts, you are in the foresight business; you know that it is much harder to distinguish accurate perceptions in advance from inaccurate ones. On the Dude Fire Staff Ride, we will be in the fortunate position of having people

Good Fire Behavior Forecasts

Some fire behavior analyses do a good job of relating to the user's situation. Here are some sample descriptions from fire behavior forecasts 41 and 42 on the 1988 North Fork Fire in Yellowstone National Park:

- *"The addition of wind to the total fire environment will push fires to high rates of spread, with fire intensities well beyond hand or machine control levels."* This sentence clearly conveys the mechanism of change—intensification of wind, the effects of this change on both rate and intensity of spread, and a forewarning that containment by conventional means probably won't work.
- *"Fuel beds that don't normally burn will become available and burn."* This is another way of telling crew leaders that what they think won't happen will happen. The implication is that all of their normal expectations might be violated.
- *"Night fires have burned with relatively high intensities and rates of spread. Be prepared for significant acreage increases from when you left the line yesterday."* This statement explicitly warns that a fresh start might be necessary. It also provides a tangible means for calibrating forecast credibility. If there has indeed been a significant acreage increase, then the rest of the analysis is more believable.

who can tell us what it was like to live through the Dude Fire. Serious learning will take place when we take their accounts seriously and neutralize some of the spurious advantage that hindsight seems to bestow.

I want to describe a drawing by the firefighter Brian Tagavac shortly after he escaped the Dude Fire (fig. 1). It summarizes what he and his crew think they learned from the incident. The caption reads, "A good scare is always worth more than a [piece of] good advice." In the drawing itself, everybody is running with tool in hand; the person in the foreground has his pack on. All of this slows the crew in reaching safety. Rather than ordering the firefighters to drop their tools so they can run faster, the leader is yelling, "Go, go!" The fire shows considerable spotting, as had been forecast for the day.

Part of our work on the Dude Fire Staff Ride will be to wrestle with this question: Do you agree that a good scare is always worth more than good advice? My point has been to make you wonder whether you can learn much of anything from a good scare. A scare can amount to little more than an intense interlude of regression and tunnel vision. If that is so, then a good scare fails to make much data available for learning.

A good scare can be meaningful only if you first have some understanding and advice you can apply to make sense of it. Good advice might take the form of the Ten Standard Firefighting Orders and the Eighteen Situations That Shout Watchout, which might prove more helpful in sorting out a near-miss experience than as a set of rules to live by in fighting fire. Besides, a good scare often comes from bad advice.

Any word that is an absolute—such as "always"—is a red flag that invites a search for exceptions. Under what conditions might it be the case that a good scare is worth *less* than good advice? Does a good scare on one fire apply to other fires? Which ones? If a good scare is the equivalent of a near miss, then does one interpret the scare as evidence that the system remains basically safe—or basically dangerous, because the escape was a close call and not everyone made it? Are the lessons of a good scare lost and overwhelmed by survivor guilt or flashes of posttraumatic stress disorder?

Naked Truths

There are no easy answers. One thing we can be pretty sure of is that moments of learning are short-lived. A perfect example comes from battlefields. According to Cohen and Gooch (1990), "In the chaos of the battlefield there is the tendency

Figure 1—*Drawing by firefighters who narrowly escaped the Dude Fire.*

of all ranks to combine and recast the story of their achievements into a shape which shall satisfy the susceptibilities of national and regimental vainglory. … On the actual day of battle naked truths may be picked up for the asking; by the following morning they have already begun to get into their uniforms."

If all goes well on the staff ride, we'll be able to recapture enough of the actual day of the tragedy to learn some naked truths. In doing so, hopefully we'll get scared enough to have the lessons stick, but not so scared that we miss details. In those details lie the truths that belie the simplistic conclusion, "The entrapment was caused by the downburst."

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Walk Back Into Tragedy: A Quantum Leap Forward

Paul Keller

A sudden, ironic breath of cross-slope wind whirls into J.P. Mattingly as 40 people in hardhats and boots weave downhill and tighten around him. The former Alpine Hotshot superintendent surveys the scattered clumps of alligator juniper and manzanita, looks up, and holds these people in his eyes.

"We are standing in one of the most significant places in my entire career in fire. This is the exact spot where I thought I had the most opportunity to die."

Front page news in the Arizona Republic. *Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1990.*

Paul Keller, a former hotshot and journalist, is a contract writer/editor for the USDA Forest Service's Fire and Aviation Management Staff, Washington Office, Washington, DC.

> "Even though I was on the Dude Fire accident investigation team, I learned a lot on the staff ride. … I now better appreciate those people who were there on that fire."
>
> *–Dave Goens, meteorologist-in-charge*

Mattingly nods reflectively. It is as if being back on Arizona's Tonto National Forest, down inside Walk Moore Canyon, has helped crystallize his memories—memories he wants and needs to share with these attentive ears.

"There was instant fire everywhere. And it was growing quickly. There were 50-mile-per-hour [20-m/s] winds pushing every single spot that took. And every spot did take."

For 15 minutes, Mattingly shares insights about what happened on that terrible fire blowup day: what he did, what others did around him. He then answers a volley of questions.

These people in the hardhats and boots have obviously studied this wildfire incident, the tragic Dude Fire (named for nearby Dude Creek). Their queries are knowledgeable and thought provoking. They trigger discussions about everything from plume-dominated fire behavior and suppression tactics to chain-of-command orders.

Death Race

Mattingly looks at his watch. It is time to move down the old dozer fireline to where Paul Linse is waiting. As the group walks, its members continue individual conversations targeting different aspects of the Dude Fire blowup until they completely encircle Linse.

The former Flathead Hotshot superintendent points downhill. It is his turn to remember.

"I was in a death race from the bottom of the canyon to right here. To this exact spot." As Linse speaks, his audience examines the terrain, the ground cover, the breaks in the surrounding ridges. They imagine how it must of have been that day.

"It was one of those life experiences," Linse continues. "I'll never forget it. By the time I got up there to the safety zone, this was all involved. Believe me, it didn't take long."

Linse, Mattingly, and former Zigzag Hotshot Superintendent Paul Gleason now lead the group a few more chains down the dozer line.

He Was On Fire

"This," Mattingly says, sticking out his arm and slowing the pace, "is where we first observed Jeff Hatch, the injured firefighter, walking up the line. At this point, the fire was running, spotting, and crowning."

"He was on fire," Gleason remembers. "There was smoke coming off him. He was burning up."

Questions—and answers—now crackle. After 30 more minutes of insights, followup questions, and discussion, Gleason leads the little contingent to where the drainage drops, narrows, and forces a single-file descent. It was here, on the afternoon of the Dude Fire blowup, that Gleason found—one by one—the perished firefighters.

As they turn a bend beside logs blackened by fire, two white crosses suddenly rise from the earth. An open fire shelter stretches out in front of each cross, where a hardhat and Nomex shirt and pants are lying in eerie faceup, prone positions.

The group has finally reached the place where firefighters were forced to take a stand, where firefighters died. A total of six crosses are pointing up into a cloudless sky.

All talk stops. The pace slows. Everyone passes in silence. Just down the line, Dave LaTour waits beside the last cross.

Sheltering Up

On that infamous day, with an estimated 70-mile-per-hour (30-m/s) wave of fire charging his crew, LaTour radioed that they were deploying their shelters. He counted those around him, yanked his shelter out, dropped to this very patch of earth, and pulled it over him—for what were no doubt the longest 45 minutes of his life.

But somehow, LaTour endured. Six others around him did not. Explanations for his survival and their demise are among the theories the group today will surmise, discuss, wrangle with.

LaTour waits for everyone to get settled around him. All eyes—somber, attentive—are focused on the wildfire survivor. And the crosses.

"As soon as I got into my shelter, I started talking to people. I could hear the crew from inside their shelters saying, 'We're going to make this, we're going to be okay.' They were trying to cheer each other up. They were sounding optimistic. We knew it was going to be a difficult situation, but I think we all thought we were going to walk away from it; we were going to make it. But when that first flame front hit us, everything changed."

Reflects one participant after Latour's talk: "I looked at how tight that drainage was where those people deployed. I thought that's an awfully tight spot. I had pictured something a bit more open. So I was even more impressed with what those people went through as they hunkered down in that little drainage."

LaTour continues: "As soon as that first wave of fire hit us, I heard Curtis Springfield screaming. He was yelling that he couldn't take it.

"I was shouting almost constantly through the whole event, telling everyone to stay in their shelters, to stay down. But quite frankly, when the flame fronts were passing over us, the sound that we heard was indescribable. It was so loud that—beyond somebody screaming right next to you—you really couldn't hear anything else.

"The winds were lifting the shelters up. Active flame and large amounts of burning debris came into my shelter and up against my body. My personal feeling is that at some

Crosses and firefighter equipment marking location of two fatalities on the Dude Fire. Photo: USDA Forest Service, Missoula Technology and Equipment Center, Missoula, MT, 1999.

point, everyone's shelters were breaking down and being lifted up. People were being burned to the point that they thought they were going to die. There was a lot of screaming and I realized people had gotten up and moved.

"But as soon as they got out of their shelters—that was it."

No Ordinary Field Trip

Welcome to the Dude Fire Staff Ride: an indepth examination of this 1990 event—a blowup tragedy wildfire.

Don't picture an ordinary, run-of-the-mill field trip. The staff ride is a unique, comprehensive, three-phase event that blends prestudy and in-the-field observation with interactive dialogue. In this case, the staff ride was designed to gain significant insights into a blowup on a fatality wildfire that entrapped 11 firefighters and claimed 6 lives.

Dave LaTour standing at the fire shelter deployment zone on the Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

To prepare for the staff ride, all participants were mailed a comprehensive history of the Dude Fire, including weather and fuel moisture summaries, fire weather forecasts, sequence-of-events summary, the Dude Fire Accident Investigation Report, and even the Dude Fire shift plans.

Known as the "preliminary study," this first phase of the staff ride ensures enlightened discussion and interaction during the second phase, a day of in-the-field stops and presentations called "stands." Dude Fire Staff Ride participants experienced a daylong series of eight different stands (see the sidebar). At each stand, presenters wove specific instructional objectives into the discussions. Presenters included local district personnel, the Dude Fire type 2 incident commander, other overhead team members, suppression crew veterans, National Weather Service meteorologists, and accident investigation team members.

"The people who were directly involved in the Dude Fire who volunteered to participate at the various stands had a tremendous investment in the staff ride's success," said Mike Hilbruner, Dude Fire Staff Ride Steering Committee cochair and applied fire ecologist for the USDA Forest Service's Washington Office. "They didn't shy away from this opportunity to participate. We truly appreciate their valuable contribution."

The subsequent "informed" interaction—an indepth dialogue between staff ride presenters and participants—serves as the staff ride's lifeline, one of its many dividends. In this final phase of the staff ride, participants blend information from the preliminary study with experience from the onsite visit to identify how lessons learned can be applied to future incidents. This is why Forest Service organizers of the March 1999 National Interagency Fire Behavior Workshop in Phoenix, AZ, chose to dedicate a portion of their week's activities to this unique examination of a wildfire.

Like all tragedy fires, the Dude Fire still generates questions. No doubt about it, the Dude Fire Staff Ride helped answer many. Explained one participant, "The staff ride made me think of how many times we read about fatality or near-miss fires and we generate this picture and these ideas of what went wrong. But I now realize that unless you get into it in the depth we got into on the staff ride, you really don't understand. It's really easy to want to draw simple conclusions. That's why, for me, doing the staff ride in that depth was so valuable."

"Three words summarize my experience on the staff ride: illumination, detail, and clarity," said Gerry Day, manager for the Northwest Area Coordination Center. "Those three things struck me as I read through the staff ride materials beforehand and prepared. But I don't think I could have taken the quantum leap that I did on the staff ride without going to the site, walking down through Walk Moore Canyon, and feeling the wind that was blowing as we heard the actual accounts from the individuals."

Hotshot Initiative

Explained another Dude Fire Staff Ride participant: "The most impressive thing I learned on the staff ride was the initiative shown by the hotshot supervisors. Until I actually went up there, I had thought there might be a little green grass around the homes—there wasn't. And we

Stands for the Dude Fire Staff Ride

A total of 135 people—in groups of 45—experienced the March 1999 Dude Fire Staff Ride in 8 in-the-field presentations/discussions (called stands). The stands, designed to stimulate interaction between participants and presenters, told the story of the 1990 Dude Fire blowup in chronological order.

Stand 1
- ***Site:*** Fire camp location (with a panoramic view of the fire's topography).
- ***Presenters:*** Fire management officer and district ranger from the host Payson Ranger District, Tonto National Forest.
- ***Discussion Topics:*** Ignition; seasonal severity; geography; management response in this type of fire/locality; general fire behavior and weather.

Stand 2
- ***Site:*** On buses traveling through the Whispering Pines residential development in the wildland–urban interface.
- ***Presenter:*** Bus facilitator.
- ***Discussion Topics:*** Fuels; terrain; suppression options.

Stand 3
- ***Site:*** Control Road and Fuller Canyon (inside the burnover perimeter).
- ***Presenters:*** Type 2 incident commander; National Weather Service fire weather forecaster.
- ***Discussion Topics:*** Night fire behavior/weather; evening fire operations; crew deployments/evacuations the first night; escape route.

Stand 4
- ***Site:*** Permanent memorial for the fallen Dude Fire firefighters in the Bonita Creek Estates residential development.
- ***Presenters:*** None (a time for respectful and reflective silence).
- ***Discussion Topics:*** An opportunity to visit this site in a moment of silent reflection.

Staff ride participants at a stand. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

At this point, the groups abandoned the buses and walked from stand to stand along the Dude Fire dozer line.

Stand 5
- ***Site:*** Safety zone.
- ***Presenters:*** Four hotshot superintendents on the fire; National Weather Service meteorologist.
- ***Discussion Topics:*** Early-morning operations; fire behavior/weather; wildland–urban interface; location of overhead, including fire behavior analysts; transition from type 2 to type 1.

Stand 6
- ***Site:*** Inside the perimeter of the Bonita Creek Estates residential development.
- ***Presenters:*** Hotshot superintendents.
- ***Discussion Topics:*** Burnout operation; tactics; fire behavior/weather; lookouts, communications, escape routes, safety zones; chronology of finding the burn victim.

Stand 7
- ***Site:*** Entrapment site.
- ***Presenters:*** Entrapment survivor; accident investigation team member.
- ***Discussion Topics:*** Entrapment and deployment chronology; "get-on-the-ground" message; fire behavior/weather, including difference at this location and the safety zone.

Stand 8
- ***Site:*** Control Road and Walk Moore Canyon.
- ***Presenters:*** Type 1 team fire behavior analyst; Tonto National Forest Fire and Aviation Management staff officer; assistant U.S. attorney involved in Dude Fire litigation.
- ***Discussion Topics:*** Postdeployment; fire behavior/weather; fatalities; litigation.

The morning following the field visits, the official "integration phase"—discussing how to apply lessons learned to future incidents—took place in nearby Phoenix, AZ. This phase actually began immediately after stand 8 as individual discussions started on the bus ride to Phoenix.

learned that there was no safety zone until the hotshots burned out that triangle on the upper end.

"And when things went [bad] and they couldn't get anybody on the radio, here was this safety zone, and they got 180 people into it—including urban firefighters and dozer operators and the whole works. Not just their own crews. And this was on their own initiative. They didn't get permission to build the safety zone. They did it on their own. I think we have to rely on this type of spontaneous mission of people."

Echoed Dave Goens, meteorologist-in-charge for the National Weather Service in Missoula, MT, "The thing that struck me most about the staff ride was that even though I was on the Dude Fire accident investigation team, I learned a lot. And I helped write the Dude Fire accident investigation report. I now better appreciate those people who were there. I want to personally thank all the hotshot foremen who were put into that situation. I couldn't build a medal big enough to give to people like Dave LaTour, Paul Gleason, Paul Linse, and J.P. Mattingly. They are heroes."

"For me, the Dude Fire Staff Ride illustrated why it is important to defend the type 1 firefighters' 'can-do' attitude," explained Gleason, Dude Fire veteran and staff ride presenter. "Being a type 1 firefighter for over 20 years, one of the enjoyments of that job is to go into chaos and make sense out of it. And this 'sense' is to do effective fire management and safe fire management work simultaneously within this environment.

"That's part of the reason we are attracted to the job," Gleason continued. "But equally important is the ability to disengage when we feel we've reached the limit. I defend the type 1 firefighters and type 1 supervisors and all of the people who have this attitude."

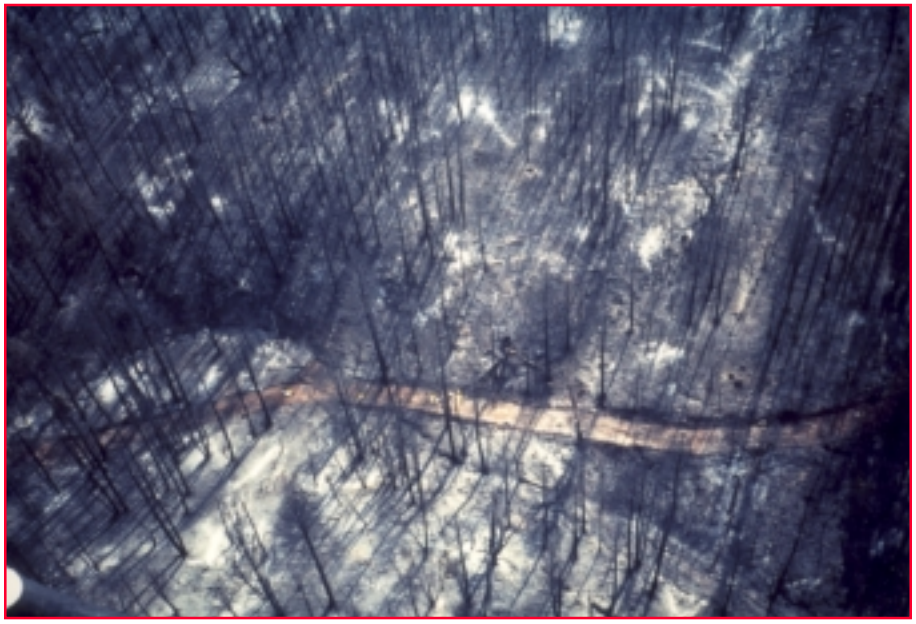
When To Disengage

The Dude Fire Staff Ride helped enlighten participants on a gamut of safety and headsup issues that apply to all wildland fire environments. A case-in-point is knowing when to disengage.

"From an operational standpoint, I can think of half a dozen experiences—some very recent—in which an attempt to do the right thing under the pressure of the moment has caused us to literally disregard everything we know," explained a staff ride participant. "And, to me, that's part of what was going on out there on the Dude Fire. The pressure to do something—to pull off a marginal chance to protect the subdivision—took everybody out of the loop. A critical piece of information that the fire had come around below them was lost.

"This was happening during transition [from the type 2 incident management team already onsite to the incoming type 1 incident management team]. And after the staff ride, I started thinking about several recent fires in which we encountered problem events during transition. And yet, I've never heard this subject emphasized, talked about, or be a key item in any of our training. So I think we have something to work on here."

Said another staff ride participant: "All conditions on the Dude Fire were out of the norm. They were experiencing extremes. When we get into these situations, somebody needs to pick up a banner and hit people on the head and say, 'This in *not* a normal fire. It is going to take some different strategies on this fire to keep our people safe.' I think the onus to do that is on us as fire behavior analysts. If we are starting to get that feeling that something is out of ordinary then we need to push as hard as we can to get that information out to as many people as we can, especially directly to the



Aerial view of fatality sites in Walk Moore Canyon. Photo: USDA Forest Service, 1990.

command and general staff. We need to take a prudent measure in safety. This needs to be done and discussed at length every chance you get."

Planning for Safety

"On the staff ride," explained another participant, "I asked the people who had been on that fire if there was any way we could have made that assignment safe. What we came up with was to put an abort time on a mission such as that. Perhaps give the mission a try, but identify a time during the operational period, in advance, that after a certain time—beyond noon or 1 p.m.—this mission is no longer a valid mission if you haven't yet got it secure. At that time I would preplan to abort that particular mission.

"I also now realize that we need to look at escape routes and safety zones as changing with fire behavior potential. Once we have escape routes and safety zones identified, during the night burning period for instance, they may be effective. But as the day goes on and fire behavior potential increases—as on the Dude Fire—we need to reevaluate and validate escape routes and safety zones, perhaps on an hourly basis."

Dude Fire deployment survivor Dave LaTour's insights on fire shelters proved particularly insightful. "We need to tell people what to expect when they get into their shelters," LaTour emphasized to the staff ride participants. "They need to know that their shelters are going to blow around—that they're going to see and hear things outside their shelter. But, most importantly, people need to know that their shelter is the best place they can be, even if they are getting burned. Staying close to the ground is the key to survival. That seemed to be what saved those of us who lived. People need to know that if you get out of your shelter, you're going to die."

More Rides Planned

The success of the Dude Fire Staff Ride prompted many people to suggest that staff rides be planned for other fires. "I came here as an ops chief," one said. "I was struck, too, that there are not simple solutions for this. I've walked through South Canyon and spent a lot of time there. But, after the staff ride for the Dude Fire, I realize that rather than saying what was right or wrong in South Canyon, we need to do what we did here on the Dude Fire Staff Ride. Talk about it. Expand our training base so that we see more of the things that are taking place around us and more of what contributes to what happens."

Yes, the Dude Fire Staff Ride was the first. But, due to its apparent success as a training and learning tool, it won't be the last. Participants said they intended to share new lessons and insights gleaned on the staff ride back at their home units, including through revised training courses.

More staff rides for other wildland fire events are now in the planning stages. Certainly, the staff ride concept and opportunity can also be used on other types of fire events, including near-miss fires, fire successes, and even wildland fire use. And, of course, as with the Dude Fire, the staff ride is also a vital tool for learning from fatality wildfires to prevent life-threatening situations in the future. For, as we now realize, to truly learn, we must go back with keener eyes and minds and walk the ground where our fellow firefighters have fallen. ■

House burning on the Dude Fire. As one staff ride participant put it, "All conditions on the Dude Fire were out of the norm." Photo: USDA Forest Service, 1990.

Why Don't We Just Leave the Fireline?

Robert W. Mutch

*Editor's note: When Bob Mutch, the eminent fire ecologist and former fire researcher and fire management officer for the USDA Forest Service, stood to give the closing remarks at the National Interagency Fire Behavior Workshop in Phoenix, AZ, in March 1999, he surprised many. Mutch explained that he had planned to show a series of fire behavior slides and give a prepared talk; but, because of the impact of the previous day's Dude Fire Staff Ride, that had all changed. The following is based on Mutch's closing remarks at the workshop.**

I started out the Dude Fire Staff Ride without any idea what a staff ride is, although we had very good briefing information. Perhaps my experience yesterday on the staff ride was not too unlike your experience.

Shift in Thinking

As I got to the stand where we met Tony Sciacca and John Holcom**—up there where they had burned-in that safety zone to provide safety for 180 people—my thinking mode started to shift. Then we went down the line and met Paul Gleason. He was a little breathless. I thought: "Well, he's come up a pretty steep hill, it's going to take him a moment to catch his breath."

But the more he talked about what went on that fire blowup day—going down into that canyon where the visibility was 200 feet (60 m); going down into a situation where it was probably too late and finding Jeff Hatch; then working back up that steep hill, trying to get this person who was badly burned to safety—suddenly, this breathlessness became symbolic for me. It started to symbolize what he and so many others went through that day. That breathlessness seemed very appropriate.

I'm sure you'll never forget that moment as he spoke so quietly about this terrible, terrible event that he lived through and some did not live through.

Then we heard J.P. Mattingly and Paul Linse. That's when a huge transition started happening for me. The thinking part was slowly just disappearing. I was absorbing emotions and feelings.

Then we went down to that spot—I'll never forget it—with Dave LaTour.*** I'm sure you'll never forget that moment, either, as he spoke so quietly in such a soft-spoken way about this terrible, terrible event that he lived through, some others lived through, and some did not live through. That was when it really struck me—almost—about what was happening on this staff ride through Walk Moore Canyon.

Inner Voice

But I still didn't totally appreciate what Tony, John, and all the others down through Dave had really done to me. Finally, we were finished at that last stand. I didn't get six paces down that dusty Walk Moore trail on that clear, bright day, when suddenly this inner voice started talking to me—it just came from the experience, I'm sure—and the little simple voice said this: "Why don't we just leave the fireline?"

I made a few more steps down that dusty trail and another voice spoke to me. This voice said: "Bob, take half the slides out of your program tomorrow morning. Because, while it might be nice to look at some slides, there are more important things to talk about than slides."

Now I have decided not to show a single slide, because I don't think we have time to look at any slides today. There is more important business in this room than seeing a few 35-millimeter slides.

I want you to know that it is a first for me to come prepared with a slide presentation and not show a

Bob Mutch is a fire management consultant in Missoula, MT.

* Bob Mutch's remarks were captured by Paul Keller, a former hotshot and journalist who contracted with the USDA Forest Service to help document the Dude Fire Staff Ride. He wrote the editor's note introducing this article.

** Tony Sciacca and John Holcom were hotshot superintendents on the 1990 Dude Fire on Arizona's Tonto National Forest. They were involved in an on-the-spot decision to burn out a safety zone for 180 people threatened by the oncoming flames. During the Dude Fire Staff Ride, they and others waited at critical points on the fire site (called "stands") and made presentations to staff ride participants.

*** Dave LaTour took the staff ride participants to the spot where 11 entrapped firefighters deployed their fire shelters and 6 of them died.

single slide. To me, that helps underscore the significance of the experience I had on the staff ride through Walk Moore Canyon.

Leaving the Fireline

So let's talk for a moment about leaving the fireline.

I stayed up late last night because the staff ride was ever-present in my mind. I could think of nothing else. As we gathered to ride back on the bus last night and during the ride back, we shared some feelings—mostly feelings, not thoughts. Last night, I recalled something Marty Alexander told us earlier in this workshop. He said that sometimes the planets align themselves to give us serious fire behavior situations and difficulties.

Hotshot superintendent (in blue hardhat) discussing his experiences at a stand on the Dude Fire Staff Ride. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

Staff ride participants descending into Walk Moore Canyon. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

But if planets can align themselves to give us a bad time out there—like they did on June 26, 1990—why can't we align some opposing planets to neutralize that effect that we don't want to see again on the fireline. Some things we don't ever want to see again: a crew going down toward a control road and encountering such a black wall of flame and smoke across the trail that they had to turn around and go back to a very inappropriate place where they had to take a stand. It was a stand of last resort.

So let's talk for a moment about lining up our planets in our favor—in opposition to the potential negatives on the fireline. We have a host of tools. We don't need to wait for further research. We don't need to wait for somebody to filter things down to us, saying, "Do it this way. This is how it should be done in the future." We know in our hearts how it could be done in the future. We just need to put all those pieces together.

Lining up the Planets

These are some of the planets I thought about last night, the ones in our favor.

One has to do with our fire danger rating system. It has to do with the knowledge that we have at our fingertips—the ability to determine what the energy release component (ERC) percentile level is before we ever embark on a fire assignment. Are we at the 95-percentile level at the end of June on the Tonto National Forest? Or are we at the 97.5-percentile level?

That's one of the planets that gives us some advance information about how easy or how difficult our assignment might be. A lot of intuitive and even some experimen-

It's the first time I've come prepared with a slide presentation and not shown a single slide. That helps underscore the experience I had on the staff ride.

tal work has been done to show us that when we've reached the 80th percentile in ERC, fires become difficult to control. That's one piece of information that we have.

What about the Haines Index at 5 or 6? That is a significant indicator that potentially signals plume-dominated fire behavior.

Let's put all the planets together. Let's say we come to a fire in the summer near the Mogollon Rim in northern Arizona, and we know we're at the 97.5-percentile level in ERC. We also know we have a Haines Index of 5 or 6 that day. We also have three or four well-placed lookouts around the fire at strategic vantage points—lookouts who are knowledgeable about fire behavior. The lookout is not someone who couldn't make it out of camp that day because he or she has a blister, so we put that person up on a mountaintop somewhere with a radio. Instead, we have people who are knowledgeable about fire behavior and know what they are looking at.

Cross erected at fatality site on the Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

Our lookouts start reporting that there is a convection column building and being sustained up to 20,000 to 25,000 feet (6,000–7,500 m). We couple that "planet" with the next "planet," which means that some of you, somewhere—in a vehicle, on the line, or on an engine—feel that first raindrop on your hand. If your glove is off, maybe it makes a small impression in the dust on your hand. And you say to yourself, "Another indicator, another planet lining itself up!"

And we use all this and maybe couple it with the "siren" that Dick Rothermel suggested* or whatever else we need to do to get the word around—the word that it's time to leave the fireline for awhile. It's time to get the message out to leave the line while there's still plenty of time to do something about it.

Remarkable Job

That is some of what I finally felt as I walked down through Walk Moore Canyon. Only the people who were there on that terrible day in 1990—the day of the Dude Fire—will fully be able to appreciate the consequences of that event. However, I think they did a remarkable job of sharing what they experienced that day with the rest of us. I hope my remarks give some sense of the impact they had on those of us who experienced the Dude Fire Staff Ride and our sobering walk through Walk Moore Canyon. ■

* For more on the concept of an audio emergency signal for wildland firefighting, see A.G. Bell, "Air Horn Helpful in Fire Emergencies," Fire Control Notes 32(1) [Winter 1971]: 9, 15.

The Staff Ride Approach to Wildland Fire Behavior and Firefighter Safety Awareness Training: A Commentary

Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts

Martin E. Alexander

I felt very fortunate to have been able to participate in all three phases of the Dude Fire Staff Ride that took place on March 3–5, 1999. Like the other staff ride participants, I found the whole experience to be extremely beneficial to my gaining a deeper understanding of the complexities involved in fire behavior and the associated firefighter fatalities resulting from the major run of the Dude Fire on the afternoon of June 26, 1990.

I am thus greatly honored to have been asked to contribute this essay for the special issue of *Fire Management Today* dealing with the Dude Fire Staff Ride. I sincerely hope that the comments offered here, based in part on the Dude Fire Staff Ride experience coupled with a 30-year career in wildland fire, will lead to enhancements as well as extensions of the staff ride concept in the future for training fire behavior analysts (FBANs) and in further developing firefighter safety awareness training.

Strengths and Limitations

Prior to the Dude Fire Staff Ride, I had only a superficial appreciation for this incident based on bits and pieces of information gleaned from various sources over the years (e.g., Campbell 1995; Gleason 1991; Goens and Andrews 1998; Johns 1996; Mangan 1996; MTDC 1990; NFES 1998a; NFPA 1990; Putnam 1995a; Rosato 1991; Rothermel 1991), including the official accident investigation report (USDA Forest Service 1990), and a conversation I had with Dude Fire veteran Paul Gleason in Missoula, MT, in June 1994.

My experience on the Dude Fire Staff Ride suggests that the wildland fire community has an excellent opportunity to develop its own unique staff ride tool.

Although the wildland fire community's adaptation of the military staff ride (Robertson 1987) concept provides a powerful learning technique, we need to recognize that it isn't necessarily a cure-all for increasing wildland firefighter safety awareness. Instead, it is just another tool in our toolkit. Nonetheless, my experience on the Dude Fire Staff Ride suggests that the wildland fire community has an

Participants in the Dude Fire Staff Ride at the fire shelter deployment site. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

Dr. Marty Alexander is a senior fire behavior research officer with the Canadian Forest Service at the Northern Forestry Centre, Edmonton, Alberta.

excellent opportunity to develop its own unique staff ride.

The two greatest values of the staff ride are:

1. ***Onsite experience.*** Rather than just reading about the incident, you get to actually visit the site and obtain a "firsthand feel" for the fire environment, the operational setting, values at risk, and other things—a sentiment expressed very well in the video *Battles Lost* (NFES 1998b). For example, without actually having visited the site of the 1949 Mann Gulch Fire as I did in June 1994, I could have never fully appreciated from simply reading Norman Maclean's (1992) book just how difficult the foot travel would have been in the very loose soil.
2. ***Interaction with those involved.*** You are able to talk to individuals who were actually involved in the incident or who participated in the subsequent accident investigation.

Although these are certainly strengths of the staff ride, they also constitute a limitation for some people, because not everyone who would like to attend can, due to the expense involved and the timing of the event. Furthermore, it would be extremely difficult to assemble the same group of individuals for the eight stand locations (or presentation/discussion stops) associated with the field phase of the Dude Fire Staff Ride, as described by Paul Keller on page 19, on any sort of regular basis.

We need to bear in mind that the Dude Fire Staff Ride was, in effect, a field trip for FBANs, albeit a very significant one, held in conjunction with a major conference, the first National Interagency Fire Behavior Workshop. This was not unlike the field trips to the 1949 Mann Gulch Fire included as part of the first National Fire Behavior Training Course held in Missoula, MT, in March/April 1958 (McDonald 1979) and the Wildland Firefighters Human Factors Workshop, which was also held in Missoula, June 12–16, 1995 (Putnam 1995b). Future staff rides would have to be linked to a major event of this kind in order to justify the time and expense of organizing a staff ride.

Future staff rides would have to be linked to a major event in order to justify the time and expense of organizing a staff ride relative to how many people would attend.

Videotape Value

Four groups of some 135 participants were involved in the Dude Fire Staff Ride. A number of the presentations and discussions that took place at the stands were videotaped and edited into a *Dude Fire Staff Ride* videotape produced by Paul Keller. This was certainly fortuitous, because it captured information and the personal feelings of certain individuals involved in the incident, such as Paul Gleason. It might not be possible to acquire this information at any other time.

Like many others who participated in the Dude Fire Staff Ride, I was mesmerized by Dave LaTour's account of death and survival; the USDA Forest Service's Missoula Technology and Development Center has incorporated his testi-

Author at the site of the 1949 Mann Gulch Fire tragedy in northwestern Montana, just 11 days prior to the firefighter fatalities on the 1994 South Canyon Fire in western Colorado, as part of a field trip for fire behavior analysts and others held following a fire behavior workshop in Missoula, MT, June 21–23, 1994. This experience, like the Dude Fire Staff Ride, had a lasting effect on the author's perspective on fire behavior and wildland firefighter safety. Photo: Marty Alexander, Canadian Forest Service, Edmonton, Alberta, 1994.

I would strongly recommend that any future staff rides videotape all the presentations and discussions at each stand in the interest of historical documentation.

monial into the new *Using Your Fire Shelter* video (NFES 2001). I would strongly recommend that any future staff rides videotape all the presentations and discussions at each stand in the interest of historical documentation. This value-added aspect of a staff ride should not be underestimated as we look to justify the time, expense, and effort of planning and carrying out staff rides in the future.

In 1997, I suggested at a fire safety conference that perhaps an annual fatality fire study tour should be developed in which a small group (perhaps 25 people) would visit a network of selected sites (perhaps 6) in different regions over a 2- to 3-week period, with each stop facilitated by a local historian for each fire (Alexander 1998). For example, Karl Brauneis (1997), a forester and fire management officer on the Shoshone National Forest, has made an extensive study of the 1937 Blackwater Fire in northwestern Wyoming (Brown 1937) and would make an excellent guide.

I also suggested that there was an overwhelming need for a comprehensive case book on fatality fires; Pyne and others (1996) have made a start at this. Although there is an obvious role for the kind of extraordinary indepth coverage of a fatality fire that Norman Maclean (1992) did for the 1949 Mann Gulch Fire, the wildland fire community also requires the "Reader's Digest" encapsulated version, such as Rothermel's (1993) Mann Gulch synopsis.

Building Institutional Memory

A formal staff ride like the one on the Dude Fire is highly appropriate for FBAN and wildland firefighter safety training. However, we need to find ways to make information from a completed staff ride available to a wider audience so that future generations might benefit, in addition to the select few who were able to attend. If we are truly serious about establishing and maintaining an institutional memory, then we should take the following steps:

- Where possible, develop a simple marked trail with interpretive signs for as many fatality fires as possible, or alternatively for a preselected few designed to illustrate certain principles. A large number of memorials already exist (Gulliford 1997).
- Create a national register of fatality fires in the form of a Website that allows one to download an incident summary; a self-guided study booklet or pamphlet, complete with a map linked to the interpretive trail system outlined above; and perhaps other information, such as reports and articles, photographs, and video clips of interviews with personnel involved in the incident.*

* For example, Smith (2002) conducted interviews in 1994 with five Civilian Conservation Corps survivors of the 1937 Blackwater Fire; and the marvelous documentary by Smith (2000) commemorating the 60th anniversary of the U.S. smokejumper program contains an excellent series of interviews related to the 1949 Mann Gulch Fire, including one with Bob Sallee (the last remaining survivor).

In this way, we could visit fatality sites at our leisure, much in the way we view other historically meaningful places. Admittedly, the personal element of being able to talk with the actual personnel involved in the incident—a strength of the Dude Fire Staff Ride—would not apply. However, this disadvantage is small compared to the advantage of more widely disseminating information in order "to use the lessons of the past so we don't have to keep relearning them the hard way" (NFES 1998b).**

Mining Our Past

Following the Dude Fire Staff Ride, I was haunted by the fact that—in spite of the information provided to the participants in a three-ring binder titled "Dude Fire Staff Ride

Payson District Fire Management Officer Pat Velasco at a stand on the Dude Fire Staff Ride. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1999.

** Notably, in the late 1990s, Dr. Jason Greenlee, former executive director of the International Association of Wildland Fire, made a strong effort to put up many of the wildland firefighter fatality accident investigation reports on the association's Website.

Preliminary Study" and the 17-minute excerpt on the Dude Fire from the NFES (1998a) video—there still seem to be many unanswered questions and perhaps conflicting opinions. Admittedly, some questions might never be definitively answered. However, new information has emerged as a result of undertaking the staff ride of the Dude Fire. For example, while it is well known that both live and dead fuels were at critically low moisture levels, the fact that fuels had accumulated in the area for at least 30 to 35 years is not documented anywhere in the literature on the Dude Fire; yet this general concern with respect to firefighter safety has been enunciated elsewhere, especially with respect to the wildland–urban interface (e.g., Mutch 1994; Williams 1995).

I was invited to attend the critique team luncheon meeting that followed the integration phase of the Dude Fire Staff Ride on the morning of March 5, 1999. At that session, I recommended that a technical report along the lines of the excellent publication by Butler and others (1998) on the 1994 South Canyon Fire in western Colorado should be done for the Dude Fire, including an analysis of the prevailing burning conditions in light of previously held views regarding blowup fires in the region (Bates 1962).

As Thomas (1994) points out, we need to avoid falling into the trap of assuming that experience will make its lessons available automatically, and therefore failing to keep systematic records to track the results of our decisions and failing to analyze these results in ways that reveal their key lessons (Russo and Schoemaker 1990). There is, as well, the concern that we might be

A Case for Wildland Fire Behavior Research Units

It has been gratifying to see the recognition of the human dimension in wildland firefighter fatality incidents (Braun and Latapie 1995; Putnam 1995b) and in recent case histories (e.g., Maclean 1992; Maclean 1999). I can still vividly recall the daylong presentation by Jim McFadden of the California Department of Forestry Fire Academy on California fatality fire case histories given at the Forest Technology School in Hinton, AB, in the mid-1980s. His case studies certainly emphasized the importance of human factors as well as fire behavior as contributing factors.

Brewer Fire Mystery

We have in some cases failed to adequately follow up on our analysis of the fire behavior and the associated fire environment on fatality fires, but especially on near-miss incidents (Munson 2000). The Brewer Fire in southeastern Montana, in which the Wyoming Hotshots were forced to deploy their fire shelters on the evening of June 23, 1988 (NFPA 1988), constitutes a case in point.* Thoele (1995) provides an excellent account of the incident in the opening chapter of his book *Fire Line: The Summer Battles of the West*. I first learned about the Brewer Fire in March 1989 from a presentation made by John Krebs and Byron Bonney, the fire behavior analysts (FBANs) assigned to the fire, at a fire behavior workshop held in Missoula, MT, following the notorious 1988 fire season.

I eventually acquired a copy of the official Bureau of Land Management/Forest Service investigation team report on the Brewer Fire shelter deployment. And I also acquired a copy of the investigation team's videotaped interviews with the Wyoming Hotshots from Mike Rogers, the crew's superintendent.

The investigation team assigned to the Brewer Fire shelter deployment concluded that the erratic change in fire behavior and the burst in fire intensity were due, more "than to any other factor," to the low foliar moisture content in the ponderosa pine trees resulting from the drought conditions at the time. No moisture content samples were taken to confirm this as far as I know. It is worth noting that the investigation team had neither an FBAN, a fire weather meteorologist, nor a fire researcher assigned to it.

* The author admittedly has more than a passing interest in the Brewer Fire, having been a member of the Bighorn National Forest Inter-Regional Fire Suppression Crew—the forerunner of the Wyoming Hotshots—in 1972 and 1973.

The team also found that the sudden calm and temperature rise (estimated to be 15 °F [8 °C] in just a few seconds) felt by crew foreman Neil Beisler and another crew member could not be explained or substantiated from the available weather information. It was Beisler's alertness that enabled the crew to seek refuge in time from the ensuing blowup in the grassy meadow where they deployed their fire shelters.

While acknowledging that live and dead fuels were at exceedingly low levels, I have been bothered over the years by the fact that there has never been an explanation for what triggered the Brewer Fire blowup. On the basis of an article that I came across in *Weatherwise* (Schlatter 1995), I now wonder whether the Brewer Fire blowup was triggered by a heat burst (HB) event. An HB is a rare summertime mesoscale weather phenomenon,** resulting from a downburst of air in the wake of a dissipating thunderstorm. It usually occurs at night. Gusty surface winds, sudden and sometimes spectacular increases in air temperature (e.g., 26 °F [14.5 °C] in 15 minutes), and rapid decreases in relative humidity are commonly associated with heat bursts (Schlatter 1995).

Need for Followup

The time has come to seriously consider the establishment of permanent, full-time national operational fire behavior research units in the United States, Canada, and perhaps elsewhere. The sole purpose of these units would be to undertake field investigations of past and recent wildfire occurrences involving firefighter fatalities and near misses, emphasizing the case history method (Byram 1954). Such a unit should be staffed with FBANs, a fire weather meteorologist, a fuels specialist, a fire operations specialist, a geographic information system specialist, a computer support specialist, and a "wildland fire psychologist," supplemented by contractors and fire research personnel on a part-time basis (e.g., short-term assignments and secondments).

Again, if we are truly serious about establishing and maintaining institutional memory when it comes to wildland firefighter safety, we would find ways to make this happen. As Chandler (1976) has so rightly pointed out, "Time and time again case histories have proven their value as training aids" (e.g., Alexander and Thorburn 2001; Cheney et al. 2001; Moore 1959; NFES 1996).

** Chandler (1976) felt that more than half of the fire-behavior-related wildland firefighter fatalities in the United States were the result of mesoscale phenomena (i.e., weather changes resulting from causes too localized to be identifiable from the basic network observations, yet too widely separated to be reasonably deduced from observations at a single local station). The increase in windspeeds on high-mountain slopes at night constitutes a good example (Baughman 1981).

failing to interpret the evidence from past outcomes for what it really says because we are tricked by hindsight effects (Russo and Schoemaker 1990). We owe it to those who have been entrapped and killed or seriously burned on wildland fires to do as thorough a job as possible.

Paying Tribute

In closing this essay, I'd like to pay tribute to the Dude Fire Staff Ride Steering Committee for their innovation and efforts in organizing a highly successful event, as well as to those responsible for publishing this special issue of *Fire Management Today* on the Dude Fire Staff Ride. The Dude Fire Staff Ride and this resultant publication constitute a glowing example of the wildland fire community paying homage to its fallen firefighters. Thus, "the living have remembered the dead, and therefore, the dead go on living" (Gulliford 1997).

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We need to find ways to make information from a completed staff ride available to a wider audience so that future generations might benefit.

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Next Steps in Wildland Fire Management*

Jerry Williams

Wildland fire is a high-risk, high-consequence business. It is influenced by high social expectations and a low political tolerance for failure. Our environment is surrounded by uncertainty and danger. It is controlled more and more by our ability to measure, manage, and mitigate risk.

In our history, every meaningful advance in wildland fire operations has been marked by some reduction in uncertainty or mitigation of risk, almost always following some accident or tragedy. Our understanding of fire behavior, the technological advances in the tools we use, the protective qualities of the gear we wear, the training we employ, and even some of the early explorations of what we call "human factors" have all made our work safer.

Still, the tragedies at Dude, South Canyon, and Thirtymile and the accident at Cerro Grande remind us of the danger that is always present in our world.**

The necessary next steps will represent a profound change in how we plan and execute the high-risk, high-consequence fire program that we are charged with leading.

Managing Risk

We face a wide variety of pressing issues, including contracting, training, the initial abatement plan from Thirtymile, leadership, workforce diversity, and the National Fire Plan. Moreover, we must not overlook preparedness for the fire season that lies ahead. Each of these issues deserves our careful attention; we need to work on all of them. However, I want to get us thinking about our vulnerabilities. I want to make the point that operational professionalism needs to be measured in terms of our ability to better manage the risks that surround us.

In today's press of managing a large, complex fire program, we have a lot of "spots coming across our line." However, before we "dig more line," we should "get up on the ridge" and spend some time reflecting on where this program is right now. What has changed around us? Where do we need to direct not only our management energy, but also our leadership energy?

Karl E. Weick and Kathleen M. Sutcliffe, in their work *Managing the Unexpected*, examined what they call high-reliability organizations in "exotic" lines of work,

The Dude Fire torching and crowning. Photo: USDA Forest Service, 1990.

Jerry Williams is the Director of Fire and Aviation Management, USDA Forest Service, Washington Office, Washington, DC.

* Based on remarks made by the author at the National Fire and Aviation Management Meeting from February 25 to March 1, 2002, in Scottsdale, AZ.

** For more on the Dude Fire, see the related articles in this issue; for the other incidents, see Bret W. Butler and others, "The South Canyon Fire Revisited: Lessons in Fire Behavior," *Fire Management Today* 61(1): 14–20; Hutch Brown, "Thirtymile Fire: Fire Behavior and Management Response," *Fire Management Today* 62(3) [in press]; and "'Remember Los Alamos': The Cerro Grande Fire," *Fire Management Today* 60(4): 9–14.

including wildland firefighting. (For a review of the book, see the article by Dave Iverson beginning on page 36.) The authors found that high-reliability organizations, despite the trying conditions around them, have "less than their fair share of accidents." They attribute our overall success to our determined efforts to notice the unexpected in the making and stopping its development. They go on to say that if we have difficulty halting the development of the unexpected, we focus on containing it. And if containment is compromised, we focus on resilience and rapid restoration of function.

Weick and Sutcliffe also note that, when we're successful, we maintain a high state of situational awareness. Yet when we fail, we make it our habit to bounce back from tragedy, knowing that tragedy—however unwanted—is an ever-present threat in wildland fire operations. As they put it, we are "pre-occupied with failure." Perhaps ironically, then, our growth and improvement depend on the very introspection that accompanies failure.

Operationally, I believe that we are absolutely tenacious in becoming sharper and safer. However, in the past few years, a recurring pattern suggests that we may need to go beyond mere operational fixes. The pattern is based on four events:

- The Dude Fire in 1990, with a loss of 6 firefighters;
- The South Canyon Fire in 1994, with a loss of 14 firefighters;
- The Cerro Grande Fire in 2000, with a loss of 235 homes; and
- The Thirtymile Fire in 2001, with a loss of 4 firefighters.

The Ten Standard Firefighting Orders must be firm rules of engagement.

Burned area on the Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1990.

Mistakenly, we may be focusing our fixes only on the margins.

The Challenge

Weick and Sutcliffe challenge us as managers to maintain an "awareness of discriminatory detail" and focus on our "ability to discover and correct errors that could escalate into a crisis." At the operational level, we have reacted to errors quickly. Over the past several years—in response to the four events described above—we have focused on policy and process. Our fire policy has changed. Our burn plans are more complete, our fire management plans are more detailed, and our large-fire situational assessments are more thorough.

I do not wish to demean any of these improvements. However, I believe that we need to go beyond the fixes that we have traditionally relied on. The necessary next steps will represent a profound change in how we plan and execute the high-risk, high-consequence fire program that we are charged with leading.

Several factors limit our decision space and our operating space:

- The fuel complexes that we work in are more flammable than ever before over more extensive areas;
- Growth remains unconstrained in the wildland/urban interface;
- Ecological perspectives challenge us to conduct landscape-scale restoration and maintenance treatments; and
- A large portion of our workforce is new and developing skills that are not acquired quickly.

We must respond to the fuels, demographic, ecological, and workforce factors that shape our

For extended attack, we need to establish risk thresholds that indicate impending danger.

Memorial for the six firefighters killed on the 1990 Dude Fire. Photo: USDA Forest Service, Missoula Technology Development Center, Missoula, MT, 1990.

working environment. There are four steps we can take to better measure, manage, and mitigate risk, ranging from our activities on the fireline to the plans that guide us:

- Make our rules of engagement firm,
- Improve our extended-attack operations,
- Position ourselves for long-duration, landscape-scale fire use projects, and
- Address fire-related issues in our land management planning.

The four steps are tied to our Brookings Strategic Agenda and consistent with our Fire and Aviation Management Program Emphasis, the two documents that emerged from our Fire Directors' Meetings, respectively, in Denver, CO, on March 27–29, 2001, and in Portland, OR, on December 4–6, 2001.

Firm Rules of Engagement

The Ten Standard Firefighting Orders must be firm rules of engagement. They cannot be simple guidelines, and they cannot be "bargained." They are the result of hard-learned lessons. Compromising one or more of them is a common denominator of all tragedy fires. On the Dude, South Canyon, and Thirtymile Fires, the Fire Orders were ignored, overlooked, or otherwise compromised.

The Fire Orders mean little after we are in trouble. That is why we must routinely observe them and rely on them before we get into trouble. We know that no fire shelter can ensure survival all of the time under all circumstances. Entrapment avoidance must be our primary emphasis and our measure of professional operational success.

Conditions on the fireline can rapidly change. In the pressure of the moment, it is easy for people to overlook something important. That is why we must encourage our firefighters to speak up when they notice safety being compromised. As Weick and Sutcliffe point out, "people who refuse to speak up out of fear enact a system that knows less than it must to remain effective." We must promote a working environment where even our greenest firefighters feel free to speak up.

Following an accident, a "stand-down" should be an accepted practice for those involved, until the facts can be sorted out. However, it is a shame that our focus on accountability too often occurs after an accident. Culturally, we must shift the weight of accountability to

Code of Conduct for Fire Suppression

As wildland fire managers, we must lead by observing these principles in our daily conduct:

- Firefighter safety comes first on every fire, every time.
- The Ten Standard Firefighting Orders are firm. We don't break them; we don't bend them.
- Every firefighter has the right to know that his or her assignments are safe.
- Every fireline supervisor, every fire manager, and every administrator has the responsibility to confirm that safe practices are known and observed.

the time before an accident takes shape. We must embrace the rules of engagement as a way of doing business—as a professional standard. Violation of any Fire Order must prompt management or supervisory intervention and, unless rapidly corrected, be unarguable grounds for release from the fireline, release from the incident, or—if egregious—serious personnel action.

However, we must not adhere to the Fire Orders for fear of punishment. We must embrace the Fire Orders because we owe it to one another. In that sense, the Fire Orders must become a shared obligation, where the leader's situational awareness depends on participation by the entire crew and where the crew's participation is tempered with respect for the leader's responsibility. Borrowing from the aviation community's model of Cockpit/Crew Resource Management, we must focus fireline operations more on *what* is right than on *who* is right.

Extended-Attack Operations

About 90 percent of the wildfires we deal with are suppressed with little notice and effort and at minimal cost. By contrast, about 5 percent of our fires, virtually from the outset, are destined to become large, costly events. It is the fires in between that challenge us now. These are the fires that rapidly transition from relatively benign events to major conflagrations. They are among the most dangerous fires we face.

Dude, South Canyon, and Thirtymile are our most recent examples of the tragedy that can result during extended-attack operations. Historically, some 70 percent of our fatalities are associated with such transition fires. Extended attack typically occurs at high fire danger levels, when fatigue and drawdown at the crew level are exacerbated by slim management oversight and overextended supervisory controls. The danger grows even greater because time is almost always compressed.

> The next step is to develop zonal fire management plans, where treatments can be planned and sequentially executed across jurisdictional boundaries.

Remarkably, we have strategies in place on both ends of the wildfire spectrum but no coherent approach to the fires in between. With few exceptions, we deal with transition fires as best we can with what we have and hope that we come out okay. Too often, we do not. As Weick and Sutcliff note, high-reliability organizations "differentiate between normal times, high-tempo times, and emergencies and clearly signal which mode they are operating in." It is time we did the same for our transition fires.

We need to take the next step by establishing risk thresholds that indicate impending danger. The thresholds will prompt us to position management oversight, supervisory control, and crew capabilities to more safely and effectively deal with the potential for extended-attack operations. The National Wildfire Coordinating Group has sanctioned this effort. We are working with the USDA Forest Service's Research staff and with the Predictive Services Branch at the National Interagency Fire Center to have preliminary support in place by summer 2002.

Though few, extended-attack fires are inarguably our most important fires. The danger that surrounds them and the consequences when we fail—in terms of costs, losses, and damages—are enormous. They deserve a more deliberate, more disciplined strategy.

Fire Use Projects

Cerro Grande taught us that landscape-scale fire use projects in the vicinity of high-hazard fuel types might require something more than a better burn plan. On a landscape scale, we need coordinated fire planning across jurisdictional interests and sequenced treatments for effective risk mitigation.

This year marks the 30th anniversary of the wilderness fire management program. Wilderness fires were our first experience with landscape-scale, long-duration fire use projects. Overall, our experience with wilderness fire has been very positive, but its use has been confined to very large areas where boundaries were generally considered safe.

The uncertainty surrounding landscape-scale fire use projects is often enormous, owing to the long durations (and long exposures) usually associated with these projects. Risk mitigation is most effective at the point of deciding whether or not to proceed with the project. But unless the project area enjoys defensible boundaries where managers can intervene when the

We need to look beyond our fire management plans and resolve some of fire-related issues raised by the decisions we make in our land management planning.

unexpected occurs, a decision to proceed is generally irreversible. The "galloping pony" fires that can result—where we know all we can do is hold on—don't give us much "cushion" where the margins of risk are already very narrow.

The Federal Wildland Fire Management Policy provides the framework for expanded fire use. However, the condition of many forest types precludes the use of landscape-scale prescribed fire treatments without risk mitigation measures that go well beyond simple burn plan requirements. The next step is to develop zonal fire management plans, where treatments can be planned and sequentially executed across jurisdictional boundaries. We must start with protective treatments next to the highest values at risk and work outward.

Land Management Planning

Over the last 2 years, many people have focused on the viability of our fire management plans. Clearly, the plans need to be updated and completed. However, fire management plans are only as good as the land and resource management plans (LRMPs) they are based on.

The Forest Service's Line Officer Team, in its annual letter for 2002, encouraged regional foresters to give special attention to fire-related issues as LRMPs are revised. The letter reminds us that resource objectives are established in the LRMPs, not in the fire management plans; consequently, it is the LRMPs that set acceptable limits of social, economic, and ecological risk. Fire management decision space in terms of safety, cost, and risk is largely predetermined in LRMPs. Yet the LRMPs rarely get the after-action scrutiny that a wildfire should prompt when it destroys valuable resources and costs tens of millions of dollars to suppress.

Weick and Sutcliffe note that high-reliability organizations are "reluctant to simplify the complexities that define their environment." For most of us, LRMPs are cumbersome, complex documents that seem only indirectly related to safety, cost, and risk. For many of us, these plans seem abstract or obtuse in relation to the operational dimensions of wildland fire management. Although the Forest Service typically spends about $600 million per year fielding a fire suppression force and another $500 million per year suppressing unwanted fires, we often lack enthusiasm for the large-scale LRMP revisions or amendments that might help reduce the potential for destructive, high-intensity fires.

Our reluctance comes at a cost. In drier forest types, inaction or poorly conceived resource objectives inadvertently favor dense, multistoried stand conditions. The resultant fuel loads, especially during drought years, greatly increase fire intensity potentials. Therefore, the objectives set in LRMPs, however remote their effects might seem, directly bear on firefighter safety, suppression costs, and protection opportunities for communities at risk.

Until we resolve the issues associated with land management planning, fuels will continue to accumulate and the improvements we make to our fire management plans will realize no more than marginal benefits. The next step is to look beyond our fire management plans and resolve some of the issues raised by the decisions we make in our land management planning.

Higher Level of Professionalism

As wildland fire managers, we know that our most important resource is our workforce. In the uncertain, high-risk, high-consequence environment we work in, the measure of professionalism is a recognition of our vulnerabilities and an uncompromising respect for our limits. A developing workforce must rely on leadership to learn these lessons. As leaders, then, we must make safety more than a platitude. We must make it a responsibility.

By "taking the next step," I mean aspiring to a higher level of professionalism in wildland fire operations. As leaders, we each occupy a position of influence. We can influence policies and procedures; but even more important, we can influence our people through our values and beliefs. Our values should infuse our standards and shape our actions if they are going to mean something to our people. ■

Book Review: *Managing the Unexpected*

Dave Iverson

Particularly on transition fires, the unexpected is par for the course. Our interagency wildland fire organization and the land management agencies that support it should be constantly prepared to manage the unexpected.

Yet how many times have we seen executives and administrators attempt to manage the unexpected after the fact by blaming it on someone—usually someone else? *Managing the Unexpected: Assuring High Performance in an Age of Complexity* (John Wiley & Sons, 2001), by Karl E. Weick and Kathleen M. Sutcliffe, offers insight into this problem. But the reader shouldn't expect easy answers, because the authors' goal is to help us learn to cope in real-world organizations and to work together to improve them. For that, we must abandon the search for quick fixes and embrace the reality of living in complex, adaptive systems and organizations.

The authors' goal is to help us learn to cope in real-world organizations and to work together to improve them.

Staying "Mindful"

Why the title "Managing the Unexpected"? The reason is simple. Most of the time, we can't manage the human and natural environment to conform to the wishes of an organization. More often than not, it works the other way around. As we try to manage organizations to function well despite the variability of the environment, we need to be constantly "mindful"—a key concept for Weick and Sutcliffe—to watch for changes in the environment and adjust organizational behavior accordingly. Weick and Sutcliffe contrast mindfulness to mindlessness—following the rules—which is useful, too, in the right context.

The authors define mindfulness as "the combination of ongoing scrutiny of existing expectation, continuous refinement and differentiation of expectation based on newer experiences, willingness and capability to invent new expectations that make sense of unprecedented events, a more nuanced appreciation of context and ways to deal with it, and identification of new dimensions of context that improve foresight and current functioning." That is certainly a mouthful—and a mind-full. However, Weick and Sutcliffe stress that sometimes you can't wrap complex subjects into the neat, tidy packages too often seen in the business and management literature.

Weick and Sutcliffe spend a lot of time leading us through a study of "High Reliability Organizations" (HROs), such as flight deck crews on aircraft carriers, where you really don't want things to go wrong. They do this to help us better understand pitfalls and strengths in the management of all organizations. Only by learning from mistakes can we learn to do better—to adapt.

Focusing on the Unexpected

Oddly enough, it is by studying HROs that we can see firsthand just how important it is to focus on the "unexpected," to learn to act mindfully. In HROs, you ignore the unexpected at your immediate peril. In other organizations, you can ignore the unexpected for much longer, pretending that somehow the universe will eventually align itself with your vision and mission.

In *Managing the Unexpected,* Weick and Sutcliffe explore the shadow side of organizational culture that many other authors overlook. They stress things like "dynamics of surprise," "preoccupation with failure," and "reluctance to simplify." Even the terms they use are unexpected to those who are steeped in win/win or quick-fix reactive management cultures.

In a subchapter titled "Enhancing Awareness and Anticipation," Weick and Sutcliffe advise us to, among other things:

- Cultivate humility;
- Be glad when you're having a bad day;
- Create an error-friendly learning culture;
- Develop skeptics;
- Be suspicious of good news;
- Seek out bad news; and

Dave Iverson is the regional economist for the Intermountain Region, USDA Forest Service, Ogden, UT.

- Treat all unexpected events as information, and share this information widely.

Creating a Learning Organization

Even this short list serves as a handy launching pad for creating a learning organization. But there is much more to *Managing the Unexpected*, such as chapters devoted to "Why Planning Can Make Things Worse," "Assessing Your Capabilities for Assured Performance," and understanding the importance of paying attention to "Organizational Culture and the Unexpected."

As I reflect on recent tragedy fires on public lands—fires with names like "Thirtymile," "South Canyon," and "Dude"—I wonder whether we could have done better in our fire suppression efforts had our broader agency cultures and our more narrowly framed firefighting cultures been more mindful. Weick and Sutcliffe's book is a start down the path of increasing our mindfulness. ■

Websites on Fire*

Ecological Restoration Institute

Established in 1998, the Ecological Restoration Institute (ERI), in the School of Forestry at Northern Arizona University (NAU), supports ecological restoration through education, research, and a common forum for open, objective consideration of ecological restoration issues. Through experimentation and research, often in collaboration with partners such as the USDA Forest Service, ERI develops comparative information on passive management versus active management using techniques such as thinning and prescribed burning, particularly in the dry ponderosa pine forest type. ERI's Website provides information about past and current research projects, answers to frequently asked questions about ecological restoration, and links to many NAU sites.

Found at **<http:www.eri.nau.edu>**

Lands in Transition

Lands in Transition consists of eight questions and feedback to help users learn more about the history of the Lake Tahoe Basin, how people and fire have affected the Tahoe forest, and what it all means for today's forests. After the questions, the user can pretend to be a forest manager, responsible for making difficult decisions that balance the interests of the people and the forest's health. As the forest manager, you consult with experts and see the results of your decisions.

The site, developed by the Gould Center for Geography Education and Outreach, Department of Geography, Pennsylvania State University, with funding from the USDA Forest Service, Pacific Southwest Region, Lake Tahoe Basin Management Unit, is very media intensive. Several movies provide interesting graphic representations of the effect of fire in the Lake Tahoe area. Almost all the photographs, tables, and graphs can be magnified to improve readability.

Found at **<www.gouldcenter.psu.edu/lit>**

* Occasionally, *Fire Management Today* briefly describes Websites brought to our attention by the wildland fire community. Readers should not construe the description of these sites as in any way exhaustive or as an official endorsement by the USDA Forest Service. To have a Website described, contact the managing editor, Hutch Brown, at USDA Forest Service, 2CEN Yates, P.O. Box 96090, Washington, DC 20090-6090, 202-205-1028 (tel.), 202-205-0885 (fax), hutchbrown/wo@fs.fed.us (e-mail).

Book Review: *How the Way We Talk Can Change the Way We Work*

Jim Saveland

The wildland firefighting community lives a repeating story. Sooner or later, disaster strikes and firefighters lose their lives in the line of duty. An investigation follows; causes are determined and remedies suggested. For a time, there is increasing vigilance for safe operations, but the vigilance declines over time. At some point, disaster strikes again and firefighters lose their lives. The question arises, does anything ever really change? Do we ever really learn anything?

Transformational Learning

How the Way We Talk Can Change the Way We Work: Seven Languages for Transformation (Jossey-Bass Publishers, San Francisco, 2001), by Robert Kegan and Lisa Laskow Lahey, examines obstacles to desired changes. As the authors point out, "people tend to say 'How can we *break down* resistance—our own or that of others? How can we *overcome* our defensiveness? *Reduce* our fear?' And so on." The authors invite the reader into a new and deeper understanding of our being, one that is more respectful of resistance and consequently more supportive of individual and organizational change.

Rather than aiming for the immediate relief of symptoms or for behavioral strategies to bring about short-term solutions, the authors focus on the deeper, underlying changes in the way individuals and groups make meaning. The book is for people interested in the possibility of their own transformational learning, as well as for people interested in supporting the transformational learning of others—an increasingly necessary feature of effective leadership.

The authors invite the reader into a deeper understanding of our being, one that is more respectful of resistance and consequently more supportive of change.

As a student of conversations, I have noticed that learning conversations often start by acknowledging and respecting silence. Another important ingredient in setting the stage for learning conversations is what I call "removing the fixer"—overcoming the urge to fix others' problems. *Seven Languages for Transformation* confirms the need for both ingredients to creating a supportive environment for transformational learning.

The book is divided into three parts. The first part introduces four new languages as tools for personal learning:

1. From the language of complaint to the language of commitment;
2. From the language of blame to the language of personal responsibility;
3. From the language of "New Year's resolutions" to the language of competing commitments; and
4. From the language of big assumptions that hold us to the language of assumptions that we hold.

Part 2 introduces three more languages that serve to maintain and continuously improve the skills developed in part 1. These are social languages, with important implications for leadership:

5. From the language of prizes and praising to the language of ongoing regard;
6. From the language of rules and policies to the language of public agreement; and
7. From the language of constructive criticism to the language of deconstructive criticism.

Part 3 speaks to how we can practice and develop all seven languages. The book takes a novel approach to the subject of why "our own genuine aspirations for change—personally and collectively" lead to "so little lasting change actually occurring."

Jim Saveland is an assistant station director, Rocky Mountain Research Station, USDA Forest Service, Fort Collins, CO.

Personal Languages

Commitment. Complaining, wishing, and hoping are the familiar modes of television talk. As the authors point out, the language of complaint is hardly conducive to personal learning and reflective leadership. Still, complaints do contain the seed of transformation, for "we would not complain about anything if we did not care about something."

The idea is to use the energy in the language of complaint as a "gateway" for expressing personal commitment. The language of commitment does not simply dismiss the complaint, but rather "goes with the complaint, honors it, and invites the complaining person to follow the forward momentum that is implicit in the complaint." From personal experience in the martial arts, I recognize this as the language of aikido.

Personal Responsibility. The authors also propose replacing the language of blame with the language of personal responsibility, a subject I have written about in connection with the South Canyon Fire (Saveland 1995). When we first stop blaming others, we tend to shift the blame to ourselves. But personal responsibility goes beyond placing blame. As the authors point out, responsibility "involves more than taking the blame or debugging the system. It involves being able to learn from the behaviors we identify, to learn from the story we tell on ourselves." I think of blame and reflection as being on opposite ends of a continuum. When we see our reflection in a mirror or other reflective surface, we are better able to see ourselves.

The authors propose replacing the language of blame with the language of personal responsibility.

Competing Commitments. Next, the authors explore why noble aspirations—what they call "the language of New Year's resolutions"—often lead to little change. We all share an immunity to change, often unconsciously. Where we see a need for change yet fail to achieve it, we tend to blame other people or unanticipated obstacles. We fail to see that "it may be nearly impossible for us to bring about any important change in a system or organization without changing ourselves (at least somewhat)."

In other words, our commitment to change is often canceled by "another commitment we hold that has the effect of preventing the change." What we are doing, the authors point out, is merely protecting ourselves, a normal human motive. In fact, self-protection is "a crucial act of self-respect." The trick is to become aware that we are reacting in this way to the challenge of change—to become aware of our own competing commitments.

Assumptions. The authors go on to argue that we are enthralled by "Big Assumptions"—the assumptions that we take to be true. "If we are certain we know how the world works—and this is how a Big Assumption operates; it creates certainty—why would we even think to look for a different reality?" We all have support communities of "colleagues, willing partners, people we can talk to" who reinforce the languages we use. Our Big Assumptions give rise to our competing commitments, thereby anchoring the whole immune system.

The authors recommend a four-step process to overcome our big assumptions:

1. Observe ourselves in relation to the big assumption;
2. Actively look for experiences that cast doubt on the big assumption;
3. Explore the history of the big assumption; and
4. Design and run a safe, modest test of the big assumption.

Our language communities embed us in "not just one Big Assumption but several." However, we can turn our "nest of Big Assumptions" in a positive direction if we use it as "a home for hatching new life, new forms, new ways of making meaning that—if nurtured—one day take wing."

Social Languages

Ongoing Regard. The regular expression of genuinely experiencing the value of a coworker's behavior is what the authors call "the language of ongoing regard." It has two aspects: appreciation and admiration. Most organizations bestow formal praise and prizes—a practice rife with problems (Kohn 1999)—but undercommunicate the genuinely positive, appreciative, and admiring experiences of their members.

According to the authors, three qualities strengthen one's communication of ongoing regard:

1. Being direct—that is, delivering appreciation or admiration directly to the person rather than to or through others;
2. Being specific; and

Our commitment to change is often canceled by "another commitment we hold that has the effect of preventing the change."

3. Being nonattributive—that is, describing the speaker's experience rather than the person's attributes.

The nonattributive quality is perhaps the most difficult to practice. We tend to jump from our perceptions of others to conclusions about their character, thereby passing judgment. As the authors point out, "If we characterize people, even if we do so quite positively, we actually engage—however unintentionally—in the rather presumptuous activity of entitling ourselves to say who and how the other is."

Public Agreement. The Ten Standard Firefighting Orders and the Eighteen Situations That Shout Watch Out can be examples of public agreements. The authors take a fresh look at the purpose of such agreements. "We do not think the value of shared agreements is to *prevent* violations," they say, "but to *create* them." Then, violations are considered with curiosity in an organization's "classroom," not used to trump up charges in its "courtroom." Public agreements are not used to "give the troops their marching orders" or to "cast out sinners"; instead, they become a way for "responsible people to collectively imagine a public life they simultaneously know they would prefer and know they will, at times, fall short of." Falling short of public agreements is a learning opportunity for oneself and an opportunity for group reflection about competing commitments and Big Assumptions.

Deconstructive Criticism. We all know the value of constructive criticism, even though most organizations fail to deliver it well. Constructive feedback is specific, supportive, problem solving, and timely; destructive feedback is vague, blameful, threatening, and pessimistic. But constructive feedback is not enough. As the authors point out, "many a relationship has been damaged and a work setting poisoned by *perfectly delivered* constructive feedback!"

Constructive feedback rests on the assumption that the provider—say, a supervisor—has the only correct view of the situation. The supervisor is privileged to (1) say what the employee is doing wrong, (2) offer help, (3) suggest a solution, and (4) give a timely message. The employee's role is to listen, accept, and gratefully receive.

Constructive feedback presumes that the supervisor has "super vision." The authors see this assumption as counterproductive to learning, because "we have little, if any, reason to check ourselves if we assume we are right." They propose instead engaging in a conversation "with the same criticism in mind" but knowing that "we may not be totally right or may even be wrong." That turns our endeavor from finding "clever ways to help the person see it our way" to exploring "what's been happening and whether our criticism is warranted."

The authors thus propose a third alternative to destructive and constructive criticism. The idea is to break down the "barriers to learning" behind constructive criticism by retreating from "a truth-claiming relationship." "We call this stance a deconstructive one because its central intention is neither to tear down nor build up but instead disassemble, and the object of attention is not first of all the other but our own evaluation or judgment."

The language of deconstructive conflict is not about making conflict disappear. It can work well yet lead to even greater conflict. "We exercise all the languages for the purpose of making our work settings richer contexts for learning," the authors conclude. "The kinds of change we are looking for are transformational. They go to the roots. They are not about fixes at the surface."

Carrying on the Work

The seven languages for transformation allow us to focus on what the authors call "our inner contradictions and Big Assumptions" rather than using them as prisms for viewing reality. That, in turn, facilitates "mental development and transformational learning." A good way of deepening "a productive relationship with our inner workings" is by building support communities that regularly use the seven languages. As the authors point out, "The seven languages are intended to be a steady supply of oxygen to keep the flame burning for as long as our learning may need."

Most organizations bestow formal praise but undercommunicate the genuinely positive, appreciative, and admiring experiences of their members.

Leaders can further the languages by designing conversational space. "When you create a place for something," the authors note, "it is remarkable how much more likely the thing is to occur." The authors try to expand our limited conception of leadership and learning. Leadership is not about "the leader ratcheting up his volume of attaboys"; instead, it is about "creating channels or contexts" for "relatively rare forms of speech at work." "Perhaps we need leaders who are able both to start processes of learning and to diagnose and disturb already existing processes that prevent learning and change, the active, ongoing immune systems at work in every individual and organization."

Next Steps

Can changing the way we talk actually reduce the likelihood of future fire fatalities and improve our individual and organizational performance? I think so. But there is only one way to find out: Try it. That's what a group of us is planning to do in the USDA Forest Service's Intermountain Region. We will get together every other month to practice with the seven languages and experiment with other reflection exercises. You are invited to join us.

Changing the way we talk can be a tremendous step in the right direction. However, more must be done to develop "situational awareness" (see, for example, Csikszentmihalyi 1990; Gallwey 2000; and Heckler 1990). But that is beyond the scope of this book review.

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Moose Fire: The Historical Perspective*

Stephen W. Barrett

From mid-August until early October 2001, a wildland fire burned about 71,000 acres (29,000 ha) of Federal, State, and private land north of Kalispell, MT (see sidebar). Dubbed the Moose Fire, its size, complexity, and threat to homes and lands in multiple ownerships made it the Nation's top-priority fire for a time. Afterward, questions arose about why the fire burned so far and for so long.

No Simple Answer

Was the fire a natural event or a horrible calamity caused by long-term fire exclusion, global climate change, or other factors? There is no simple answer, because the question itself is too simple. Landscape-scale fires burn across various forest types, each with unique fire frequency and severity patterns. These patterns represent "fire regimes," which have been the focus of my research for the past two decades.

Some fire regimes, such as the "nonlethal" type in dry ponderosa pine forests, have been heavily affected by fire exclusion. The resulting fuel buildups in many areas have been exacerbated by high-grade logging. However, the nonlethal fire regime type is rare in the valley of the North Fork Flathead River, where the Moose Fire occurred.

Steve Barrett, a consulting fire ecologist in Kalispell, MT, has studied fire history throughout the Northern Rockies since 1979.

* This article is derived from an op-ed column that appeared in *Daily Inter Lake*, November 21, 2001.

At the stand scale, stand replacement fire regimes have been relatively unaffected by people because the natural fire intervals are longer than the fire exclusion period to date.

Instead, "stand replacement" fire regimes predominate, where fires after a century or more typically kill whole stands. The fires are driven primarily by regional droughts; at the stand scale, the stand replacement regimes have been relatively unaffected by people because the natural fire intervals are longer than the fire exclusion period to date. Thus, the stands in the North Fork Valley were still experiencing natural succession at the time of the Moose Fire.

Fire regimes modeling suggests that about 60 percent of the Moose Fire acreage occurs in the two stand replacement regimes, where average fire intervals are 150 years and 250 years, respectively. Interestingly, the Moose Fire killed about

Moose Fire

The Moose Fire began on August 14, 2001, when lightning struck dry vegetation on the Flathead National Forest, north of Kalispell, MT. Drought conditions prevailed, with total precipitation in August well below normal. Moisture levels in thousand-hour fuels stood at 8 to 12 percent, much lower than the historical low readings of 16 to 17 percent. Conditions were ripe for extreme fire behavior.

A rash of fires broke out in mid-August. In 4 days, fire crews from the Flathead National Forest and Montana Department of Natural Resources and Conservation responded to a total of 28 different fires. The Moose Fire was first detected on August 16, when two smokejumpers walking out from another fire saw it from 4 miles (6.4 km) away. A helicopter overflew the fire and reported it to be half an acre (0.2 ha) in size and burning in heavy fuels at midslope. When crews and aircraft arrived on the fire a few hours later, it was 20 acres (8 ha) in size and growing.

Fueled by tinder-dry vegetation and driven by strong winds, the fire escaped initial attack and repeatedly crossed firelines, spreading onto State and private lands. On September 1, it crossed into Glacier National Park. Not until early October did crews finally bring it under control. By then, it had burned about 71,000 acres (29,000 ha), mostly on Federal land.

60 percent of the stands that burned within the perimeter, matching the historical pattern.

The remaining 40 percent of the burned acreage shows a "mixed severity" pattern. Burning ranged from light surface fire to relatively severe fire that killed all but the most fire-resistant larch and Douglas-fir. This also fits the historical pattern, which shows evidence of two mixed-severity fire regimes, with average intervals of 30 years and 70 years, respectively.

My North Fork Valley study shows that only the driest sites, occupying less than 15 percent of the Moose Fire acreage and wholly within Glacier National Park, were affected by fire exclusion between 1926 and 1988. However, several prescribed fires in recent years had reduced area fuels prior to the Moose Fire. As a result, those stands are well on their way toward a more natural condition.

No Silver Bullet

Outside the park, such as on the Coal Creek State Forest, a few old larch stands previously thinned to emulate the effects of mixed-severity fires also survived the Moose Fire. This suggests that ecologically appropriate logging (see sidebar) can provide a modicum of fire protection. Logging is no "silver bullet," however; the fire easily overwhelmed some of the most heavily roaded and logged terrain in the North Fork Valley.

Clearly, most of the unlogged forest burned by the Moose Fire was still on a natural cycle—unlike the heavily altered ponderosa pine forest destroyed by the 2000 fires on the Bitterroot National Forest in west-central Montana. Studies suggest that major fire periods also occurred in the North Fork Valley and elsewhere in the Flathead River basin between 1650 and 1680, between 1730 and 1750, and between 1889 and 1930. We are now in another drought-induced fire period, perhaps begun in the late 1980s. Undoubtedly, regional

Planning for Postfire Salvage Harvest

Following large fires such as the Moose Fire, proposals for salvaging some of the fire-killed timber often emerge. Reasons for salvage harvest range from reducing fire hazards to creating local jobs and, on State trust lands, generating funds for schools and other public works.

The USDA Forest Service and States such as Montana incorporate biodiversity guidelines into their forest plans. The guidelines reflect principles of wildland forestry popularly known as "ecosystem management." In the context of postfire salvage harvests, ecosystem management means retaining and emulating natural patterns and processes, the same basic principles used in managing unburned forests. For example, it means:

- Retaining "islands" of green and partially burned trees;
- Leaving snag patches of varying sizes, species, and densities;
- Leaving plenty of downed logs for microhabitats and soil replenishment; and
- Retaining some of the largest snags and partially burned trees, such as old larch and Douglas-fir.

Fire-wounded trees provide particularly valuable wildlife habitat. Although relatively scarce in severely burned terrain, such trees can survive for centuries after a fire. When the trees eventually die, some persist as snags for another 100 years. Then, after falling to the forest floor, the big trees provide microhabitats and soil nourishment for another century or so. All told, some of the trees scorched by the Moose Fire could still play important roles in the ecosystem in the year 2500 and beyond.

In fact, trees with dead tops are so valuable—and so scarce in some parts of the West because of long-term fire exclusion and other factors—that the Forest Service has actually hired contractors to create such habitat by dynamiting and girdling the tops of large trees.

In much of the West, the highest quality (largest diameter) snags and partially burned trees occur in low- to mid-elevation montane forests, where most salvage harvest typically occurs. Upper elevation areas are often dominated by small trees, such as lodgepole pine "whips," that are less valuable for wildlife and long-term nutrient cycling. Therefore, it is particularly important for salvage plans to closely follow biodiversity guidelines.

Logging is no "silver bullet";
the fire easily overwhelmed some of the most
heavily roaded and logged terrain in the North Fork Valley.

droughts will continue to generate large fires well beyond the control of any firefighting organization.

Although the Moose Fire certainly was dangerous and frightening, consider what early-day residents had to endure. Archival maps show countless acres burned in the Flathead River basin between 1910 and 1929 alone—including some 40 percent of the forest on the west side of Glacier National Park. As for individual fires, the Moose Fire pales in comparison to truly holocaustic events such as the 1929 Halfmoon Fire and the great fires of 1910. Those fires swept across hundreds of thousands of acres in a matter of days.

Amazingly, however, even 1910 is readily dwarfed by the historic 1889 fire year. Evidence of the 1889 fires reaches from southern Idaho to Jasper National Park in Alberta, Canada, and from the Rocky Mountain Front to Oregon's Blue Mountains. In the context of the past four centuries, the Moose Fire ranks as a rather average landscape-scale event.

One last point: The forest in the North Fork Valley is dominated by some of the most dangerous fire regimes in the West. Were Federal firefighters overly cautious on the Moose Fire, as alleged by some angry local residents? You be the judge.

Complex Story

In summary, the fire history of the North Fork Valley reveals a much more complex story than the one told by various advocacy groups. One protimber group, for instance, claims that the Moose Fire was unprecedented and hence is a "wakeup call" to review Forest Service management policies. Equally groundless is the message from the "zero-cut" environmental groups that today's forests and fires are all "natural," regardless of historical fire regimes.

Most forests—the ones we know and love today—were spawned by fires. The Moose Fire was a continuance of a primeval pattern. To me, the question is not how to prevent large fires, but how society will adapt to that dominant, inevitable force.

Acknowledgments

The author would like to thank Don Black, program leader for Fire, Aviation, and Air on the Flathead National Forest, Kalispell, MT; and Fred Vanhorn, fire management officer for Glacier National Park, West Glacier, MT, for reviewing and contributing to the article. ■

Estimating Canopy Fuels in Conifer Forests

Joe H. Scott and Elizabeth D. Reinhardt

Crown fires occur in a variety of coniferous forest types (Agee 1993), including some that are not historically prone to crown fire, such as ponderosa pine (Mutch and others 1993). The head fire spread rate of a crown fire is usually several times faster than that of a surface fire burning under the same conditions, which leads to a significant increase in the number of acres burned during a given period. In addition, crown fires cause more severe and lasting damage than do surface fires. Consequently, predicting the behavior and effects of crown fire, determining the susceptibility of stands to crown fire, and designing treatments to mitigate the potential damage from crown fires are priorities for fire managers.

Systems and Models

Researchers have developed models of crown fire transition (Alexander 1998; Gomes da Cruz 1999; Van Wagner 1977) and crown fire spread (Albini 1996; Gomes da Cruz 1999; Grishin 1997; Rothermel 1991). Some of these models have been incorporated into computer systems to assess either surface and crown fire potential (NEXUS [Scott 1999]; FFE–FVS [Beukema and others 1997]) or surface and crown fire growth (FARSITE [Finney 1998]).

Both the computer systems and the models need a quantitative description of the canopy fuels; specifically, canopy bulk density (CBD) and canopy base height (CBH). CBD, usually expressed in kilograms per cubic meter, is the dry weight of the available canopy fuel per unit of canopy volume, including the spaces between the tree crowns. CBH is the lowest height above the ground at which there is enough available canopy fuel to propagate fire vertically into the canopy.

Available canopy fuel is the part that can burn in the flaming front of a crown fire. The foliage and some branch wood, which is less than 0.25 inches (0.6 cm) in length, are usually considered available canopy fuel. Larger fuel pieces in the canopy do not burn quickly enough to contribute to crown fire spread. CBD ranges from zero, where there is no canopy, to about 0.4 kg/m^3 in very dense stands.

Existing Methods

Currently, canopy fuel is estimated using instrument-based, inventory-based, and heuristic techniques. Instrument-based techniques use ground-based passive optical sensors to estimate the Leaf Area Index (LAI), which is the amount of foliage surface area per unit of ground area. LAI is used with estimates of specific leaf area and canopy depth to estimate CBD.

Inventory-based techniques use individual-tree allometric equations, which relate tree size to crown biomass, to predict the available canopy fuel loads for every tree in a stand. Available canopy fuel load divided by canopy depth yields CBD. A variation of this technique is to generate a vertical fuel profile of the stand. CBD is then computed as the maximum 15-foot (5-m) running mean predicted for each stand (Scott and Reinhardt 2001).

Heuristic methods rely on expert opinion to estimate CBD. For the Selway–Bitterroot Wilderness, tables of CBD by cover type and density class were developed using expert opinion, without quantitative measurements (Keane and others 1998).

None of the above methods have been tested against direct measurement (collecting and weighing the fuel), so we do not know if their estimates are reliable. Additionally, no previous studies have directly sampled CBD to provide ground-truth data to test the indirect methods.

> Because the effects of crown fires are longer lasting and more severe than surface fires, learning more about crown fires is a priority for fire managers.

Joe Scott is a forester for Systems for Environmental Management in Missoula, MT; and Elizabeth Reinhardt is a research forester for the USDA Forest Service, Missoula Fire Sciences Laboratory, Rocky Mountain Research Station, Missoula, MT.

Canopy Fuel Project

The Joint Fire Sciences Program provided funding to the USDA Forest Service's Missoula Fire Sciences Laboratory to investigate the indirect methods of estimating canopy fuels by comparing them with the results of direct measurements. The primary study objective was to compare the results from the indirect methods against real data. Other objectives were to:

- Document the vertical, horizontal, and size-class distribution of canopy fuels for one stand in each of five forest types;
- Document the effects of progressive levels of tree removal on canopy fuels;
- Develop a preliminary canopy fuel photo guide; and
- Calibrate and compare several optical canopy sensors.

We chose study sites that are prone to crown fire in five major forest types. Although these sites provided a series of examples and a basis for future, more extensive work, they did not document the range of conditions within each type. The need to directly sample an area up to 2 acres (0.8 ha) in size prevented us from using sites in national parks or wilderness areas. Additionally, we chose only sites approved for tree removal or that could be exempted from environmental analysis. Four of the five sites that we used were on National Forest System land (table 1); one of these was in an experimental forest. The fifth site was in a State-owned university research forest. We sampled only one plot on each site.

We used two fixed-radius plot sizes: a 49-foot (15-m) radius for plots with low stem density and a 33-foot (10-m) radius for plots with higher stem density. We conducted a standard inventory of each plot, recording the species, diameter at breast height, tree height, crown base height, live crown ratio, tree health, and crown class for all trees taller than 4.5 feet (1.4 m). Smaller trees were tallied by species and height class on four subplots. After sampling, we collected a cross-section from the stump to determine tree age and we mapped the location of every tree. We measured surface fuels using eight planar-intercept fuel transects (Brown and others 1982) at each plot.

We computed basal area for each tree, sorted the trees by diameter, and assigned each tree to one of four treatments, which contained 25 percent of the initial basal area. In the first treatment, we sampled the smallest trees until reaching 75 percent of the initial basal area. In the second treatment, we sampled the next smallest trees up to 50 percent of the initial basal area, and so on. We remeasured canopy fuels with optical sensors and took photographs after each treatment. By sampling in stages, we crudely mimicked progressive intensities of low thinning and obtained more canopy conditions. Our treatment samples did not represent the canopy fuels of a stand with a naturally occurring basal area equal to a quarter of the sample stand. At each level of the treatment, we thinned a donut-shaped area surrounding the plot so that the trees outside the plot would not bias the optical sensors.

Table 1—*Location and characteristics of the canopy fuel study sites.*

Forest type	Location	Slope (percent)	Aspect	Elevation (feet [m])
Ponderosa pine/ Douglas-fir	Lolo National Forest, MT	6	NNE	3,450 (1,050)
Douglas-fir	Salmon-Challis National Forest, ID	25	SE	7,500 (2,300)
Climax ponderosa pine	Coconino National Forest, AZ	11	S	7,575 (2,308)
Sierra Nevada mixed conifer	Blodgett Forest Research Station, CA	7	NNE	4,250 (1,300)
Lodgepole pine	Tenderfoot Experimental Forest, Lewis and Clark National Forest, MT	7	NE	7,520 (2,290)

Measurements

We measured canopy characteristics using several instruments—Licor LAI 2000, Accupar Ceptometer, Nikon Hemiview digital camera, and CID Plant Canopy Imager.* We also estimated canopy cover with a concave mirror optometer (spherical densiometer) and a GRS densiometer. A GRS densiometer indicates whether a point is beneath the tree crown. The fraction of points along a transect (or in a grid) covered by the tree crowns equals the amount of canopy cover. Lastly, we photographed the stands using vertically oriented 35-mm color slides, with 28-mm and 50-mm lenses.

We used direct measurement to determine the spatial and size class distribution of the canopy fuel at each plot. For small trees up to about 16 feet (5 m) tall, we sampled each tree as a whole, recording the number of live branches, crown diameters, weight of live branches, and weight of dead branches for each meter in height above the ground. On about 10 percent of the small trees, we separately sorted the live and dead branches into size classes and components (table 2). We collected samples to determine the moisture content of live and dead fuels by size class. We used the moisture content data to correct the field weights to oven-dry weights for reporting and the size class proportions from the sorted trees to estimate the proportions on the remaining trees.

For large trees, we measured individual branches and will summarize to estimate the tree and stand biomass. We measured the diameter, length, width, foliated ratio, and field weight of every live branch greater than 0.4 inches (1 cm) in diameter within each meter in height. We noted the average vertical angle of branches for each meter and sorted a subsample of branches (7–10 percent, depending on the species) into size classes and components (fig. 1). We also recorded the weight of all sizes of dead branches and small live branches that were less than 0.4 inches (1 cm) and sorted a sample of dead and small live branches into size class and component.

Because it was important that branches were intact before measurement, we used special rigging equipment to lower trees that were up to about 40 feet (12 m) tall. We could not safely lower the larger trees, so we used spurs to climb the bole, cutting branches along the way. Ground crews tended the climber, measuring and weighing branches as they came off the tree (fig. 2). The climber topped the tree where the bole diameter reached about 4 inches (10 cm) (fig. 3). The top branches sustained little damage even when they were dropped from more than 110 feet (34 m).

Table 2—*Size classes and components for sorting branch biomass.*

Component/class		*Live*	*Dead*
Foliage		X	–
Lichen		X	–
Cones		X	
Branchwood diameter class (mm)	0–3*	X	X
	3–6	X	X
	6–10	X	X
	10–25	X	X
	25–50	X	X
	50–75	X	X
	75+	X	X

*Finer than the finest size class used in most previous studies.

Initial Results

On all five study sites, we sampled about 300 main canopy trees and 300 under- and middle-story trees. Our data include gross weight, size, and *x*-, *y*-, *z*-coordinates for all branches within the study plots—a total of about 12,000 branches weighing 14 tons (13,000 kg). We sorted more than 900 branches into size classes. Five conifer species were present at the study sites: ponderosa pine, Douglas-fir, lodgepole pine, incense cedar, and white fir. We measured a very small amount of subalpine fir at the lodgepole pine site.

The study sites varied in initial density and tree size (table 3). The main canopy in all stands was even aged. The ponderosa pine/Douglas-fir and Sierra Nevada mixed conifer stands had younger age classes of Douglas-fir or white fir in the understory, as reflected in their estimated vertical fuel profiles. The

*The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement of any product or service by the U.S. Department of Agriculture. Individual authors are responsible for the technical accuracy of the material presented in *Fire Management Today*.

Figure 1—*A lodgepole pine sample branch before (above) and after (below) being sorted into size classes. Photo: Joe Scott, Systems for Environmental Management, Missoula, MT, 2001.*

stands without an understory—lodgepole pine, ponderosa pine, and Douglas-fir—had bell-shaped vertical distributions of available canopy fuels. The stands with an understory—Sierra Nevada mixed conifer and ponderosa pine/Douglas-fir—had canopy fuel under the main canopy (fig. 4).

Based on allometric equations, the highest available canopy fuel load was in the ponderosa pine stand, while the lowest load was in the ponderosa pine/Douglas-fir stand (table 4). Similar to the available canopy load, CBD was highest in the ponderosa pine stand and lowest in the ponderosa pine/Douglas-fir stand. The Sierra Nevada mixed conifer stand had the second highest load but had the second lowest bulk density because the fuel was distributed throughout a deep canopy. In all stands, the maximum 1-foot (0.3-m) CBD was only slightly higher than the maximum 15-foot (5-m) running mean.

We completed fieldwork during the summers of 2000 and 2001. Data entry and analysis are underway, and the results should be available soon.

Discussion and Conclusion

Allometric estimates of canopy fuels reveal interesting relationships among the stands. The ponderosa pine stand had the highest canopy fuel load and the highest bulk density; several possible explanations exist. We located the plot in the highest density portion of a high-density stand—the basal area was 50 percent higher in this stand than the next highest basal area. This plot does not characterize the ponderosa pine forest type. The high density implies that we should expect high canopy fuel estimates. However, because the trees grow at such a high density, the allometric equations might overestimate individual-tree biomass.

Using developed allometric relationship for dominant and codominant trees, we made assumptions about the biomass of subdominant trees. In stands that are dense, the biomass of dominant trees might be overpredicted by relationships derived from trees of similar size from less dense stands. Our direct measurements will shed light on whether canopy fuels are really that high in this stand, or if the allometric equations were overestimated.

Quantitative estimates of canopy fuels are needed to predict crown fire occurrence and behavior effectively, and to assess and mitigate crown fire hazard. The canopy fuel study is testing several indirect methods by comparing them with direct measurement. This paper reports the initial results that were based on allometric methods. We will report the comparison with direct measurement when all the data are available.

For more information, visit the canopy fuels project Website at <www.firelab.org>. Links to canopy fuels project publications will be posted as available.

Acknowledgements

The authors gratefully acknowledge the dedication of the field and laboratory crews who worked on this project; and the valuable assistance of the forest and district personnel who located study sites, completed environmental analyses, and provided logistical support.

Figure 2—*The ground crew measured and weighed branches sent down by the climber, who used a self-rewinding tape to measure branch height. Photo: Joe Scott, Systems for Environmental Management, Missoula, MT, 2001.*

Figure 3—*After cutting all the branches on the way up, the climber made a topping cut at about 4 inches (10 cm) in diameter. Even when dropped from more than 110 feet (34 m), there was very little damage to the top branches. Photo: Joe Scott, Systems for Environmental Management, Missoula, MT, 2001.*

The research was supported by funds from the USDA Forest Service's Rocky Mountain Research Station and the Joint Fire Sciences Program, in cooperation with Systems for Environmental Management and the University of California at Berkeley, Center for Forestry, Blodgett Forest Research Station.

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Table 3—*Stand characteristics of the canopy fuel study site plots.*

Forest type	*Species*	*Basal area*		*Quadratic mean diameter*		*Density of trees >10 cm (4 in)*		*Stand height*	
		m^2/ha	*ft^2/ac*	*cm*	*in*	*#/ha*	*#/ac*	*m*	*ft*
Ponderosa pine/ Douglas-fir	Ponderosa pine	22.7	98.7	24.5	9.6	240.3	97.3	22	72
	Douglas-fir	7.8	33.9	6.5	2.6	240.3	97.3		
	Total	30.5	132.6	–	–	480.7	194.6		
Douglas-fir	Douglas-fir	29.2	127.2	15.3	6.0	859.1	347.8	17	56
	Lodgepole pine	8.5	36.9	15.0	5.9	350.0	141.7		
	Total	37.7	164.1	–	–	1,209.1	489.5		
Ponderosa pine	Ponderosa pine	69	300	18.8	7.4	2,067.4	837	15	49
	Total	69	300	–	–	2,067.4	837		
Sierra Nevada mixed conifer	White fir	22.8	99.1	33.7	13.3	169.7	68.7	34	112
	Incense cedar	14.7	64.2	28.3	11.1	113.1	45.8		
	Ponderosa pine	8.9	38.6	63.1	24.8	28.2	11.4		
	Douglas-fir	0.4	1.7	19.0	7.5	14.1	5.7		
	Total	46.8	203.6	–	–	325.1	131.6		
Lodgepole pine	Lodgepold pine	42.7	185.8	15.5	6.1	1,145.3	463.7	19	64
	Subalpine fir	0.009	0.04	2.0	0.8	0	0		
	Total	42.7	185.8	–	–	1,145.3	463.7		

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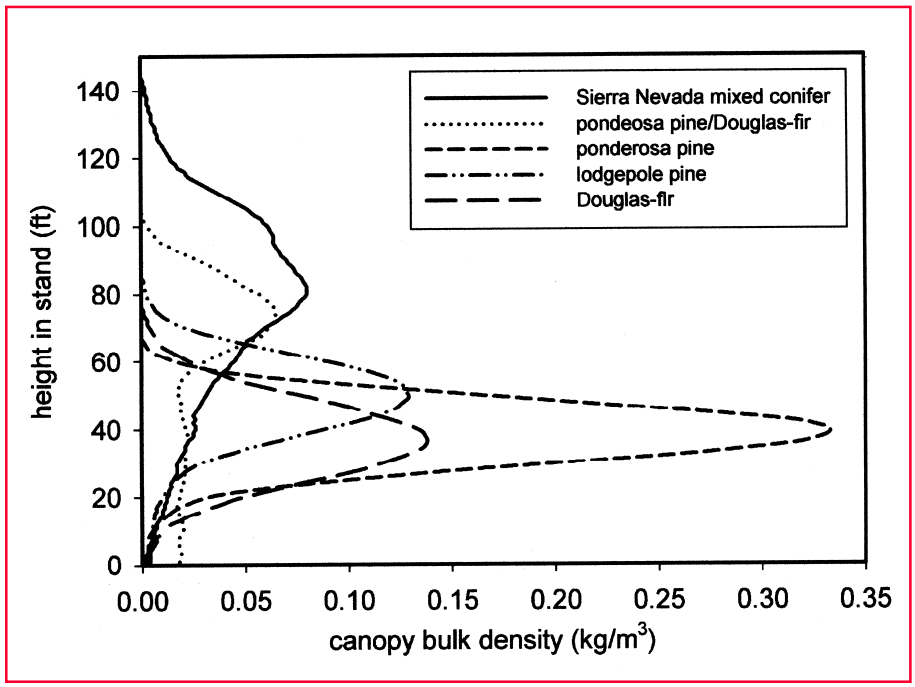

Figure 4—*Estimates of the vertical profiles of canopy bulk density in 1-foot (0.3-m) layers for each sample stand. Curves for each site represent a 15-foot (5-m) running mean. These estimates are summarized from allometric equations for individual trees, not from direct measurement. When available, direct measurements will be used to validate the accuracy of the estimates. The ponderosa pine site was in a very dense portion of a dense stand; available allometric equations probably overestimate its canopy biomass.*

Table 4—*Initial canopy fuel load and bulk density estimates. The estimates of canopy fuel load and canopy bulk density were made using existing allometric equations for individual-tree biomass, not with the direct measurements made during this study.*

	Available canopy fuel load		*Canopy bulk density (CBD)**		*Maximum 0.3-m (1-ft) CBD*		*Height of maximum CBD*	
Forest type	***kg/m²***	***t/ac***	***kg/m³***	***lb/ft³***	***kg/m³***	***lb/ft³***	***m***	***ft***
Ponderosa pine/Douglas-fir	0.859	3.83	0.065	0.00406	0.082	0.00512	23	75
Douglas-fir	1.255	5.60	0.138	0.00862	0.153	0.00955	11	36
Ponderosa pine	2.241	10.0	0.333	0.02079	0.400	0.02497	12	39
Sierra Nevada mixed conifer	1.379	6.15	0.080	0.00499	0.085	0.00531	25	82
Lodgepole pine	1.255	5.60	0.129	0.00805	0.136	0.00849	15	49

*The maximum 15-foot (5-m) vertical running mean predicted for each stand.

Texas Volunteer Firefighters Benefit From New Legislation

Traci Bowen

Firefighters putting personal safety on the line to rescue those in need has become an all-too-familiar scene. Texas, in passing two pieces of historic legislation in 2001, acted to thank firefighters for their dedication. One bill provides funds for firefighter training and equipment, while a second piece of legislation offers workers' compensation and accidental death and disability insurance to these courageous women and men.

Firefighter Funding

The Rural Volunteer Fire Department Assistance program will provide $15 million every year for the next 10 years for equipment and training at volunteer fire departments with 20 or fewer paid firefighters. The revenue for the program will come from money collected from various insurance companies. According to the Texas Department of Insurance, insurance companies will likely pass the $15 million a year on to policyholders, but because of the high number of policies sold in Texas, individual policies will increase by only a few cents annually.

"The legislature took proactive action in passing the Rural Volunteer Fire Department Assistance program," said Mark Stanford, chief of fire operations for the Texas Forest Service. "This legislative support is historic in Texas. The legislature should be commended for its foresight."

Traci Bowen is a fire prevention specialist with the Texas Forest Service, Granbury, TX.

Most volunteer fire departments are in a constant struggle to raise funds for operational costs and training.

The Palo Pinto Wildland Strike Team, a volunteer hand crew from north-central Texas, comes off a fire near Bluff Dale, TX. The strike team's type 6 engine (lower right) was purchased through a cost-share program with the Texas Forest Service. Photo: Texas Forest Service.

Don Galloway, Volunteer Fire Department Assistance Programs coordinator for the Texas Forest Service, agreed that the significant increase in funding came at a great time. "The impact of these programs is going to be tremendous for the rural fire service in Texas," he said. "It is going to address three key areas of need—equipment, training, and insurance."

The Texas Forest Service will administer the program, which will be up and running by September 1, 2002. Texas Forest Service regional fire coordinators conducted a statewide survey of all fire departments. "The results [of the survey] will be used to design the assistance program," Stanford said. "[The survey] will establish baseline data for the fire service, as well as determine what type of assistance they need."

Although volunteer fire departments in Texas will still rely on donations, the assistance program will ease the burden on departments that cannot afford to replace wornout equipment or send members to outside training, according

Legislative support in Texas is providing more than just lip service to help firefighters help people.

to Mark Stinson, fire chief in Heart of the Pines. "Older equipment and Federal excess property are the mainstay for many of the departments. The ability to purchase new equipment will free up funds for other things, such as training outside the department. The assistance program will help us all tremendously," said Stinson, who is also president of the Bastrop County Firefighters Association.

Firefighter Insurance

Volunteer fire departments will soon provide their firefighters with workers' compensation and accidental death and disability insurance, thanks to the Rural Volunteer Fire Department Insurance program. House Bill 3667 provided funding for insurance by assessing a 2-percent sales tax on the retail sale of fireworks. An advisory council will help put the insurance plan together, and fire departments will begin to reap the benefits of this program in September 2002.

Mike Fisher, the emergency management coordinator for Bastrop County and a member of the Rural Fire Advisory Council, said the legislation was a long time in coming. "This bill's been introduced in the last four sessions," he said. "Senator Ken Armbrister and Representative Robby Cook were finally able to get it passed. It's my feeling that the governor is so aware of the needs of rural fire protection that he signed the bill even though it was a tax."

A Proven Friend

Although these two programs are significant accomplishments, the Texas Legislature has been a proven friend of the volunteer fire service for many years. In 1995, Senate Bill 1232 established the Volunteer Fire Department Motor Vehicle Self-Insurance Risk Pool—administered by the Texas Forest Service—to help volunteer fire departments afford low-cost liability insurance on their equipment.

Two years later, the legislation passed House Bill 680, the Volunteer Fire Department Helping Hands Program. This program provides liability relief to industry, businesses, cities, and other groups or individuals who donate surplus fire and emergency equipment to the Texas Forest Service. After screening by the Texas Forest Service, the equipment is distributed to volunteer fire departments across the State. Before the Helping Hands Program, companies routinely destroyed surplus fire equipment because they could not afford the liability exposure incurred when donating.

Understanding and being thankful for the bravery exhibited by firefighters is the first step. The State of Texas went a step further by establishing needed programs to help firefighters do their jobs better and more safely—ultimately benefiting us all. ■

A private contractor donated this 750-gallon (2,839-L) pumper to the Texas Forest Service, which passed it on to the Lake Kickapoo Volunteer Fire Department through the Helping Hands Program. The program allows individuals and businesses to donate surplus fire equipment without worrying about liability costs. Photo: Texas Forest Service, 1998.

Bullets to Buckets: Florida's New Helicopter

Sylvia Melvin

The newest inductee into the Florida Division of Forestry firefighting armada recently underwent a facelift and name change. No longer painted drab olive, the Bell AH–1 helicopter now sports a forest-green nose top, a black tail, and a white body with red lettering. Known to Vietnam War pilots as a Cobra gunship, Florida firefighters fondly call the chopper a Fire Snake. The wings, shortened by 18 inches (46 cm), do not carry weapons; and the turret, which previously housed guns and bullets, has been replaced by a 25-gallon (95-L) tank, which holds a firefighting foam concentrate.

Only the mission remains the same—eliminate the enemy. In Florida, the enemy is wildfire.

From Cobra to Fire Snake

In 1999, the State experienced unprecedented fire activity due to the persistent drought conditions in central and southern Florida. Cobra gunships were delivered for use by the Florida Division of Forestry; ownership remains with the Federal Government. Lear–Siegler, an aircraft maintenance and modification company in Fort Drum, NY, undertook the task of demilitarizing the gunships. Each chopper lost nearly 2,000 pounds (900 kg) of weapons systems and armor plating. It was quite a challenge to rewire and install the special equipment needed for the helicopter's new firefighting mission.

> The Fire Snake's sleek, aerodynamic body gives it the agility to skim above the treetops and maneuver around a fire scene quickly.

The most visible change was installation of a cargo hook and Bambi bucket. The collapsible bucket is made of a waterproof, heavy-duty, tear-resistant fabric. It is tethered to the chopper by several 20-foot (6-m) cables and can hold approximately 320 gallons (1,210 L) of water. When the water is mixed with a foam retardant, the mixture is the equivalent of about 3,000 gallons (11,360 L) of water. Only 3 feet (0.9 m) of standing water is necessary to fill the bucket. However, the Snake's powerful rotor wash and heavy bucket prevent routine use of swimming pools.

Firefighting Capabilities

Using helicopters to fight fires is not new in Florida; Hueys—the Bell UH–1H helicopter—have been the firefighting workhorse for the past 13 years. However, the Fire Snake, with a top speed of 215 miles per hour (346 km/h) and a cruising capability of 160 to 170 miles per hour (260–270 km/h), is 30 percent faster than the Huey! The sleek, aerodynamic body, which is only 36

Florida Forestry Fire Snake and collapsible Bambi bucket. Photo: Sylvia Melvin, W.H. Rhodes Elementary School, Milton, FL, 2001.

Sylvia Melvin is a teaching assistant at W.H. Rhodes Elementary School in Milton, FL.

inches (90 cm) across, gives the Snake the agility to skim above the treetops and maneuver around a fire scene quickly.

Because of the short tether used on the Snake, skilled pilots can drag the bucket close to the hottest parts of the fire to make accurate drops. Other helicopters typically use 80- to 150-foot (24- to 46-m) lines, which can result in fewer accurate drops unless the pilots are especially skillful.

Of the three Fire Snakes in service in Florida, two carry a Bambi bucket and a third is equipped with conformal tanks and a snorkel. The tank-and-snorkel system consists of two 200-gallon (757-L) saddle tanks and a flexible 10-foot (3-m) snorkel tube that is 6 inches (15 cm) in diameter, with a hydraulically driven pump. Each tank has a large drop door that allows for either individual 200-gallon (757-L) or simultaneous 400-gallon (1,514-L) drops. The tank-and-snorkel system eliminates the danger of snagging a bucket in trees or wires. Another advantage is that the snorkel requires less than 12 inches (30 cm) of water to draw from, and it can take up 400 gallons (1,514 L) of water in 15 seconds.

Fire Snakes offer a safety bonus: The pilot has an especially broad field of view in the "see-and-avoid" world of visual flying. Although Snake pilots sit in a relatively confined space, they are shielded from flying ash, embers, and smoke by a fully enclosed cockpit. Air conditioning keeps the temperature comfortable.

The Fire Snake pilot has an especially broad field of view in the "see-and-avoid" world of visual flying.

Air Attack Role

When a fire warrants the use of air attack, ground commanders can direct Fire Snake pilots to the particular area of concern. Crews depend on the pilots to warn them of where the fire is going, what kind of fuel it is consuming, and what the potential is of the fire raging out of control and endangering lives and property. Pilots continually assess the fire situation and relay the information to the ground forces.

It is not unusual, particularly in Florida's many swampy areas, for firefighting equipment to get stuck. When fire is threatening to quickly destroy everything in its path and firefighter safety is a concern, the ground mission focuses on saving firefighters and equipment. But now, with superior trained crews and unrivaled air support from Fire Snakes and Hueys, Florida can better fight and suppress one of the fiercest enemies a community can face—a wildfire. ■

Skimming, usually no more than 200 feet (60 m) above the ground, a Fire Snake makes a training drop on Florida's Blackwater River State Forest. Photo: Michael Kassinger, Milton, FL, 2001.

A Unique Aviation Tool for Firefighting

Jill Evans

Although both the firefighting crew on California's Los Padres National Forest and the President of the United States fly in the same type of helicopter, they use the ships to accomplish very different missions. The forest's Arroyo Grande helibase in San Luis Obispo County, CA, is the proud home of a Sikorsky S–61 helicopter—the only wildland firefighting helicopter in the Nation equipped to simultaneously carry both water and crew. The forest uses the ship to provide initial attack support on fires throughout southern California and to support firefighting efforts nationwide.

The National Fire Plan has enabled the Los Padres National Forest to contract for a helicopter that greatly improves a crew's firefighting ability.

Tax Dollars at Work

The helicopter and flight crew at the Arroyo Grande helibase began their relationship at the start of the 2001 fire season. In the past, the crew flew a smaller, 12-person Bell 212 helicopter. The Sikorsky S–61 type 1 ship, which belongs to the largest class of helicopters, can concurrently transport up to 18 firefighters and drop up to 1,000 gallons (3,785 L) of water via a suspended bucket. The four other type 1 helitankers in the State can only carry and drop water.

The Los Padres National Forest contracted the S–61 with funds provided by the National Fire Plan. "Taxpayers should know that money from the National Fire Plan has been well spent and has allowed this crew to make a greater contribution to wildfire suppression efforts," said Ted Mathiesen, Arroyo Grande crew superintendent. With 29 years of experience fighting wildland fires, Mathiesen knows how important it is to have the right tools to successfully complete a job. "The value of this helicopter to the local community and the entire country is extraordinary," said Mathiesen.

Firefighting Success

By the close of the 2001 fire season, the crew had responded to approximately 30 fires in California. Because of the S–61's ability to simultaneously transport firefighters and water, the crew had significantly reduced the size and intensity of at least five of these fires. Thanks to its newfound mobility, the crew is frequently the first on a fire scene. If no clearing is available for the large helicopter to land, crew members rappel from the ship to the ground, where they make firelines and clearings for other helicopters.

Of the 28-person crew, about half are students who are participating in a nationwide Forest Service apprentice program. Members of the Arroyo Grande crew serve a 2-year apprenticeship in three disciplines—engines, helicopters, and hotshots. At program conclusion, successful students are eligible for fire positions within the State or elsewhere in the Nation. On the Los

National Fire Plan in California

The National Fire Plan, implemented in 2001, was designed to "assure that fire management planning and firefighter personnel and resources are prepared for extreme fire conditions in the future." In 2001, all national forests in California received $190 million in total allocations—a 50-percent increase from the previous year, thanks to the National Fire Plan. The increased funding will allow the USDA Forest Service's Pacific Southwest Region to hire 1,611 additional firefighting and support personnel, train 340 more apprentices, and purchase $22.5 million in firefighting vehicles during the next 3 years. Comprehensive plans have been established for fuels reduction, rehabilitation and restoration, forest health management, research and development, and community assistance. For additional information about the National Fire Plan, visit <**www.fireplan.gov**>.

Jill Evans is the information assistant for the USDA Forest Service, Los Padres National Forest, Santa Lucia Ranger District, Santa Maria, CA.

Padres National Forest, apprentices have the advantage of learning the tools of the trade in a program that uses the unrivaled Sikorsky S–61.

During the winter, the Forest Service contracts the ship to either British Columbia, Canada; or Maui, HI. The ship returns to the Los Padres National Forest in early spring, when the crew begins intensive training. Each year, about half the previous year's crew returns to the Arroyo Grande station. The crew is rounded out with new hires from the apprentice program. At the end of the fire season, the apprentices will either continue their firefighting training or, if ready, convert to senior firefighters and compete for career positions around the country.

Rigorous Training

The crew maintains a strict training regimen to ensure that everyone is prepared to perform all duties in the helicopter and on the ground at the start of the fire season. The season begins with a mandatory safety refresher course, followed by physical training and interagency helicopter instruction. Each crew member begins rappel training from the station tower—quickly progressing to a stationary ship.

After the trainees have completed their practice rappels, they "live rappel" from an airborne helicopter. Each new firefighter must complete at least nine rappels before certification. At training conclusion, the fire season is already raging, and the crew is ready for any fire situation.

When not fighting fires, the crew continues its equipment and physical training activities. Crew members clear forest trails, perform prescribed fires, and ensure that they stand ready to quickly board and expertly operate their unique fire-firefighting tool, the Sikorsky S–61. ■

Safety First!

Ed Hollenshead

The cover of the Fall 2001 issue of *Fire Management Today* (volume 61, number 4) shows a group of firefighters digging line on a rocky ridge (fig. 1). Based upon what we can see in the photograph, the firefighters are working safely. However, just above the firefighters are three observers committing a number of safety violations:

- Their sleeves are rolled up;
- The cameraman has no safety equipment;
- None are wearing gloves; and
- They apparently have no fire shelters.

Several readers commented on these safety violations. I want to thank them for their attentiveness to these important details. For me, they set a good example; their regard for and attention to safety is not situational, it is simply the way they do their work. Good job!

Ed Hollenshead is the fire operations safety officer for the USDA Forest Service, Fire and Aviation Management, Washington Office, National Interagency Fire Center, Boise, ID.

Figure 1—*The safe, effective fireline preparation shown in this photo is offset by several safety violations committed by the three observers at top right.*

Three Small Smokes

Stephen W. Barrett

The year 2000 was certainly an exciting time for a fire ecologist. One August day, I was in a vast mountain wilderness, studying, of all things, fire history. Around noon, I noticed three small smokes across the canyon, caused by a recent lightning bust. And eastward, some 50 miles off, a 20,000-foot-tall mushroom cloud arose from a fire, both beautiful and awe-inspiring.

Steve Barrett, a consulting fire ecologist in Kalispell, MT, has studied fire history throughout the Northern Rockies since 1979.

The solitude readily evoked a simpler time, when nature alone ruled the Earth. Before any "Montana" and "national forests." And long before the region became populated by folks at loggerheads over what has been and should be done to the land.

Inevitably, however, my daydream was interrupted by the approaching smokejumper plane, coming for the three small smokes in the canyon. ■

Guidelines for Contributors

Editorial Policy
Fire Management Today (*FMT*) is an international quarterly magazine for the wildland fire community. *FMT* welcomes unsolicited manuscripts from readers on any subject related to fire management. Because space is a consideration, long manuscripts might be abridged by the editor, subject to approval by the author; *FMT* does print short pieces of interest to readers.

Submission Guidelines
Submit manuscripts to either the general manager or the managing editor at:

USDA Forest Service
Attn: April J. Baily, F&AM Staff
Mail Stop 1107
1400 Independence Avenue, SW
Washington, DC 20250-1107
tel. 202-205-0891, fax 202-205-1272
e-mail: abaily@fs.fed.us

USDA Forest Service
Attn: Hutch Brown, Office of Communication
Mail Stop 1111
1400 Independence Avenue, SW
Washington, DC 20250-1111
tel. 202-205-1028, fax 202-205-0885
e-mail: hutchbrown@fs.fed.us

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USDA Forest Service
Attn: Hutch Brown, 2CEN Yates
201 14th Street, SW
Washington, DC 20024

If you have questions about a submission, please contact the managing editor, Hutch Brown.

Paper Copy. Type or word-process the manuscript on white paper (double-spaced) on one side. Include the complete name(s), title(s), affiliation(s), and address(es) of the author(s), as well as telephone and fax numbers and e-mail information. If the same or a similar manuscript is being submitted elsewhere, include that information also. Authors who are affiliated should submit a camera-ready logo for their agency, institution, or organization.

Style. Authors are responsible for using wildland fire terminology that conforms to the latest standards set by the National Wildfire Coordinating Group under the National Interagency Incident Management System. *FMT* uses the spelling, capitalization, hyphenation, and other styles recommended in the *United States Government Printing Office Style Manual*, as required by the U.S. Department of Agriculture. Authors should use the U.S. system of weight and measure, with equivalent values in the metric system. Try to keep titles concise and descriptive; subheadings and bulleted material are useful and help readability. As a general rule of clear writing, use the active voice (e.g., write, "Fire managers know…" and not, "It is known…"). Provide spellouts for all abbreviations. Consult recent issues (on the World Wide Web at <http://www.fs.fed.us/fire/planning/firenote.htm>) for placement of the author's name, title, agency affiliation, and location, as well as for style of paragraph headings and references.

Tables. Tables should be logical and understandable without reading the text. Include tables at the end of the manuscript.

Photos and Illustrations. Figures, illustrations, overhead transparencies (originals are preferable), and clear photographs (color slides or glossy color prints are preferable) are often essential to the understanding of articles. Clearly label all photos and illustrations (figure 1, 2, 3, etc.; photograph A, B, C, etc.). At the end of the manuscript, include clear, thorough figure and photo captions labeled in the same way as the corresponding material (figure 1, 2, 3; photograph A, B, C; etc.). Captions should make photos and illustrations understandable without reading the text. For photos, indicate the name and affiliation of the photographer and the year the photo was taken.

Electronic Files. See special mailing instructions above. Please label all disks carefully with name(s) of file(s) and system(s) used. If the manuscript is word-processed, please submit a 3-1/2 inch, IBM-compatible disk together with the paper copy (see above) as an electronic file in one of these formats: WordPerfect 5.1 for DOS; WordPerfect 7.0 or earlier for Windows 95; Microsoft Word 6.0 or earlier for Windows 95; Rich Text format; or ASCII. Digital photos may be submitted but must be at least 300 dpi and accompanied by a high-resolution (preferably laser) printout for editorial review and quality control during the printing process. Do not embed illustrations (such as maps, charts, and graphs) in the electronic file for the manuscript. Instead, submit each illustration at 1,200 dpi in a separate file using a standard interchange format such as EPS, TIFF, or JPEG, accompanied by a high-resolution (preferably laser) printout. For charts and graphs, include the data needed to reconstruct them.

Release Authorization. Non-Federal Government authors must sign a release to allow their work to be in the public domain and on the World Wide Web. In addition, all photos and illustrations require a written release by the photographer or illustrator. The author, photo, and illustration release forms are available from General Manager April Baily.

Contributors Wanted

We need your fire-related articles and photographs for *Fire Management Today*! Feature articles should be up to about 2,000 words in length. We also need short items of up to 200 words. Subjects of articles published in *Fire Management Today* include:

- Aviation
- Communication
- Cooperation
- Ecosystem management
- Equipment/Technology
- Fire behavior
- Fire ecology
- Fire effects
- Fire history
- Fire science
- Fire use (including prescribed fire)
- Fuels management
- Firefighting experiences
- Incident management
- Information management (including systems)
- Personnel
- Planning (including budgeting)
- Preparedness
- Prevention/Education
- Safety
- Suppression
- Training
- Weather
- Wildland–urban interface

To help prepare your submission, see "Guidelines for Contributors" in this issue.

Photo Contest Announcement

Fire Management Today invites you to submit your best fire-related photos to be judged in our annual competition. Judging begins after the first Friday in March of each year.

Awards

All contestants will receive a CD–ROM with all photos not eliminated from competition. Winning photos will appear in a future issue of *Fire Management Today*. In addition, winners in each category will receive:

- 1st place—Camera equipment worth $300 and a 16- by 20-inch framed copy of your photo.
- 2nd place—An 11- by 14-inch framed copy of your photo.
- 3rd place—An 8- by 10-inch framed copy of your photo.

Categories

- Wildland fire
- Prescribed fire
- Wildland-urban interface fire
- Aerial resources
- Ground resources
- Miscellaneous (fire effects; fire weather; fire-dependent communities or species; etc.)

Rules

- The contest is open to everyone. You may submit an unlimited number of entries from any place or time; but for each photo, you must indicate only one competition category. To ensure fair evaluation, we reserve the right to change the competition category for your photo.
- Each photo must be an ***original color slide*** or ***print***. We are not responsible for photos lost or damaged, and photos submitted will not be returned (so make a duplicate before submission). ***Digital photos will not be accepted*** because of difficulty reproducing them in print.
- You must own the rights to the photo, and the photo must not have been published prior to submission.
- For every photo you submit, you must give a detailed caption (including, for example, name, location, and date of the fire; names of any people and/or their job descriptions; and descriptions of any vegetation and/or wildlife).
- You must complete and sign a statement granting rights to use your photo(s) to the USDA Forest Service (see sample statement below). Include your full name, agency or institutional affiliation (if any), address, and telephone number.
- Photos are be eliminated from competition if they have date stamps; show unsafe firefighting practices (unless that is their express purpose); or are of low technical quality (for example, have soft focus or show camera movement). (Duplicates—including most overlays and other composites—have soft focus and will be eliminated.)
- Photos are judged by a photography professional whose decision is final.

Postmark Deadline

First Friday in March

Send submissions to:

USDA Forest Service
Fire Management Today Photo Contest
Attn: Hutch Brown, Office of Communication
Mail Stop 1111
1400 Independence Avenue, SW
Washington, DC 20250-1111

Sample Photo Release Statement

(You may copy and use this statement. It ***must be signed.***)

Enclosed is/are _____ (*number*) slide(s) for publication by the USDA Forest Service. For each slide submitted, the contest category is indicated and a detailed caption is enclosed. I have the authority to give permission to the Forest Service to publish the enclosed photograph(s) and am aware that, if used, it or they will be in the public domain and appear on the World Wide Web.

Signature_____ Date _____

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