THE JUNGLE PRESCRIBED FIRE REVIEW

AN EXPERIMENT IN LEARNING

Two weeks after its escape, the Jungle Prescribed Fire burn crew discusses the event near the burn site with the Jungle Prescribed Fire Review Team. Top photo shows the burn on ignition day, June 28, 2007—six days before the escape.

Manti-La Sal National Forest • Ferron Ranger District
Ferron, Utah

October 2007

"We need to amend our view of accountability and measures of success to reflect not only outcomes, but also the appropriateness of the decisions and behaviors leading up to them."

Dale Bosworth, former Chief
USDA Forest Service

Dear Reader:

During the last five years the Federal fire agencies have started a steady movement toward becoming "learning organizations." For example, the Wildland Fire Lessons Learned Center in Tucson, AZ, is specifically chartered to promote a "learning culture" that enhances effective work practices.

A "learning organization" is skilled at acquiring, interpreting, transferring, retaining, and purposely modifying its behavior to reflect new knowledge and insights. In a learning organization, mishaps are looked at as rich opportunities for learning and for improving performance.

In a learning organization, mishaps are looked at as rich opportunities for learning and for improving performance.

After the Jungle Prescribed Fire escape, Mike Dudley, Director of Fire and Aviation Management, Intermountain Region, USDA Forest Service, convened a national Review Team to develop and implement a prescribed fire review process that was *not* about blaming the prescribed fire personnel. He wanted this review to examine and help propel organizational learning.

This review was also guided by the spirit of the foundational principles developed in both the *Fire Suppression Doctrine* and the draft *Prescribed Fire Doctrine* report.

The Jungle Prescribed Fire Review Team now recommends that the next review team seeking to use a similar process follow its lead and share the principles of high reliability and learning with the home unit at the outset of the review, then engage the unit in a collective assessment of events—always taking into consideration the five essential principles of high reliability organizing.

The Jungle Prescribed Fire Review Team

"When something goes wrong, we want to look at the entire system, the whole environment—and not automatically say that the employee did something wrong."

Bill Waterbury,
Assistant Director for Risk Management and Human Performance,
National Interagency Fire Center, Boise, Idaho

First day of the Jungle Prescribed Fire.

CONTENTS

The Jungle Prescribed Fire Review Team's overarching framework was not to find out—in hindsight—what the burning crew did "wrong," but to look at the "system" that was in place during the Jungle Prescribed Fire, and how people individually and collectively made sense of the dynamic fire.

This report outlines the Review Team's approach and provides a chronology of key phases of the prescribed burn project, an assessment of mindfulness, considerations for deeper learning, references and additional resources, and a glossary and appendix to capture additional detail.

"The advice that I would give to an FMO/Duty Officer who was getting ready to initiate a burn typical to the Jungle Prescribed Fire would be to have extra resources on hand—more than just contingency resources. I know sometimes budget has a huge part in it.

Dig very deep into your burn plan and run all scenarios through the 'what if?' game even if you have tried to burn the same acres for the past ten years. Don't get in the game that 'well it burned that way last year' or 'it hasn't burned with any intensity ever on this burn'.

Keep the respect, character, and trust with the resources on the fire."

Brandon Hoffman, Duty Officer, Jungle Prescribed Fire
North Zone Fire Management Officer, Manti-La Sal National Forest

I BACKGROUND AND INTRODUCTION

The Jungle Prescribed Fire, located in the high plateau country of southern Utah, was ignited on the Ferron Ranger District, Manti-La Sal National Forest near Ferron, Utah, on June 28, 2007. To meet the project's primary objective—aspen regeneration—an intense fire was ignited in mixed aspen and bug-killed subalpine fir and spruce forest stands.

Today's Prescribed Fire Challenges

The same challenges that the Ferron Ranger District prescribed fire organization faced with the Jungle Prescribed Fire are confronting fire and land managers across the Western United States. These people and programs are challenged with designing and executing complex restoration burns in ecosystems that need high-intensity, stand-replacing fire to accomplish resource objectives. Specific challenges that faced the Ferron District's burning organization with the Jungle Prescribed Fire:

- Conduct a prescribed fire in vegetation that includes subalpine fir and Engelmann spruce, a forest type known to be dangerous and difficult to control and which needs a high-intensity, stand-replacing fire—including fire spread through torching and crowning.
- Fuel loadings, weather, and climatic patterns that are outside of historical norms.
- Personnel with varying experience levels for burning subalpine fir forests.

For six days, the prescribed fire was successfully contained. On July 3, the fire exceeded the burn unit's boundaries, it was declared an escape, and suppression actions were initiated. The fire burned a total of 549 acres outside the prescribed fire unit and threatened homes. Wildfire suppression costs were approximately $800,000. (For a complete fire chronology, see section *IV Jungle Prescribed Fire Summary*.)

Shortly after the escape, the Director of Aviation and Fire Management, Intermountain Region, USDA Forest Service, convened a five-person team to review the Jungle Prescribed Fire.

Because the Jungle Prescribed Fire was extremely well-organized and professionally planned and implemented—with no significant deviations from the line officer-approved prescribed fire burn plan or the incident "Red Card" qualifications of the burn's personnel—the Review Team was directed by the Intermountain Region to develop and implement a process to "learn" from this prescribed fire escape.

Brandon Hoffman, Duty Officer for the Jungle Prescribed Fire, points to a map as he discusses the event near the burn site with the Review Team.

Review Team Objectives

The Jungle Prescribed Fire Review's central question was not *"What went wrong?"* but, rather: *"How did the burn crew 'make sense' of the prescribed fire as it developed from early planning through ignition, holding, escape, and suppression?"*

One of the Review Team's overall objectives was to determine the existence of early "weak signals" that—if detected early enough and corrected—might have lessened the chance of the burn's escape.

It should be noted that this report is not an exhaustive analysis of the event itself. Rather, this review focuses on themes that encompass high reliability organizing. (See *Appendix A – What is High Reliability?***)** It includes a discussion of issues common across many escaped prescribed fires (Dether 2005, Dether and Black).

Jungle Prescribed Fire Review Key Objectives

1. Create a practical document that prescribed burners can use to improve their next prescribed fire project; a report that builds the confidence of the prescribed burning organization and does not erode it.
2. Create a review environment in which hard issues can be looked at non-defensively and where learning—rather than blame—is the ultimate goal.
3. Use the concept of mindfulness (see next page) to evaluate how the Jungle Prescribed Fire organization identified and acted on the early weak signals that possibly led to the escape.
4. Use and describe the mindfulness review process to enable others to begin to replicate this process.
5. Use a facilitated learning process, designed in the field by the Review Team, to review the Jungle Prescribed Fire escape.
6. Produce a report for regional/national distribution that reflects the learning of both the Jungle Prescribed Fire organization and the Review Team.

To be mindful is to anticipate what might go wrong and organize in such a way as to be best positioned to catch small indications that all is not going according to expectations—and respond appropriately <u>before</u> small, early errors/mishaps become large and uncontrollable.

Review Team Looked Through the Lens of Mindfulness and High Reliability Organizing

The Review Team developed a process to analyze the actions of the Jungle Prescribed Fire organization using the concept of *mindfulness,* as this term is applied in high reliability organizing (HRO). The hallmarks of organizing for high reliability are:

- **Preoccupation with Failure**
  Constantly thinking about what could go wrong, and how mitigate that.
- **Reluctance to Simplify**
  Maintaining multiple explanations of developing events to guard against jumping to conclusions and oversimplification. Questioning assumptions.
- **Sensitivity to Operations**
  Constant sensitivity to one's own situational awareness *and* of how this fits into the entire puzzle—to better create a collective "big picture."
- **Resilience**
  A consciously constructed ability to improvise and bounce back.
- **Deference to Expertise**
  Knowing where expertise exists and having the ability to take advantage this expertise.

To be *mindful* in this sense is to anticipate what might go wrong and to organize in such a way as to be best positioned to catch small indications that all is not going according to expectations, then respond appropriately *before* small, early errors/mishaps become large and uncontrollable.

The Review Team screened the actions of the Jungle Prescribed Fire organization through the five templates of *mindfulness* and concentrated on ten key focus areas:

1. **The Big Picture,**
2. **Planning,**
3. **Boundaries,**
4. **Fire Behavior,**
5. **Error Detection,**
6. **Burn Organization,**
7. **Trigger Points,**
8. **Communication and Team Skills,**
9. **Learning Collectively, and**
10. **Experts and Expertise.**

Besides examining the actions and decisions that transpired on the Jungle Prescribed Fire under all of these focus areas (above), the Review Team also included a list of thought-provoking questions under each focus area to encourage further discussion and learning. (See section *V Lessons Learned Findings: What the Jungle Prescribed Fire Can Teach Us*.)

Ideally, readers of this report can now use these questions as starting points for deeper discussions about upcoming prescribed burns on their own units.

Firsthand Lessons Learned Insights and Recommendations From the Line Officer

In discussions with the Jungle Prescribed Fire Review Team, Ferron District Ranger Mesia Nyman was asked to voice her "organizational learning" advice for other line officers who will, likewise, be conducting stand replacing, high-intensity burns:

Ferron District Ranger Mesia Nyman, (far left) during a Jungle Prescribed Fire Review Team onsite group discussion.

- "Have your experts study the planned burn boundaries and design them to be effective under extreme burning conditions. I had three effective boundaries and one that was not. The burn crossed the ineffective boundary.
- Monitor the mental stamina of your fire leadership during the burn. The rollercoaster of holding a fire can wear mentally on personnel. Take action to mitigate if personnel are mentally tired.
- Plan that outside holding crews will not share the same interest in holding the burn as you and your team. The investment is different. Recruit outside crews that have experience in high-intensity, stand replacing fire suppression. Watch for disgruntlement about no hazard pay. Release the 'bad apples' if morale cannot be corrected—these people can contaminate the entire organization.
- Listen for the weak signals that foretell escape. A small smoke that puffed for days was our problem. We had resources on the smoke but, for various reasons, they were not effective in cooling the spot. Be proactive in correcting the reasons personnel are not being effective: change strategy, switch crew assignments, supplement with additional resources . . ."

A central purpose of this review is to assist the larger prescribed fire community in thinking, acting, and organizing to improve future prescribed burns.

II PURPOSE OF THIS NONTRADITIONAL BURN ESCAPE REVIEW

A central purpose of this burn escape review is to assist the larger prescribed fire community in thinking, acting, and organizing to improve future prescribed burns.

The underlying assumption of most traditional burn escape reviews—that generally produce lists of tactics, activities, and process checks to follow—is that if one follows the review's edicts, success will result on future burns. This review, however, focuses on increasing the capacity to detect weak signals and improvise responses quickly in complex burning situations.

While this report does not offer an explanation—let alone *'the'* explanation—for why the Jungle Prescribed Fire escaped, it does:

- Present a chronology of major events.
- Describe lessons learned from key members of the burn organization.
- Explain high reliability organizing using fire examples.
- Compile recommendations, insights, and questions designed to help others decrease risk and increase the probability of success on their future burns.
- Provide in resources, glossary, and appendices, links to additional HRO materials and background on the Jungle Prescribed Fire review process.

The Review Team used the concepts of mindfulness to explore areas of high reliability and to identify where the entire prescribed fire community might gain from further inquiry and attention.

III REVIEW TEAM METHODOLOGY

The Review Team conducted its analysis through open dialogue with members of the Manti–La Sal National Forest, Ferron Ranger District, and the Jungle Prescribed Fire organization. These discussions were based on questions developed by leading researchers for understanding the human factors in accident review and high reliability organizing.

The Review Team's process was reviewed by an outside team of advisors (see Appendix D) comprised of fire personnel, government researchers, and academics.

The Review Team held three interview sessions:

- An initial, small group interview with District and Forest personnel at the prescribed fire site;
- A large group discussion the following day that included two of the engine crews, and
- Several shorter interviews with prescribed fire implementation team principals and off-Forest personnel (see Appendix C for detailed agenda).

Initial meetings captured the flow of events, who knew what, when, where and to whom that information was shared. Later meetings clarified the Review Team's understanding of the event and captured lessons learned by participants. The Review Team then used the concepts of mindfulness to further explore areas of high reliability and to identify where the entire prescribed fire community might gain from further inquiry and attention.

How This Review Deviates From 'Traditional' Escaped Prescribed Fire Reviews

This experimental review process represents a significant deviation from traditional escaped prescribed fire reviews. For instance:

- Most interviews were conducted in groups and only a few individually.
- Open-ended discussion was used to make sense of the Jungle Prescribed Fire.

The Jungle Prescribed Fire on day of ignition, June 28, 2007.

"The Review Team expressed to everyone who was involved with the [Jungle Prescribed Fire] burn—from the specialists involved in the ID team to the first-year firefighter on the ground—that they should have ownership in the review report. The Review Team completed three sets of group interviews. One set included the specialists involved in the Jungle Prescribed Fire NEPA process, the line officers, FMOs, and burn overhead. Another included everybody—anyone who was involved or concerned with the burn. The third set was an interview with the Burn Boss, Holding Boss, and Burn Boss trainee. Phone calls were made to the individuals who could not attend the group interviews. At no time did I feel anyone was restricted or pressured from expressing their feelings about the burn."

Colt Mortenson,
Manti-La Sal Forest Fire Management Officer

- Employees up and down the chain-of-command were invited to offer their opinions and comments.
- Minor Review Team issues concerning the Red Card qualification system and in the prescribed fire burning plan were dealt with informally with the Ferron Ranger District fire management staff.
- The personnel on the Manti-La Sal National Forest were viewed as joint collaborators in the review. The Review Team shared major findings with them and obtained feedback for this report.
- The review included consideration of the entire planning and implementation process, from pre-NEPA through suppression.
- As reflected in direct quotes throughout this report, individual statements of advice from the people "on the ground" on the Jungle Prescribed Fire were included as a major facet of this review.

Been There; Done That

Prescribed Fire Insights and Advice from the Burn Boss

- *"Be diligent on working through as many 'worst case scenarios' and 'what ifs?' you can possibly think of—and develop a contingency plan for each.*
- *Base all options or plans on as much feedback as possible.*
- *Stay focused on your task at hand. Do not become distracted by other outside issues that others are delegated to handle.*
- *Stay abreast of changing conditions over time (i.e. years) on burn attempts that have not succeeded.*
- *Ensure you are well informed, familiar, and comfortable with the project, its objectives, the burn plan, and history—prior to implementing the burn."*

Joe Arnold,
Jungle Prescribed Fire Burn Boss,
in his comments to the Review Team.

IV JUNGLE PRESCRIBED FIRE SUMMARY

The Jungle Prescribed Fire was initially designed in the late 1980s and early 1990s. The boundary of the original project was significantly larger than the final size analyzed and identified in the final NEPA document.

The first NEPA package was completed and signed on January 25, 1996. The decision memo states that the project would treat approximately 1,100 acres within a 2,000 acre project area. A review of the NEPA documentation was completed and a letter written to the file that the project was still valid on September 19, 2005.

Fuels on site were fuel model 10 with an estimated 46 tons of available fuel per acre. The prescribed fire project area is a mix of wet meadows, aspen, and mixed conifer stands. Upper slopes have dense mixed conifer stands comprised predominantly of Engelmann spruce and subalpine fir. During the last decade, up to 70 percent of the conifer stands have been beetle-killed outside the treatment area. On the lower slopes of the prescribed fire area, Douglas fir is the dominant conifer, intermixed with aspen. Potential vegetation is aspen and vigorous regeneration is expected in the burned areas. The fire treatment necessary to meet the project objectives would require a predominantly crown/stand replacement fire.

The Jungle Prescribed Fire objectives:

1) Reduce dead and down fuel loadings by 50 percent.
2) Reduce conifer encroachment by 65-75 percent in the areas actually burned.
3) Stimulate aspen regeneration over 65 percent of the areas actually burned.
4) Stimulate understory forage production to 500+ lbs/acre within 5 years.

Burn crew ignites test fire for Jungle Prescribed burn.

To Successfully Achieve Burn Objectives, Summer Ignition Deemed Necessary

Numerous attempts to conduct the prescribed fire were undertaken between 1996 and 2006. All of the burns attempted in the spring and fall utilized many gallons of drip torch and helitorch mix, required a large workforce to cover the project area, and produced very few areas of actual burned stands. These attempts produced less than desired results.

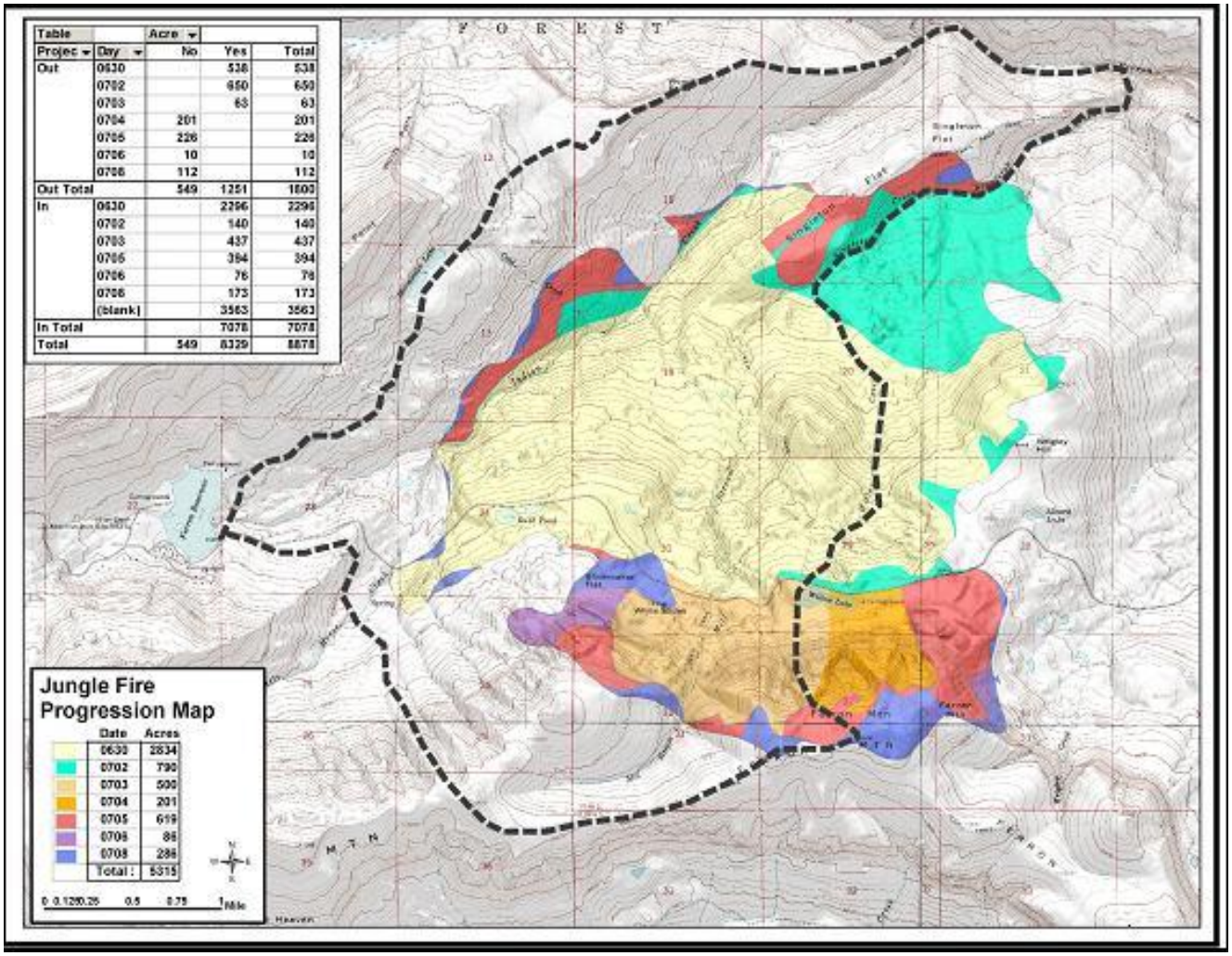
After each failed burn attempt, burn plan adjustments were implemented in an effort to obtain the desirable weather and fuel conditions necessary to achieve project objectives.

Based on these experiences, it was concluded that to achieve the desired results, the prescribed fire would need to be conducted during the summer to successfully mimic the natural role of fire on this site.

An attempt was made to burn this area during August 10-14, 2006 with limited success—and after consuming considerable amounts of Alumagel (the incendiary mixture with gelling agent). While this attempt did produce some desired results, a cold front moved across the area producing light rain, cooler temperatures, and higher relative humidity values which closed the burning window for the season.

The decision was made to once again conduct the Jungle Prescribed Fire in the summer with ignition planned to begin June 28, 2007. Before ignition occurred, a portable RAWS station was set up onsite and structure protection equipment was installed around the 12 "summer home" residences near Ferron Reservoir. On June 27, the Regional Office was notified that ignition was being planned for the following day. All elements were forecasted to be within prescription parameters for the duration of the project.

JUNGLE PRESCRIBED FIRE ESCAPE PROGRESSION MAP



Jungle Prescribed Fire Ignition and Burning Chronology

June 28, 2007 – Ignition Day

Review Team interviews with most Jungle Prescribed Fire overhead revealed that most were hopeful, but not convinced, that the prescribed fire would produce desired results. A significant amount of drip torch fuel is therefore brought to the burn site--because so much had been consumed in previous unsuccessful attempts at burning this area. The "go-no-go" checklist is completed. A pre-ignition briefing is conducted on site at 1030 on June 28, 2007. The test fire, consisting of a 10-acre stand, is initiated at 1130 and all personnel are somewhat surprised, but pleased, at how well the fire burns. Flame lengths are 8-10 feet with torching and short range spotting (less than 100 yards) is observed. The test fire results are adequate to meet the prescription objectives. Ignition continues on units south of the 50022 Road.

Approximately one hour into the prescribed fire operation, spots are encountered north of the 50022 Road. Because this area is inside the project area and fire effects meet resource objectives, no suppression actions are employed on these areas. The spot fires take approximately one hour to get established and start torching.

Ignition continues west on the south side of the 50022 Road. Some concern is expressed by the safety officer over lighting the last unit to the west (Harmonica Point) due to the amount of free ranging fire north of the road. After the weather is checked at 1335, the decision is made to complete the final unit (which effectively blackens the area between the main project fire and the primary summer home houses/values-at-risk). Ignition ceases at 1435.

All areas ignited in the prescribed fire pull into the main smoke column. The fire is monitored throughout the afternoon and into the evening. All resources are camped near Willow Lake, which is located 1.5 miles east of the area ignited. The fire continues to be active with torching and short-range spotting progressing east/northeast and down into the Indian Creek drainage during the night. High winds (10-15 mph eye level) blow all night. The onsite RAWS does not indicate these winds. (It should be noted that the RAWS station was sheltered and that the spot weather forecast for the evening indicated relatively light winds.) A Haines Index of 5 was predicted through the night.

June 29, 2007

As soon as the sun hit the east aspects, fire behavior starts to increase. Longer range spots are observed moving east into the non-continuous fuels to the east of the prescribed fire project area. Spots are picking up. They are torching within 10 minutes of landing on a receptive fuel bed. Incoming contingency crews are briefed and deployed in the most critical areas (eastern edge) to conduct mop-up activities and suppress spot fires. Control lines (meadows) are holding the prescribed fire on the west, south, and north flanks. However, long range spotting compromises the boundary to the east—an area of patchy fuels and no values-at-risk. As planned, the fire becomes well-established in Mill Stream and continues moving to the east. Crews

work through the day monitoring, holding, and taking care of spot fires as conditions allow. While the prescribed fire is still burning inside of the project area, it is approaching the eastern boundary. Fire activity dies down at night.

June 30, 2007

Focus of the day is containing a slop-over on the eastern edge west of Wrigley Point, utilizing the 52095 road and other natural features. This area from Mill Stream to Wrigley Point is outside of the project area. All other flanks are holding. Additional crews are ordered and deployed to increase capabilities. Efforts are successful in defending and establishing a control line on the east flank. Consultation between the Line Officer and Regional Office occurs to discuss whether or not the burn is meeting the FSM 5140 policy requirements. Because the slop over is contained and other conditions remain within prescription parameters, the prescribed burn classification remains in place.

July 1-2, 2007

Holding and mop-up activities on all flanks and in Mill Stream continue with good success. All resources, though tired and looking forward to duties as the 4th of July weekend approached, believed that the highest possibility of escape has passed.

July 3, 2007

Crews continue to work on hot spots along the entire perimeter. A persistent area in Mill Stream drainage that has been staffed since the 28th continues to pose problems with flare-ups and spotting.

At approximately 1500, spot fires are detected south of the 50022 road—outside of the project boundary. Crews respond but are overwhelmed by increasing numbers of spot fires.

A reconnaissance flight is conducted by the Burn Boss to locate indirect features to serve as possible control lines.

A complexity analysis is completed that indicates the fire requires a Type 2 management organization. This information is relayed to the Line Officer.

At 2200, the fire is declared an escaped prescribed fire and classified as a wildfire by the Line Officer. All required notifications are made of the change. A Type 2 Incident Management Team is ordered to manage suppression efforts.

Table 1 – Evolution of Burn Prescription Parameters

Prescription Parameters	1996 RxBP	2006/2007 RXBP	2006 Actual Weather	6/28/07 Actual Weather
Temperature	50-85	30-85	58-77	80
Relative Humidity	10-35%	10-35	26-61	13
Wind Speed/Direction	3-15mph/ any	/SW,W, or NW	3-15/ W,NW, N,NE,	0-4 gusts to 15/S, SW,W,NW
Mid-Flame Wind	0-15	0-15	E-S/0-6	
Days Since Rain	4+	*	#	#
1 hr Fuel Moisture	5-14%	4-11	8-12	4
10 hr FM	7-26%	5-15	#	8
100 hr FM	*	8-20	#	10
1000 hr FM	*	10-30	#	#
Live Woody FM	50-120%	50-120	#	100
Stability	Unstable	*	#	#
Clearing Index	500+	500+	700-1000	1000+
Haines Index	*	*	5-6	6
Prob. Of Ignition	*	30-50	20-40	#
Rate of Spread	*	3.9-51.6	#	14
Flame Length	*	3.4-12.2	#	6.9
Scorch Height	*	20-60	#	#
Spotting Distance	*	.25 mile	#	#

* – **No value prescribed** # – **No value recorded**

V LESSONS LEARNED FINDINGS

What the Jungle Prescribed Fire Escape Can Teach Us

Thinking, Acting, and Organizing for the Next Prescribed Burn

The Principles of High Reliability

How should we organize to manage a prescribed fire of this type? If you have 2,000-4,000 acres of high-intensity, free-ranging fire, what type of burn organization does it actually take to manage such an event?. . . How do you build and maintain the "big picture" of what's occurring on a prescribed fire? **. . .** *How often and when do you update what you are seeing and sensing about the fire behavior?*

These are some of the questions posed in this chapter that identify actions and decisions that were made on the Jungle Prescribed Fire. These questions are intended to help propel the various "high reliability" lessons learned from this prescribed fire—most of which can be applied to all future prescribed fire events on any unit.

As you will see, the chapter has been divided into ten key focus areas: 1. The Big Picture, 2. Planning, 3. Boundaries, 4. Fire Behavior, 5. Error Detection, 6. Burn Organization, 7. Trigger Points, 8. Communication and Team Skills, 9. Learning Collectively, and 10. Experts and Expertise. Discussion and observations and follow-up questions are included under all of these focus areas.

Prescribed burners trying to do a better job on their next burn can use these lessons of the Jungle Prescribed Fire. The many questions highlighted under each of this chapter's sections can serve as launch points for rich, learning discussions.

As explained in detail in *Appendix A – What is High Reliability?*, organizing for high reliability is about consistently producing the desired results in a dynamic and unpredictable operating environment in which errors can quickly magnify into catastrophes. Successful wildland fire management, like a number of other high-risk/high-consequence disciplines, requires high reliability—or *mindfulness*. Yet mindfulness is more a quality of attention than a state of achievement; it is a process and way of functioning that must be constantly recreated. The discussion and thought-provoking questions in this chapter are intended to help this review's readers in their quests to better view their worlds through a high reliability lens.

For more information on organizing for high reliability, an insightful discussion can be found in *Appendix A – What is High Reliability?* that further outlines and explains the five high reliability organizing principles.

"The Jungle Prescribed Fire taught me that when igniting a burn in conifer in conditions where a stand replacement fire can exist, do not expect to complete the burn in four or five days with only monitoring and marginal mop-up afterward."

Colt Mortenson
Manti-La Sal Forest Fire Management Officer

1. The Big Picture

Four different sets of people had "eyes" on the Jungle Prescribed Fire at different locations—on its north, southeast, west, and interior. While these multiple positions provided excellent perspectives on the fire, key pieces of information did not seem to be fully synthesized and reinterpreted to recreate a new situational awareness as the burn progressed. For instance:

- The zone FMO and former FMO were the ignition specialists, walking along the ignition line, igniting by hand, and watching fire behavior in their immediate neighborhood. Their visual perspective was limited to very local fire behavior and fuels consumption in the target fuels.
- The holding boss was positioned west of the western-most burn unit, located between the fire and the summer homes. He had a good perspective of the column, which was well-developed and pulling in nicely. While he has a sense that the fire is burning quite actively, he was new to the area and was focused on the need to put in a reliable black line between the main fire and the critical values-at-risk.
- The new FMO, also acting as safety officer, was situated in the best overview perspective. He could see the entire project area. Sitting with a regional fire expert, he saw the fire moving downslope unimpeded and free roaming into the interior of the project area—adding significantly to the amount of fire on the ground.
- Meanwhile, the burn boss and burn boss trainee were located on the fire's southeast side near the test fire. They have a good visual overview of the event. However, snags falling across the access road prevented face-to-face communication.

How—and *how well*—did these four groups collectively share and form a "situational awareness" for the burn? Was that situational awareness adequate?

Follow-up Lessons Learned Discussion Questions

- **How do you build and maintain the "big picture" of what's occurring on a prescribed fire?**
- **How do you acknowledge and integrate different or conflicting perspectives?**
- **How does building situational awareness over the radio differ from face-to-face contact? What can you do to mitigate the lack of ability to read body language?**

2. Planning

The Ferron Ranger District's integrated approach to project design demonstrates a 'sensitivity to operations' too rarely seen in project planning. Over the course of a decade, and across several changes in key staff positions, the silviculturalist, fire management officer, wildlife biologist, and fuels specialist engaged in ongoing discussions—in the field and in the office—about the goals of the project and the conditions under which the objectives could be met.

The first project boundary, for example, represented the integration of the silviculturalist defining implementation boundaries based on target vegetation conditions that could carry fire, and the fire management officer defining an external project boundary for defensibility determined by natural fire boundaries. **This basis for setting boundaries, however, seems to have been lost in subsequent boundary changes.**

Follow-up Lessons Learned Discussion Questions

- *How widely shared is your vision and planning? Are you talking with and including other resource areas—even if those discussions are difficult?*
- *What is the basis for setting your project boundaries? Are they defensible from many perspectives, not only fire but also hydrologic and ecological, for example?*
- *What if your landscape-level prescribed fire was a Wildland Fire Use event? How would you think about it differently?*
- *Would you use RERAP to establish management action trigger points for a prescribed fire?*

3. Boundaries

Karl Weick, noted "Managing the Unexpected" author and University of Michigan professor says *"be very, very careful about labeling a thing as fact."* On the Jungle Prescribed Fire, there was a tendency to label the natural fuel breaks in this area as "fact." How did the burn team "know" the fuel barriers would hold the fire? **They seemed to label the meadows and eastern boundary as a 'fact' that they were barriers to holding fire spread. In this case, the meadows did stop ground fire and short-range spotting, but long-range spotting continually challenged their project boundaries.**

Ultimately, it was heavy short-range spotting that ended up swamping their holding forces and resulted in the fire establishing in beetle-killed spruce outside the project boundary, forcing a wildfire declaration.

This lack of focus on the eastern boundary, however, was not without rationale. The string of wet meadows and other natural boundaries located well within the project boundary led the burn crew to believe that there would be no holding concerns—particularly in relation to the "summer" homes and continuous fuel stringers leading up to these residences on the western boundary.

Follow-up Lessons Learned Discussion Questions

- **What is an effective natural boundary (to stop fire spread)? What changes an effective boundary into an ineffective one? Is a bigger project boundary actually a more effective boundary? What are the difficulties with conducting NEPA at the watershed-level using natural boundaries?**
- **How do you <u>constantly</u> mentally test a boundary's potential effectiveness? Under what conditions might the burn escape, and if it does, what happens? What will you do then? Will the boundary withstand an unexpected wind event? How would you monitor for such changes?**
- **What does the boundary actually mean? Is it solid or soft? Who has the "big picture" of the boundary? Is it a single person or are there multiple perspectives?**
- **Comments made by the burn crew about the Jungle Prescribed Fire escape include: *"Expect the unexpected. Pay attention to boundaries; look at the worst case and plan boundaries that way. For each trouble-spot, evaluate whether your efforts are working and take necessary corrections. It was almost too late by the time we updated. Plan for resources for the worst case and for the most troublesome area."* How do you turn these oft-stated comments made in hindsight into active, in-the-moment acts of mindfulness? How do you make them 'real'?**

4. Fire Behavoir

The series of unsuccessful ignition attempts over the years likely reinforced the Jungle Prescribed Fire burn team's expectation that the area was virtually impossible to burn. The very name "the Jungle" describes the area's dense vegetation and usually moist conditions.

During the first summer season ignition attempt (early August 2006) when conditions were at the low end of their prescription, the Ferron Ranger District used 800 gallons of helitorch fuel, two helicopters, and a daisy chain firing sequence. Yet they achieved only minimal ignition and insufficient fuel consumption.

As prescribed fire personnel approached the project area at the end of June 2007, the mindset was still that they would not get what they were hoping for. This was indicated by several involved in the Jungle Prescribed Fire who commented: *"I was just hoping it would go."*

Though there were additional signals, several "facts" seemed to dominate their thinking:

- Previous unsuccessful ignition attempts,
- Low ERCs in mid and late June, and
- The lack of availability of severity funding.

In hindsight, it appears the Jungle Prescribed Fire team missed early, weak signals that the fire would spot and would be more intense than expected.

Follow-up Lessons Learned Discussion Questions

- **How often and when do you update what you are seeing and sensing about the fire behavior? How far should you go with the "what if?" scenarios? How can you ensure that your updates are sufficiently broad—acknowledging that your initial frame, not just content, may need to change?**
- **If you're always gaming you won't take action. But if you don't game, you can easily get in a jam. A reasonable compromise is to ask: *"What am I/are we counting on to function?"* Then ask: *"What would happen if that fails?"* Addressing this question gets you through your first level of contingency planning. Dare to ask what would happen to this fire if we get a thunderstorm downdraft or strong frontal wind?**
- **What is the actual window for ignition in these high-elevation systems? How can we hold and mop-up fire in these systems?**
- **When fire danger indices are beyond historical norms, how can they then be used to make burning decisions?**
- **What are the weather indicators for short- versus long-range spotting? What can we do to anticipate long-range spotting? Once we have long-range spotting, how do we contain it?**
- **Where are our weakest boundaries? Can we "harden them" by putting *more* fire on the ground?**

The Jungle Prescribed Fire burn team members identified a number of lessons learned regarding fire behavior:

- ***"Base all action on current and expected fire behavior; then readjust…***
- ***You can't guarantee anything— it's fire; it's NOT a controlled burn; it's a prescribed fire.***
- ***Until fire is under control, treat it as if it is blazing . . .***
- ***Fire is fire and we need to treat it that way, not look at prescribed fire differently than suppression . . .***
- ***Spotting ½ to 1 mile does pose a control problem. Really think about your boundaries . . .***
- ***Stay with the game, "it looked dead," stay focused. Fire behavior in dead spruce wasn't as vigorous as green, but it was vigorous . . .***
- ***Don't let your guard down—the fire looked asleep—then it blew up."***

To truly learn from this event, all of these comments and observations deserve intense conversation. All of them can be turned into discussion points, prior to and during burns. For instance:

Follow-up Lessons Learned Discussion Questions

- **How can you deal with spotting in subalpine fir? Can you live with this spotting? If it does pose a problem, how can you deal with it?**

The Jungle Prescribed Fire burn crew might have thought the fire behavior in Mill Stream (an area of continuous fuels crossing a critical boundary that also was aligned with the predicted winds) was safe because only a few minor-seeming smokes lingered there.

Several small signals and opportunities were detected by individuals in this phase. They were never acted upon or incorporated into the full collective discussion. For instance, one portion of the burn crew noticed a small smoke at Mill Stream, but was distracted and decided not to jump on it. It was this smoke that blew up and ultimately caused the escape.

Follow-up Lessons Learned Discussion Question

- **In hindsight, it seems clear that the organization could have responded more strongly to these signals. But how could we have known that before? How can we recognize such signals?**

5. Error Detection

The Jungle Prescribed Fire project evolved over nearly 10 years. During this time period, an extensive beetle infestation moved through the area.

The prescribed fire project area had been unusually dry for several years. The day before the prescribed fire, several prescribed fire team members visited the area and noticed that the green branches were breaking easily. One team member, who had returned to the area recently, recalls he "knew the burn would go." It is unclear how these signals about fuel conditions were incorporated into people's expectations of the next day's fire behavior.

Follow-up Lessons Learned Discussion Questions

- **What, if anything, in the environment has changed since initial project planning and NEPA? How does that impact your assumptions about the burn, the plan, contingencies? What assumptions are you holding about the environment—are there any conflicting signals that you might want to pay closer attention to?**
- **Of the myriad weak signals one can pick up in the environment, how can you take care of them? How can you bring seemingly innocuous weak signals into the collective understanding of conditions and into the decision process—yet without getting swamped by them?**

Ten minutes after ignition, the burn team realized they had a *"tiger by the tail,"* but interpreted this as *"We've <u>finally</u> got our target fire behavior to meet our objectives!"*

Instead of having to rely on hand ignitions to ignite each unit, within 15 minutes of test fire ignition, the fire had jumped across the road into a unit they had previously and unsuccessfully burned in. Yet, spot fires were within expectations and prescription: 100 yards in advance with new spots taking an hour to establish and move up into the crowns.

Aerial view of Jungle Prescribed Fire showing burn mosaics.

Follow-up Lessons Learned Discussion Question

- **How do you let your focus on "getting the burn" accomplished *not* divert you from detecting and paying attention to weak signals? What might those weak signals be and how will you detect them?**

In continuing to build assumptions and expectations, the burn organization did note that the fire brands falling into the meadows were going out. This was apparently interpreted as a key signal that "all was well and as expected" and did *not* pose safety or holding issues. One burn crew member said: *"Pay attention to your assumptions and expectations and actively test and update these."*

If you are making sense of the world using automatic reactions, be very careful because you are vulnerable to being blindsided. Being on auto-pilot and following old routines are signals of being "mindless."

Follow-up Lessons Learned Discussion Questions

- **Ask "what is happening?" Am I on automatic pilot? What am I missing? How do I know whether I *or my crew* is on automatic pilot?**
- **Am I paying attention to how this burn is following the plan, or to indications that it is not? What do I need to pay attention to?**

One factor that increases the time crews will have to stay on the burn is the burning period duration.

By burning in late June or July, the burning period can be more than double that of spring and fall burns. Often in the fall, your burn window starts in the early afternoon and ends around 1700. In late June, the burn window can start mid-morning and end just after sunset."

Colt Mortenson
Manti-La Sal Forest Fire Management Officer

6. Burn Organization

After ignition, the prescribed fire team shifted to a Type 3 organization to assist in the holding operation—thinking that this was a familiar organizational structure through which to manage both local and out-of-area holding resources.

However, it is easy to imagine that with a significant smoke column, stand replacing fire behavior, and the transition to a suppression organization, this situation might have had an unintended consequence of giving mixed signals as to whether this was, in fact, a prescribed fire or a suppression event?

Follow-up Lessons Learned Discussion Questions

- **How should we organize to manage a prescribed fire of this type? If you have 2,000-4,000 acres of high-intensity, free-ranging fire, what type of burn organization does it actually take to manage such an event? Is it a "prescribed fire" or a "wildfire?"? What difference does such a classification make?**
- **How will you hold these discussions? What signals will you be looking for to indicate that you may need to rethink your organization and classification?**
- **Who maintains the situational awareness (the "cognitive map") of this "new" fire? Is the suppression fire "different" from the prescribed fire? Might the reluctance of some holding crews to become engaged with the wildfire be a sign that they saw the "new" fire differently?**

7. Trigger Points

Fires ignited in subalpine fir either burn or don't. These fires do what they want, particularly when winds are introduced. The Jungle Prescribed Fire was a classic example of this phenomenon. This burn underscores the necessity to be "preoccupied with failure" in the sense of playing out (pre-planning) wind events as close to trigger points as possible—before and during the burn—with contingency forces commensurate with these types of events. This burn also highlights the need to be willing and able to act quickly and decisively in response to early signs of danger.

Follow-up Lessons Learned Discussion Question

- **What predetermined "trigger points" (such as pre-treated areas, reinforced boundaries, additional holding equipment and personnel) could be used to hold your prescribed fire within the project boundary?**

8. Communication and Team Skills

"Managing the Unexpected" authors Weick and Sutcliffe emphasize that *"with every problem, someone somewhere sees it coming. But those people tend to be low rank, invisible, unauthorized, reluctant to speak up, and may not even know that they know something that is consequential."*

On the Jungle Prescribed Fire, at least two people recalled recognizing problems and potential solutions with fire in a key drainage—but were these brought into a full discussion with the burn boss?

"I would have done a burnout at Mill Stream several days before it blew out of there. I thought about it and even mentioned it to others but did not pursue it. Apparently the wind was from the south (down slope) and conditions were right for a burnout—but others did not want to put any more fire on the ground.

I would have put out the weather station several weeks earlier so we would have better trend data on the fuels. I also would have put out a second weather station in the upper portion of the burn."

Daron Reynolds, Burn Boss Trainee on the Jungle Prescribed Fire

---

Follow-up Lessons Learned Discussion Questions

- **It is difficult but essential to high reliability to be able to raise dissenting perspectives, quickly improvise a solution, and move on. This takes practice. How comfortable is the atmosphere in your unit for raising contrary viewpoints? What can you do to help develop these skills?**
- **The Jungle Prescribed Fire burn crew member comments on what they would like to carry forward include: "*actively work to build communication skills, knowledge of decision traps, and skills to avoid hearing only what you want to hear…learn skills to be able to actively voice your opinion. If you see something, speak up…character, attitude, and respect are keys to relationships*." These skill sets don't just naturally occur. To achieve these responses and behaviors takes practice. How can you work with your burn organization to build these skill sets?**

A Jungle Prescribed Fire burn team member told the Review Team: *"Know your crews; know their strengths and capabilities… Pay attention to morale—your crew's discouragement and fatigue."*

All crews may not share your commitment to your burn. What processes do you therefore have in place to handle or mitigate a circumstance in which a crew/crew member might not be willing to do what you want them to?

Such processes include how you actually handle the situation externally and also how you internally acknowledge or dismiss others' interpretation of the situation. Such differences may indicate an early weak signal about a developing situation that is important to pay attention to.

Follow-up Lessons Learned Discussion Question

- **How do you build your resilience—physical, mental, emotional, and political—to pick up on weak signals and bounce back during long duration events (or longer duration than anticipated)?**
- **How do you build your burn unit's capacity to be resilient in this same manner?**

9. Learning Collectively

Burning in stand-replacing fire regimes—particularly those with subalpine fir—is tricky *and* necessary. Because many managers across the West face this situation, the Review Team recommends that the Intermountain Regional Office consider convening a meeting to discuss prescribed burning in subalpine fir forests. Suggested agenda items for this meeting:

Follow-up Lessons Learned Discussion Questions

- **What are the similarities between the Sandford Prescribed Fire escape on the Dixie National Forest and the Jungle Prescribed Fire? Both of these prescribed fires were located in high-elevation forests and escaped their boundaries. Is there something to be learned by comparing both escapes with one another (as well as with other escaped prescribed fires in subalpine fir forests across this country)?**
- **What is a "logical boundary" for a prescribed fire in subalpine fir forests?**
- **Is it even possible to expect "success" with prescribed burning in subalpine fir forests where the only prescribed fire that will do the proper job is an intense burn that is ignited under hot fire weather conditions?**
- **What does a "successful" prescribed fire prescription look like? Subalpine fir fires either don't burn well or become—under droughty conditions—intense and burn *too* well. There seems to be little middle ground between the two. As Rothermel and Williams state, when *"…in subalpine fir, the rapid transition to crown fire potential that occurs when the stand is dry enough to burn results in a narrow window of opportunity for prescribed burning."*[1]**

Keeping an historical record of prescription conditions and actual weather for each prescribed fire attempt (successful or not) can build situational awareness for new fire management officers, fuels specialists, and silviculturalists helping to build more precise parameters for successfully burning in these fuel types.

Follow-up Lessons Learned Discussion Questions

- **From the accumulation of these experiences, what are you learning concerning appropriate prescriptions? Do you have a solid sense of the "hair trigger" for burning in this fuel type?**
- **What is the weather difference between short-range spotting and long-range spotting? How will you monitor for this? How will you respond to a change?**
- **Is ERC important or not? Why?**

[1] Williams, J. T. and R. C. Rothermel. 1992. Fire Dynamics in Northern Rocky Mountain Stand Types. Intermountain Research Station. Research Note INT-405.

10. Experts and Expertise

Bringing in a someone from outside the local area (from a neighboring Forest, the Regional Office, or another agency or Region) with a great amount of experience (several years' worth) and expertise in prescribed burning in spruce/fir forests could help build expectations for the prescribed fire. Using this person's "slide tray" of experiences can increase the level of preoccupation with an escape and help identify more potential "weak signals" that things could be going wrong.

Follow-up Lessons Learned Discussion Question

- **How do you know when and what you *don't* know—how do you recognize your own sufficient/insufficient experience in burning in a particular fuel type?**

On the other hand, it is important to test assumptions, whether your own or those of an (outside) "expert." For instance, on the ground prescribed fire personnel often take the advice of onsite "experts" without questioning the expert's assumptions.

As one Jungle Prescribed Fire crew member stated: *"Did I know that this fire would do what it did? No, I wasn't sure what the fire behavior would be. I relied on local experts."* Experts can be wrong, too.

Follow-up Lessons Learned Discussion Question

- **How will you interpret and apply an expert's opinions against local knowledge?**

VI CONCLUSION

This report should serve as a launch point for deeper learning.

To make the most of the observations and questions posed in the preceding chapter, people involved in prescribed burning should begin active discussions about the principles of mindfulness—discussed throughout this report.

This process of mindful thinking will only become instilled in a burn organization when its people strive to become more mindful in their daily practices. This review is intended to help chart a clearer route to this important course of action and behavior.

As previously stated, this review *does not* provide simple "black and white" answers for why the Jungle Prescribed Fire escaped. What this review does do is pose questions back to its readers with the responsibility placed on *them* to provide the answers. Through this process, it is hoped that the people who must implement fire use operations in the future will become more highly skilled at error detection.

This review does provide a series of questions formed during the review process, that—if used as discussion points *before* future prescribed burns—will aid prescribed burners in becoming better at detecting weak signals that could lead to future escapes.

IMPORTANT NOTE

To use this report correctly, the reader must vigorously engage with its proposed questions—hopefully in a group setting, perhaps around a sand table or a chalk board. Such discussion processes should ensure that these questions are fully explored and developed for the individual unit. In this way, the lessons learned from the Jungle Prescribed Fire escape can be fully realized and utilized in future fire use operations.

VII REFERENCES AND RESOURCES

The following references and resources, all easily obtained, are excellent places to begin a more thorough study of learning organizations and mindfulness. Many of them are available for downloading from the Wildland Fire Lessons Learned webpage, or, for purchase from a private company or bookstores.

Dekker, Sidney. 2006. The Field Guide to Understanding Human Error. Ashgate Publishing Company. Burlington, VT.

Dether, Deirdre M. 2005. Summary of Escaped Prescribed Fire Reviews and Near Miss Incidents: What key lessons have been learned and what knowledge gaps exist?
http://www.wildfirelessons.net/documents/Rx_Fire_LL_Escapes_Review.pdf

Keller, P. 2004. Managing the Unexpected in Prescribed Fire and Fire Use Operations: A Workshop on the High Reliability Organization. General Technical Report RMRS-GTR-137.

http://www.wildfirelessons.net/documents/MTU_Santa_Fe_Workshop_rmrs_gtr137.pdf

Reason, James. 1997. *Managing the risks of organizational accidents*. Aldershot, UK: Ashgate.

Weick, Karl and Kathleen Sutcliffe. 2007. Managing the Unexpected - Resilient Performance in an Age of Uncertainty. Josey-Bass Publishers.

The following resources on prescribed burning, the learning organization and high reliability organizing are produced by the Wildland Fire Lessons Learned Center, Tucson, AZ, and available for purchase from Custom Recording and Sound.

The Lessons Learned Center has created numerous video productions to aid the learning needs of the professional wildland firefighter community. The titles of our productions are listed below and you may order them directly from the following source:

Custom Recording and Sound
Phone: (208) 344-3535, FAX: (208) 323-0373, Email: customorders@cableone.net

The cost of the videos is $12.95 per video which includes shipping and handling. Custom Recording and Sound will send videos out the next day whenever possible.

Wildland Fire
Lessons Learned Center
Videos by Title

1. **Managing the Unexpected Series** - [includes three programs: Overview of High Reliability Organizations (50 minutes), Return to Cerro Grande (1 hour), and Overcoming Your Immunity to Change (20 minutes) 2005.]

2. **Dude Fire Staff Ride-** [(30 minutes) re-release in 2005 from 1998 fire behavior analyst workshop.]

3. **Burn Boss Stories** [(40 and 20 minute versions) – learning from veteran burn bosses 2005.]

4. **Rx Fire and Fire Use Lessons Learned**-[(1 hour) – experiences of veteran fire management officers 2005.]

5. **Building a More Effective Learning Organization-[** (1 hour and 30 minute versions) – organizational learning in wildland fire featuring Learning in Action author David Garvin 2005.]

6. **Decision Making for Prescribed Fire and Fire Use Managers-** [(1 hour) – effective decision making featuring Learning in Action author David Garvin 2005.]

7. **Fire Effect Monitoring Stories**-[(30 and 15 minute versions) – learning from experienced interagency fire effects monitors 2004.]

8. **Conducting Effective After Action Reviews (AAR) Training Package** – [(Lessons Guide, AAR Power Point, How To Conduct an AAR, Facilitation Techniques for AARs) 2006.]

9. **Managing the Unexpected** – [A Second Workshop on High Reliability Organizing Featuring the Field Study of the Okefenokee Ecosystem Fire Management Program. 2007.]

10. **The "Hawkins Wildland Fire Use Trilogy" DVD**.-[(This DVD is about the Hawkins Wildland Fire Use event that occurred on the Dixie National Forest.]

VIII GLOSSARY

Deference to Expertise: Flexible authority structures where decisions and feedback move up and down the chain of command as needed.

Facilitated Learning Analysis: A facilitative process that is concerned with organizational and individual learning and not blaming the organization or the individual.

Fire Suppression Doctrine: A set of foundational principles that guide forest fire operations.

High Reliability Organizations: High risk occupations with low accident/error rates.

Learning organization: A learning organization is skilled at acquiring, interpreting, transferring, retaining and purposely modifying its behavior to reflect new knowledge and insights.

Preoccupation with failure/preoccupation with learning: The need for continuous attention to detail to detect small discrepancies that could be symptoms of larger problems in a system.

Reluctance to simplify: A hesitancy to live by generalizations and generic categories; complex views to register differences between present and past experiences more fully.

Resilience: To be aware of errors that have already occurred and to correct them before they worsen and cause serious harm.

Situational awareness: To construct and maintain the cognitive map that allows firefighers to integrate into a single picture the fire's overall situation and operational status. *"Having the situational awareness"* of a prescribed fire is not the map cognitive map itself, but the knowledge that the map is in place.

Sensemaking: Karl Weick's definition: **"**…the transformation of raw experience into intelligible world views…sensemaking lends itself to multiple, conflicting interpretations, all of which are plausible."

Sensitivity to Operations: One of the five principles of mindfulness. In forest firefighting, a concept that is similar to a firefighter's "situational awareness."

Updating: The mental process of reviewing and changing our expectations and understanding a situation.

IX APPENDICES

Appendix A – What is High Reliability?

Organizing for high reliability is about consistently producing the desired results in a dynamic and unpredictable operating environment in which errors can quickly magnify into catastrophes. Successful wildland fire management, like a number of other high risk/high consequence disciplines, requires high reliability, or mindfulness. Yet mindfulness is more a quality of attention than a state of achievement; it is a process and way of functioning that must be constantly recreated. Its goal is to enable members of an organization to notice errors when small, effectively communicate these, and take action so that small adjustments help avoid errors that otherwise might line up into a major failure.

This perspective focuses attention on small events, feelings, thought processes, and actions taken long before and often quite removed from the proverbial 'straw that broke the camel's back' in a near miss, accident, or escape. There are no single points of error or blame but arrays of distraction, misinterpretation, missed signals, and miscommunication. Improving organizational outcomes requires identifying and changing underlying patterns of thought, attention, interpretation and sense-making. It is a difficult task.

It is easy to become mindless and every one of us falls into this trap each day. We follow a recipe instead of thinking through an action, use old categories to understand a situation; we act rigidly, conceal problems, and operate on automatic pilot. We all do it; but doing so robs ourselves and our organizations of potentially critical information.

There are ways to organize to decrease the probability of mindlessness. We can seek a variety of perspectives, cultivate the skeptic in ourselves and each other, encourage divergent perspectives and fierce conversation. We can develop and hold After Action Reviews, staff rides, sand table exercises, and have dialogue. We should develop practices to mentally and verbally game out different alternatives and scenarios, particularly those surrounding things we are counting upon. We can school ourselves to increase our vigilance whenever we sense signs of distress and defensiveness, or whenever we start becoming complacent. Typical signs are when we hold onto past assumption, blame authority, scapegoat, deny a problem, externalize the enemy, find a distracting issue, or jump to conclusions.

Principles of High Reliability

The five principles of high reliability (preoccupation with failure, sensitivity to operations, reluctance to simplify, commitment to resilience and deference to expertise) are presented here as they are frequently grouped - into Anticipation, and Containment. Practically speaking (according to Weick and Sutcliffe, 2007), if you're good at anticipation you have persuaded your organization to be chronically concerned about the

unexpected and the potential for surprise; the group has created a climate in which people feel safe to question assumptions, and they are wary of success. "If you're good at containment, you're paying just as much attention to capabilities to cope with errors as you are to improving anticipation" (Weick and Sutcliffe, 2007).

ANTICIPATION

Preoccupation with Failure is not about capital "F" failures, but about articulating the mistakes you do not want to make or have happen. Like defensive driving, it is about assuming the worst and paying attention for those events or things that indicate the system is something different that what you expect, not about how reality conforms to your expectations and plans. It is human nature to notice features of our environment that reinforce our expectations.

Thus, it is important to expect the unexpected, identify markers of things we don't want to have happen, then watch for indications that these are developing. It may not be the exact relative humidity but the trend that is important. A preoccupation with failure allows one to pick up changes early so that one can make small adjustments and avoid getting caught having to play catch up.

Preoccupation is closely linked with updating, the process of reviewing and changing our expectations and understanding a situation. Such things as management action points or trigger points can be established to cue us to rethink an operation or its trajectory. When the evidence before you doesn't quite fit, ask yourself - is this the system I thought it was? If not, how does that difference impact my plans, expectations, and contingencies?

According to Weick (2007), recent research indicates we all are most likely to update our understanding of a situation within our initial mental framework - such as "is it getting dry enough to burn?" - rather than updating our frame itself – such as changing the question to "is it too dry to burn? This makes new eyes and "rookies" valuable assets (different mental frames) to any organization, and why encouraging people to speak out about what they see, regardless of whether they understand or know the implications of it, is important. It is also important to challenge our assumptions of how closely previous experience mirrors the current situation.

Reluctance to Simplify prompts us to be skeptical of drawing quick conclusions about a situation, to watch for 'group think,' and to cultivate shades of gray. How might a fire be both a prescribed fire and a suppression event? How is this current fire different from my slide reference? This principle suggests that we don't *decide* what we face, but we figure that out by taking action and paying attention to how the system reacts to our actions. In this view, our 'slides' and previous experiences are held cautiously, but are quite possibly a good starting point. Use that to take initial action, then pay attention to how, where and why this is an inaccurate characterization of the current reality.

Sensitivity to Operations focuses attention on the moment to moment actions and activities, and builds a perspective of the 'big picture' all the way to the bottom of an

organization. As such, it's more than Situational Awareness – it incorporates an understanding of how one fits into the picture and how the pieces of the puzzle (human and environmental) relate to one another. Being sensitive to operations requires robust and clear communication. When communicating, it is important to tell people what you think they/you face and share both your observation and interpretations of that observation. This allows them to build their own interpretation so that they can compare interpretations. It may not be enough to say 'there is enough fire on the ground'. Share what it is you see and why you reached your conclusion. Whenever possible, seek to tell people: What you think you/they should do, why you think that is what you/they should do, and what you/they should keep an eye on as an indicator of change. Ask what is unclear, what you might have missed, and what they may not be able to do.

CONTAINMENT

Commitment to Resilience has three aspects: elasticity (the ability to bounce back from an unwanted, unexpected event), recovery (the length of time it takes to become fully functional after an unexpected event), and growth (taking advantage of all opportunities to increase capacity and knowledge). Elasticity and recovery imply some slack or redundancy in the system, which is critical for managing unexpected events. Resilience includes apparent contradictions, such as the value of being able to improvise and make do with the resources at hand, while not being timid about acknowledging crew fatigue and calling for additional resources.

When thinking about an event, picture it as a series of standing dominoes, then ask: where are the dominoes closest together (indicating a tightly coupled system)? What can I/we do to increase the distance between these, or create redundancy so that if one should fall, it won't take down the entire system?

Deference to Expertise covers both organizational flexibility in authority and knowing the capabilities of all participants. Having flexible decision authority does not mean categorically that those authorities flow down the line; it means that they flow to their appropriate position – up for higher consequence and politically sensitive decisions, down or across when the decision requires first hand or operational knowledge.

This principle also encourages getting to know each other so that we have a good map of each other's skills; not simply those skills we see every day, but previous experience or knowledge that might come in useful at some unanticipated moment in the future.

Appendix B – HRO Principle Definition, Example and Questions

The following table lists and defines each of the five principles of mindfulness and then describes what they look like when practiced in the field, then poses a series of open-ended questions, that when discussed, will enlarge one's perspectives about fire operations in a prescribed fire environment.

Principle	Definition	Looks like	Questions
Preoccupation with failure	Operating with a chronic wariness of the possibility of unexpected events that might jeopardize the operation/project by engaging in proactive and preemptive analysis and discussion.	Articulate mistakes you don't want to make Treat lapses as signals Encourage error reporting Learn from near misses and errors Be wary of complacency	What are you counting on to happen/not happen? What do you expect from what you count on? In what ways can those things you count on fail? How can we position ourselves/organization to notice 'error' or deviations from expected? How can we organize ourselves to hear and communicate?
Reluctance to simplify	Taking deliberate steps to question assumptions and received wisdom to create a more nuanced picture of ongoing operations.	Be skeptical of assumptions, received wisdom Reconcile differences of opinion while maintaining nuances of meaning Recognize that similarities mask deeper differences	How is the current situation different from my expectation, from my slide of a similar event? What would indicate a difference, or a change in system behavior?
Sensitivity to operations	Ongoing interaction and information sharing about the human and organizational factors that determine the safety and functioning of the whole system.	Publicly puzzle through a situation, public sense-making Be attentive to the here and now Notice and discuss accumulating deviations from expectations Know when to update your assumptions/expectations Pay attention to relationships	Where is my attention? How does that relate to our preoccupation with failure and our expectations? Where are the most sensitive sensors, operations? How are communications flowing? What's going on there?
Commitment to resilience	Developing capabilities to detect, contain and bounce back from errors that have already occurred, but before they worsen and cause more serious harm.	Errors don't disable Detect, contain, bounce back from the inevitable Game out possibilities together Cultivate a deep knowledge of fire and your organization	Is there enough slack in this system? How fatigued are my resources; do I need to call for more? What are my alternatives and contingencies? How might I handle 'x'? Is there a training opportunity here?
Deference to expertise	During high-tempo times decision making authority migrates to the person/unit with the best perspective or most expertise with the problem at hand, regardless of their rank.	Develop and communicate a flexible decision structure Get to know each 's capabilities and experiences Get critical information from the person best positioned to see or know.	Who is in a position to notice? Who knows what – now, and from previous experience? Who has the expertise, attitude, knowledge?

Appendix C – Jungle Prescribed Fire Review Process Outline

1. Once the Jungle Fire Prescribed Fire Review Team was comprised and had traveled to the Ferron Ranger District on the Manti – La Sal National Forest in Ferron, Utah, an In-Briefing was conducted with both District and Forest level personnel. (Thursday July 12 1500)

   The process for the Review, which would be utilizing High Reliability Organizational (HRO) analysis techniques, was then discussed amongst Rx Review Team members and the Forest/District Personnel.

   A proposed schedule for the Review, including logistical details, was also agreed upon amongst the Team and the District.

2. The Team then met after the in-briefing to discuss the desired format for a report that would be useful for both the District and for the Region.

   A critical element of this Review was to develop and test a new process for learning in an escaped prescribed fire analysis and review.

   A decision was made to break down the review process into three main interview/discussion components:

   a. Small Group Interview (on Rx fire site with District/Forest Personnel)
   b. Large Group Discussion (following day, 7/14/07, town of Ferron)
   c. Theme Interviews (Select Rx Fire personnel, 7/14/07, District Office)

   It was decided to break the "discussion sections" for the Small Group Interview into:

   - Planning
   - Silvicultural Prescription and Specialist Reports
   - Burn Plan Production
   - Prescribed Fire Implementation
   - Escape
   - Suppression

3. A conference call was conducted with Karl Weick, Mark Giacoletto, Jim Saveland, Paul Chamberlin, the Rx Review Team, and District Personnel to discuss the details of employing the High Reliability Organizational (HRO) concepts to the Jungle Prescribed Fire Review. (Friday July 13 0800)

   A key question that evolved from this discussion was:

   "Who knew what where when?" And how did they know it?

It would be important for the Review Team to elicit this information from as many of the key players as possible, while simultaneously trying to be aware of "hindsight bias" from their responses.

As repeatedly identified in analysis of fire incidents, it was clearly suggested that the time of transition would be an essential component of the Rx Fire to explore in depth.

4. A thorough review of Prescribed Fire Policy (FSM Chapter 5140) and the Incident Qualifications of the Rx Fire personnel was made. No significant discrepancies or violations were discovered.

5. The Rx Review Team (Dether, Dueitt, Hetts) reconned the fire via helicopter with Forest Fire Management Officer, Colt Mortenson. (July 13 1100)

6. Small Group Interview conducted. (July 13 1230 – 1730)
   Present:

   - Five members of the Rx fire Review Team (Thomas, Black, Dether, Dueitt, Hetts)
   - 13 District / Forest personnel (see Appendix A)

   Interview divided into the previously listed (item 2) six "discussion sections."

7. After digesting the content of the Small Group Interview, the Rx Review Team decided the two Themes they would focus their analysis on would be:

   - Project Design
   - Fire Behavior

   It was decided the focus of the Theme Interview would be Fire Behavior, with the decision to interview the Burn Boss (RXB2), the Burn Boss Trainee (RXB2 (t)), and the Holding Boss as a group.

   We also decided to interview two Regional / Local level fire experts on this same Fire Behavior Theme.

   It was also decided that the focus question for the Large Group Open Discussion would be:

   "What is important for other people to hear about your experience on the Jungle Prescribed Fire?"

8. Large Group Open Discussion (July 14 1000 - 1200)

Responses were elicited from a larger group of 18 Rx Fire and District personnel to the above stated question.

9. Theme Interview – Fire Behavior (July 14 1230 – 1830)

   Burn Boss, Burn Boss Trainee, and Holding Boss group interviewed on Fire Behavior focus element. (1230 – 1430)

   External Regional / Local level experts (two individuals, one Long Term Fire Analyst (LTAN) and one LTAN trainee) interviewed on same Fire Behavior focus element. (1630 – 1830)

10. Jungle Prescribed Fire Review Team Report Write-up (October 12, 2007)

Appendix D – Jungle Prescribed Fire Review Team Organization

The Jungle Prescribed Fire Review Team

Dave Thomas	Team Leader	Renoveling, Ogden, UT	Former Regional Fuels Specialist, Region 4, U. S. Forest Service
Mike Dueitt	Team Member	National Forests of Mississippi, Jackson, MS	Forest Fire Management Officer
Katharine Hetts	Team Member	Uinta & Wasatch- Cache National Forests, Provo, UT	Forest Fuels and Fire Use Specialist
Deirdre Dether	Team Member	Boise National Forest, Boise, ID	Forest Fuels Specialist
Anne Black	Team Member	Aldo Leopold Wilderness Research Institute, Missoula, Montana	Social Scientist/ Ecologist

Advisors to Review Team

Karl Weick	Professor, University of Michigan Business School, Ann Arbor, MI
Paul Chamberlin	U. S. Fish and Wildlife Fire Safety Manager, Missoula, MT.
Mark Giacoletto	Fire Management Officer, Shoshone National Forest, Cody, WY
Jim Saveland	Program Manager, Rocky Mountain Research Station, Fort Collins, CO
Paula Nasiatka	Center Manager The Wildland Fire Lessons Learned Center, Tucson, AZ
Dave Christenson	Center Assistant Manager The Wildland Fire Lessons Learned Center, Tucson, AZ
Gary Jarvis	Regional Fuels Specialist, Intermountain Region (R4), USDA Forest Service, Logan, UT
Paul Keller	High Reliability Organizing (HRO) Concept Editor USDA Forest Service

Manti–La Sal National Forest and Ferron Ranger District Representatives Working with the Review Team

Mesia Nyman	District Ranger, Ferron Ranger District, Ferron, UT
Brandon Hoffmann	North Zone Fire Management Officer, Ferron Ranger District, Ferron, UT
Colt Mortenson	Forest Fire Management Officer, Manti-La Sal National Forest, Price, UT
Rod Player	Acting Forest Supervisor, Manti-La Sal National Forest, Price, UT