Fire Management *today*

Volume 72 • No. 2 • 2012

LESSONS LEARNED

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/fmt/index.html>.

Tom Vilsack, Secretary
U.S. Department of Agriculture

Melissa Frey
General Manager

Thomas L. Tidwell, Chief
Forest Service

Rick Harroun, HR Communications, LTD.
Managing Editor

Tom Harbour, Director
Fire and Aviation Management

May 2012

Trade Names (FMT)
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*.

Fire
Management today

Volume 72 • No. 2 • 2012

CONTENTS

SHORT FEATURES

On the Cover:

The Black Cat Fire moved out of the timber down a dry, grassy slope into the wildland-urban interface a few miles northwest of Missoula, MT; August 2007. Photo taken by Mark D. Roper, San Juan National Forest, CO.

The USDA Forest Service's Fire and Aviation Management Staff has adopted a logo reflecting three central principles of wildland fire management:

- *Innovation:* We will respect and value thinking minds, voices, and thoughts of those that challenge the status quo while focusing on the greater good.
- *Execution:* We will do what we say we will do. Achieving program objectives, improving diversity, and accomplishing targets are essential to our credibility.
- *Discipline:* What we do, we will do well. Fiscal, managerial, and operational discipline are at the core of our ability to fulfill our mission.

Firefighter and public safety is our first priority.

ANCHOR POINT

by Tom Harbour
Director, Fire and Aviation Management
Forest Service, Washington, DC

THE NATIONAL COHESIVE WILDLAND FIRE MANAGEMENT STRATEGY: WHAT'S NEXT?

After the enactment of the Federal Land Assistance, Management, and Enhancement (FLAME) Act of 2009, the Wildland Fire Leadership Council (WFLC) directed the development of a national cohesive strategy to address the Nation's wildland fire management issues. The WFLC recognized that the wildland fire management issues are not just "Federal" issues but are "national" in scope, and that all of the partners must work together if we are to successfully tackle wildland fire issues across all lands and jurisdictions. The council also recognized that simply writing a report would not fix the problems, and that the issues could not be completely resolved within the 1 year afforded by the FLAME Act. The *National Cohesive Wildland Fire Management Strategy,* therefore, defined a three-phase process that would provide the greatest opportunities to incorporate input from Federal, State, tribal, and local wildland fire management agencies and organizations, as well as feedback from nongovernmental organizations and other various stakeholders across America with an interest in wildland fire management.

> Response to the strategy and partner and stakeholder desire for further involvement was astounding.

> The benefits of Phase II surpassed WFLC expectations. The levels of collaboration, cooperation, and enthusiasm were key contributors to the success of Phase II and have set the stage for continued success in Phase III.

Phase I was completed in March 2011. The Secretaries of the U.S. Departments of Agriculture and the Interior officially released two documents: *A National Cohesive Wildland Fire Management Strategy* and *The Federal Land Assistance, Management and Enhancement Act of 2009 Report To Congress. A National Cohesive Wildland Fire Management Strategy* developed the framework, guiding principles, and national goals. *The Federal Land Assistance, Management and Enhancement Act of 2009 Report To Congress* addressed specific elements of the act regarding wildland fire management in the United States. WFLC directed that the cohesive strategy address the Nation's wildland fire management issues by focusing on three key areas:

- Restoring and maintaining resilient landscapes,
- Creating fire-adapted communities, and
- Responding to wildfires.

The cohesive strategy effort used a collaborative, science-based approach to seek solutions across all lands, regardless of jurisdiction. Recognizing that a national "one-size-fits-all" approach was not realistic, the country was divided into three regions—the Northeast, Southeast, and West—for the Phase II work.

In Phase II, the Wildland Fire Executive Council (WFEC) was created to provide oversight and direction during Phase II and to report back to the WFLC. The WFEC chartered regional strategy committees that, in turn, created workgroups for each of the three regions. The WFEC charged the regional strategy committees with the development of regional objectives, actions, and activities that could potentially be implemented toward achievement of the three national goals of the cohesive strategy. During Phase II, collaboration surpassed that of Phase I. Response to the strategy and partner and stakeholder desire for further involvement was astounding. Building on this response, regional strategy committees conducted extensive outreach during Phase II and identified regionally specific issues, values, objectives, and actions. Regional reports were prepared, and the national report was submitted to WFLC in December 2011. The national report builds on the regional reports and provides the foundation for Phase III as the National Science and Analysis Team begins to conduct a national risk tradeoff analysis.

Phase III began in late 2011. The National Risk Tradeoff Analysis will be performed in Phase III and will be based on the work and progress made during Phase II. The National Science and Analysis Team will work closely with each regional strategy committee to validate conceptual and analytical models and will help to facilitate development of region-specific alternatives to be analyzed during the tradeoff analysis. In February 2013, the final Phase III report will be completed and sent to the Secretaries of Agriculture and the Interior.

The benefits of Phase II surpassed WFLC expectations. The levels of collaboration, cooperation, and enthusiasm were key contributors to the success of Phase II and have set the stage for continued success in Phase III. Partners and stakeholders across the country are working together to systematically and thoroughly develop a dynamic approach to planning for, responding to, living with, and recovering from wildfire incidents across all lands. It is an exciting time to be actively involved in wildland fire management across America. I encourage you to become involved—ask how you can help be part of the solutions to our Nation's wildland fire management issues. ■

> It is an exciting time to be actively involved in wildland fire management across America. I encourage you to become involved—ask how you can help be part of the solutions to our Nation's wildland fire management issues.

Contributors Wanted!

Fire Management Today is a source of information on all aspects of fire behavior and management at Federal, State, tribal, county, and local levels. Has there been a change in the way you work? New equipment or tools? New partnerships or programs? To keep up the communication, we need your fire-related articles and photographs! 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* may 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

TEXAS TACKLES DEVASTATING FIRE SEASON WITH COMPLEX, INTERAGENCY RESPONSE

TEXAS
FOREST SERVICE
The Texas A&M University System

Holly Huffman and April Saginor

All the conditions for a devastating fire season were in place from the start.

Tropical storms stalled over Texas in fall 2010, unleashing heavy rains that spurred fine fuel growth across much of the State. As winter set in, the overabundance of vegetation was cured by freezing temperatures, leaving behind receptive fuel beds.

Then came the winter winds, compounding the problem as they pushed wildfires that already were fueled by unprecedented amounts of dead vegetation.

Normally, the State would see some relief with the advent of spring rains. But with Texas mired in an unrelenting drought, those never came. Extreme, triple-digit temperatures did.

By the time 2011 was over, wildfires had burned nearly 4 million acres (1.6 million hectares (ha)) and destroyed almost 3,000 homes.

With fires burning, at times, from border to border, the 2011 Texas fire season was considered one of the worst in recorded State history. It resulted in one of the most complex responses the State ever has put together.

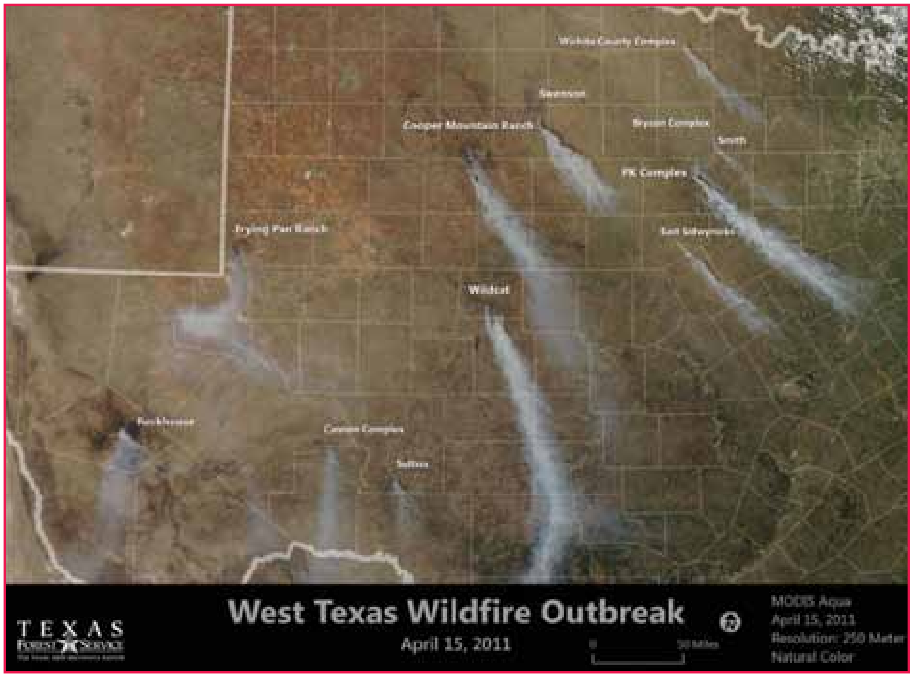
> "During peak burning periods, firefighters had to shift to defensive tactics and focus on protecting life and property."

"Throughout the winter and summer, we experienced fires that were a force of nature," said Mark Stanford, Texas Forest Service fire chief. "During peak burning periods, firefighters had to shift to defensive tactics and focus on protecting life and property."

A Devastating Season

During the 2011 fire season, Texas Forest Service and local fire departments responded to more than 30,000 fires. But there was one in particular that stood out as the most devastating in State history when considering the total number of homes lost.

The Bastrop County Complex was a 34,000-acre (14,000 ha) fire that ignited over Labor Day weekend and was driven by winds related to a tropical storm that tracked across Louisiana. Massive and deadly, the blaze killed two residents and



MODIS satellite imagery shows that between April 6 and April 30, 2011, more than 300 wildfires scorched 1.5 million acres (600,000 ha) destroying 278 homes. Image courtesy of Texas Forest Service.

Holly Huffman and April Saginor are communications specialists with the Texas Forest Service in College Station, TX.

Table 1—*2011 Southern Plains wildfire outbreaks.*

Date	Number of Wildfires	Extent in Acres (Hectares)	Number of Structures Destroyed	Number of Fatalities
February 27	145	222,233 (89,935)	127	0
March 10	25	14,202 (5,747)	6	0
March 22	69	4,241 (1,716)	2	0
April 3	67	13,672 (5,533)	2	0
April 9	83	453,474 (183,514)	106	1
April 14	47	83,213 (33,675)	3	0
April 15	160	45,829 (18,546)	15	1
April 26	45	48,808 (19,752)	12	0
May 27	5	854 (346)	0	0

destroyed 1,649 homes and 38 commercial buildings.

But that wasn't the extent of the fire's destruction. The wildfire also dealt a tremendous blow to the Lost Pines ecosystem. Home to the western range of loblolly pines, Bastrop County could eventually lose 1.5 million trees as a result of the deadly wildfire.

And while Bastrop may have been home to one of the State's worst fires, central Texas certainly wasn't the only part of the Lone Star State to feel the wildfires' devastating effects.

In west Texas, the Rockhouse Fire ran 25 miles in just one afternoon, destroying 41 homes as it scorched nearly 315,000 acres (127,000 ha) of ranchland, making it the third largest fire in State history. In north Texas, the PK Complex Fire burned more than 126,000 acres (51,000 ha) around Possum Kingdom Lake, destroying 168 homes in the resort community. Both fires ignited on the same day—April 9, 2011.

In east Texas, the Bear Creek Fire—the largest fire in the region's history—burned nearly 41,000 acres (17,000 ha), destroyed 66 homes and charred nearly 17.3 million cubic feet (490,000 m^3) of timber, an amount of wood that could have produced $159 million worth of forest products.

The Bear Creek Fire and others like it had a damaging impact on the east Texas timber industry.

By the year's end, wildfires in east Texas had burned through more than 151,000 forested acres (61,000

Texas Forest Service and fire departments across the State responded to more than 30,000 wildfires during the 2011 fire season. Photo courtesy of Texas Forest Service.

> "Despite the devastating fire season, Texas Forest Service and its interagency partners saved thousands of homes, more than any previous year."

Table 2—*Largest Texas fires in recorded history.*

Fire Name	Date	Fire Extent in Acres (Hectares)	Number of Homes Destroyed
East Amarillo Complex	March 2006	907,245 (367,149)	9
Big Country	March 1998	366,000 (148,000)	0
Rockhouse	April 2011	314,444 (127,251)	41
Glass	February 2008	220,000 (8,900)	0
Deaton Cole	April 2011	175,000 (70,800)	0
Cooper Mountain Ranch	April 2011	162,625 (65,812)	4
Wildcat	April 2011	158,308 (64,065)	0
PK Complex	April 2011	126,734 (51,287)	168
Swenson	April 2011	122,500 (49,574)	2
Huckabee	April 2008	98,168 (39,727)	0

ha), taking out $97 million worth of trees. The total volume of that timber could have produced $1.6 billion worth of forest products and would have resulted in a $3.4 billion total economic impact in east Texas.

"Despite the devastating fire season, Texas Forest Service and its interagency partners saved thousands of homes, more than any previous year," said Don Galloway, Texas Forest Service policy and planning analyst. "That is further proof of the efforts firefighters made throughout the season."

Scope of the Problem

In the midst of the driest year on record, Texas was facing a wildfire response that stretched 600 miles (965 km) across the State. The sheer scope and complexity of the response became the biggest challenge facing the agency.

Fire is a component in all of Texas' ecoregions. Fires burn across the Plains, the mountains of west Texas, the Hill Country, the east Texas pine forests, and even the Coastal Plains. But, it is unusual for each of these ecoregions to undergo a fire season at the same time.

Compounding the problem was the State's growing wildland-urban interface: More than 80 percent of fires in Texas occur within 2 miles of a community, making a majority of fires a potential threat to life and property.

To manage a wildfire response that was nearly as big as the State itself, Texas Forest Service turned to its multilevel response framework, which calls upon local, State, and interagency resources.

"We devise our response based on the needs of the State," Stanford said. "Because Texas has so many unique challenges, we developed a tiered response that calls for fire departments to be the initial attack force. They respond to 80 percent of the fires without State assistance."

Texas Forest Service is called when the capabilities of local fire departments have been exceeded. The State agency responds to just 20 percent of all wildfires, but those wildfires burn 80 percent of the land that's charred each year.

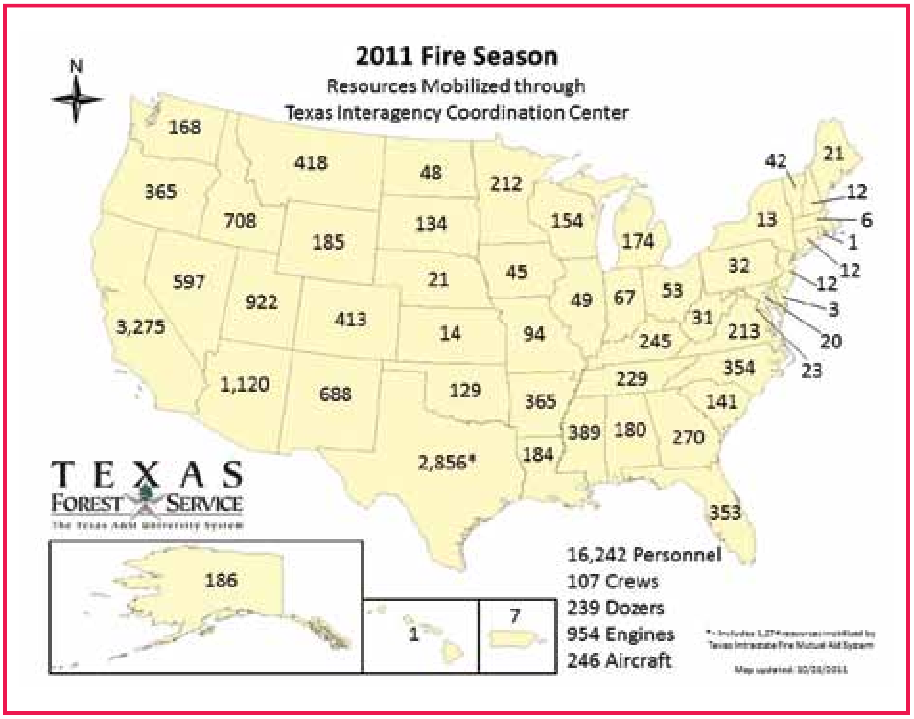
As Texas Forest Service resources are committed, the agency can call upon its State and Federal partners to aid in the response. And, it did. Ultimately, more than 16,000 resources were mobilized and brought to Texas during the 2011 fire season.

"We're very grateful to the folks that came in," Galloway said. "They did a great job, and we couldn't have done it without them."

Mobilizing a Network of Partners

Texas Forest Service divided the State into seven operational branches, each managed by an

Fires burn across the Plains, the mountains of west Texas, the Hill Country, the east Texas pine forests, and even the Coastal Plains. But, it is unusual for each of these ecoregions to undergo a fire season at the same time.



Resources including personnel and equipment mobilized from across the country to respond to Texas wildfires during the 2011 season. Image courtesy of Texas Forest Service.

assistant chief regional fire coordinator. The branches are further divided into regions, with each managed by a regional fire coordinator.

During fire season, each branch reports to the incident command post (ICP), which is housed just outside of Abilene in Merkel, TX. The Lone Star State incident management team (IMT) is based at the Merkel ICP and maintains direct supervision and support of fire suppression resources statewide. Due to the lengthy fire season, team members were rotated out on a regular basis to mitigate fatigue issues.

A command group based at the agency's Emergency Operations Center in College Station, TX, is responsible for strategic oversight.

"The command group keeps an eye on the size and complexity of fires, as well as the tempo of operations across the State, and serves as a point of contact with other State and Federal agencies," Galloway said.

During day-to-day operations in central and west Texas, Texas Forest Service resources are assigned to task forces. This same concept is applied during fire season, utilizing interagency dozers, engines, and water tenders. The teams can be easily moved to the area facing the most risk, which is important during a wildfire response that stretches across multiple branches.

Ultimately, more than 16,000 resources were mobilized and brought to Texas during the 2011 fire season.

"Responding with task forces allows us to arrive at the fire ground with enough of a footprint to have an immediate effect while enhancing command, control, and safety," said Paul Hannemann, Texas Forest Service Incident Response department head and fire operations chief.

"However, even with prepositioning, travel times can be problematic, so helicopters and other aircraft are a vital tool used to protect structures and slow fire growth until task forces arrive."

Utilizing task forces and aircraft are just two of the many options available to the agency.

"There is no single answer in a State with so many different ecoregions. We try to maximize our

The 2011 Fire Season

During the 2011 fire season:

- Texas Forest Service and local fire departments responded to 30,079 wildfires that burned 3,981,754 acres (1,611,359 ha) and destroyed 2,906 homes. Another 38,905 homes were saved.
- Texas Intrastate Fire Mutual Aid System was mobilized 9 times, bringing in 329 engines and 1,274 personnel.
- Texas Interagency Coordinating Center mobilized 16,242 personnel, 107 crews, 239 dozers, 954 engines, and 246 aircraft.
- Aircraft logged 16,963 flight hours and 54,477 drops, dropping 6,145,610 gallons (23,263,664 liters) of retardant and 28,033,106 gallons (106,116,849 liters) of water.

options and implement concepts that serve as force multipliers," Stanford said. "That's necessary because the State is so diverse and the fuels are so varied."

One of those force multipliers is the Texas Intrastate Fire Mutual Aid System (TIFMAS), a statewide mutual aid network of engines and personnel that can be mobilized quickly. TIFMAS incorporates fire engines, support vehicles, and trained personnel from municipal fire departments into the statewide response.

During the 2011 fire season, TIFMAS was mobilized 9 times, supplying a total of 329 engines and 1,274 personnel. Every time TIFMAS is activated, an all-hazard type 3 IMT also is mobilized to assist with logistics and resources tracking.

The Texas Forest Service initiated an all-hazard IMT program in 2004. Governor Rick Perry's Executive Order RP57 mandated the program in 2006. Since inception of the program, Texas has trained nearly 700 local government emergency responders in all-hazard incident management.

"It's given us the ability to create a surge in resources based on high-impact weather days," Hannemann said. "With short-term, really high-risk days, we can utilize these resources to expand our capacity, infrastructure, and framework. With TIFMAS strike teams and type 3 IMTs, we're able to push a large amount of resources into the system to meet peak resource demands."

During the last 3 weeks in April, Texas Forest Service was managing more than 1 million acres (400,000 ha) of uncontrolled fires each day, which stretched fire management capabilities and prompted the need for additional incident management capacity.

Texas has trained nearly 700 local government emergency responders in all-hazard incident management.

National and regional IMTs were mobilized to manage project fires. Throughout the season, the Texas Forest Service mobilized the following type 1 and 2 teams: Morcom from the Northwest Area; Wilder, Dueitt, and Quesinberry from the Southern Area; Opliger from California; Graham from Florida; Hildreth and Howard from North Carolina; and Wilde from the Western Great Basin.

The Texas Forest Service also mobilized national incident management organization (NIMO) teams led by Steve Gage, Bob Houseman, George Custer, and Dan Kleinman. The Texas Forest Service used NIMO teams to manage extended attack fires that had the potential to become project fires, but did not require a full team. Because the NIMO teams staff based on need, they proved to be nimble and flexible and could react quickly to new starts.

During the 2011 fire season, Kleinman's NIMO team was sent to the Bastrop County Complex Fire to provide a quick, initial assessment of the situation. The team was able to coordinate the initial State response and then transition with Wilder's Southern Area team.

"They were able to immediately tell us what the situation was and how complex it was, as well as the need for additional management and

The Cooper Mountain Ranch Fire in Kent County burned 2,200 acres in October. Photo courtesy of Texas Forest Service.

tactical resources. That was really critical," Hannemann said. "They immediately gave us an order for what they needed. This way, tactical resources were en route at the same time as additional incident management capabilities."

Both incident management organizations—NIMO and IMTs—filled critical needs.

"We couldn't have asked for better support," said Texas Forest Service Director and State Forester Tom Boggus. "The response we received from our interagency partners was outstanding."

Forecasting a Firestorm

Knowing what kind of response is warranted during a record-breaking fire season requires Texas Forest Service fire managers to turn to the Predictive Services department, which is tasked with tracking weather patterns, drought conditions, and the condition of fuels across the State.

"We place a high priority on Predictive Services to obtain resources and position them based on risk," Stanford said.

Working together with the National Weather Service, the Predictive Services team can predict when and where high-impact fire weather is likely to occur, allowing fire managers to preposition resources accordingly.

Working together with the National Weather Service, the Predictive Services team can predict when and where high-impact fire weather is likely to occur, allowing fire managers to preposition resources accordingly.

Never was this ability more important than with the discovery of the Southern Plains Wildfire Outbreak in spring 2010. The National Weather Service used Texas Forest Service fire data to identify a pattern of conditions that seemed conducive to fast-moving, destructive fires in the Southern Plains.

Ten outbreaks had been documented in the last 5 years. A record-breaking nine more were documented during the 2011 fire season alone.

Because the outbreaks generally can be predicted several days ahead of time, Texas Forest Service quickly launched a public education campaign to alert local emergency responders and the general public of the potential dangers and the need to evacuate if ordered to do so.

The forecast also allowed TIFMAS resources to be mobilized prior to the outbreaks.

The agency created a Web site (<http://texasfirestorm.org>) that details the dangers surrounding the outbreaks and teaches people how to better protect themselves and their community. It also features

Texas Forest Service Guiding Principles

- Career and volunteer fire departments are the primary initial attack force in Texas. We are here to help them.
- Career and volunteer fire departments are our partners in fire prevention and suppression.
- Safety of firefighters is our primary concern.
- Our job is to provide support, assistance, coordination, and leadership in wildland fire issues.
- We recognize the independent nature of Texas fire departments and of local government.
- We recognize that volunteers are just that—volunteers. They have jobs and private lives. They volunteer their time to their communities.
- We will require of ourselves the proper stewardship of the Texas rural fire defense programs.
- We will keep to a minimum the bureaucracy of our programs.
- We will keep to a minimum the requirements and policies that limit local decisionmaking.
- We will strive to provide "one-stop shopping" to Texas fire departments.
- We will treat firefighters with the respect they deserve.

a video that explains the phenomenon, a copy of which was distributed to fire departments and emergency officials across the State.

“The ability to forecast the Southern Plains Wildfire Outbreak is one of the most significant advances in fire weather forecasting that we have seen in a while,” said Tom Spencer, Texas Forest Service Predictive Services department head. “This allows us to better provide for the safety of the citizens of Texas.”

Briefing the Troops

With so many emergency responders from different backgrounds and organizations flooding the State, it’s important for crews to be working out of the same playbook. To ensure they are, Texas Forest Service requires all incoming emergency responders to attend an in-depth briefing.

During the “in-briefing,” all responders are given pocket cards and briefed on weather, fuel conditions, and hazards that are specific to Texas. The in-briefing then goes a step further, delving into State values and cultures, as well as standard government operations and disaster response models.

With roughly 95 percent of land privately owned, Texas is considered a private property State, which means nearly all fire response is multijurisdictional.

All responders are briefed on weather, fuel conditions, and hazards specific to Texas. Photo courtesy of Texas Forest Service.

> Texas Forest Service always assumes a unified command with local officials. “We’re here to assist, not take over.”

“It’s important for responders to understand the local government component and the local government’s responsibilities during a disaster,” said Hannemann, noting that Texas Forest Service always assumes a unified command with local officials. “We’re here to assist, not take over.”

In addition to the initial in-briefing, Texas Forest Service also holds daily conference calls that include the outlook for weather and fuels, safety messages, and field and aviation reports. With responders spread out across the State, the calls are critical in ensuring that everyone has the same information.

Because the calls are telephone- and Web-based, participants view accompanying slides showing the Predictive Services observations and forecasts, operational maps, and safety messages being discussed. The audio and video are recorded and stored online, which allows firefighters who are mitigating their work-rest ratio access to the presentation when they come on shift.

The agency also requires all incoming aviation personnel to attend an extensive in-briefing for air operations and participate in a daily, statewide aviation call to discuss aviation weather as well as dispatch and safety issues.

Placing a Priority on Safety

Fire managers point to the emphasis on communication as part of the reason for the agency’s solid safety record during the 2011 fire season.

Though the season lasted more than 300 days, ground crews reported just 26 minor injuries. During that same time, firefighting aircraft logged almost 17,000 flight hours and dropped more than 34 million gallons (129 million L) of water and retardant—all with no accidents or incidents with potential.

But, the season was not without tragedy. Firefighter Caleb Hamm—a member of the Bureau of Land Management’s Bonneville Interagency Hotshot Crew—died in July from hyperthermia while fighting the CR337 Fire northwest of Mineral Wells in Palo Pinto County.

An Interagency Accident Investigation Team investigated the incident and released a Factual Report in October 2011. The National Institute for Occupational Safety and Health also is conducting an independent investigation.

In addition to the hotshot crew member, three volunteer firefighters suffered line of duty deaths on three separate fires during the season. Texas Forest Service firefighters were called to the Crawford Ranch Fire near Amarillo after one of the fatalities occurred. The agency was not requested to respond to the other two fires.

Placing the highest priority on responder and public safety, Texas Forest Service requested air and ground safety reviews throughout the season. The agency brought in two ground and three air safety teams to review procedures and evaluate safety practices. Numerous individual roving aviation specialists were used as "on-call" problem solvers, as needed, throughout the State.

Warning the Public

In addition to internal communication, the Texas Forest Service also places a strong emphasis on external communications, working to alert local emergency responders and the general public when fire danger is forecast for their area.

Predictive Services products are updated using data from remote automated weather stations and posted online daily. These products are the result of a collaborative relationship between Texas Forest Service and the Texas A&M University's Spatial Sciences Laboratory. The lab falls under the umbrella of the College of Agriculture and Life Sciences and Texas AgriLife Research, which, like Texas Forest Service, are part of the Texas A&M University System.

Fostoria Road Fire, San Jacinto County. Ten homes were saved on this 400-acre fire, despite extreme fire behavior. Photo courtesy of Texas Forest Service.

Situation reports and wildfire updates are posted on the Texas Forest Service Web site and Facebook page, as well as the Texas Interagency Coordination Center Web site during fire season. They also are emailed regularly to a voluntary listserv of more than 3,000 people.

When extreme burning conditions were predicted and evacuations were a possibility, the Texas Forest Service issued news releases to the media and emergency alerts through the Texas Law Enforcement Telecommunications System and Texas Department of Transportation electronic messaging signs.

The public seemed to get the message. Journalists from across the Nation helped spread the word, reporting about wildfires and their devastation. Meteorologists warned morning news viewers about red flag days. County agents with the Texas AgriLife Extension Service helped educate community members about the importance of fire education. Nearly every county in the State implemented a burn ban, setting a new record.

At the peak of fire season, upwards of 1 million people were visiting the Texas Forest Service Web site, and nearly 20,000 people had begun to follow the agency's Facebook page.

"Basically, there is no reason that anyone should be able to talk about unexpected fire behavior," Galloway said. "We had tremendous, extreme fires, but I don't know of a single case where we didn't know what was about to happen and warn everyone across the State." ■

Online Resources

- Southern Plains Wildfire Outbreak: <www.texasfirestorm.org>
- Texas Forest Service: <http://texasforestservice.tamu.edu/>
- Texas Interagency Coordinating Center: <http://ticc.tamu.edu/>
- Learn how to be firewise: <www.texasfirewise.org>
- Google Earth Common Operating Picture: <http://ticc.tamu.edu/Response/FireActivity/>
- YouTube public service announcements: <http://www.youtube.com/user/TexasForestService>

BACK ON THE ROAD: VOLUNTEER FIREFIGHTERS REBUILD A FIRETRUCK

Andrea Pendergast

The volunteer firefighters of Floyd, IA, love a challenge, but even for them, this last project was a big one. Armed with only a photo of a totaled fire truck and a few sentences describing its specifications, Floyd Fire Chief Ben Chatfield was able to convince other firefighters and the fire department's board to take on another rebuilding project. "Another," because this was the second time Floyd firefighters would outfit a truck acquired at no initial cost through the Iowa Department of Natural Resources' Forestry Bureau, which provides fire departments with equipment that is no longer needed by the Federal Government but is still considered suitable for conversion to firefighting service.


A totaled firetruck would seem like so much scrap—except to a team of dedicated firefighters. Photo: Courtesy of Benjamin Chatfield, Fire Chief, Floyd Community Volunteer Fire Department.

Firefighters could not view the truck firsthand, but did their best to determine the extent of rebuilding required and the cost of necessary parts and estimate a total cost for the rebuilding effort.

Available for Adoption: One Totaled Firetruck

The tanker that Chatfield found through a Web site list of available vehicles was only a few years old, but it had been involved in a rollover accident that left it totaled. Yet Chatfield—and others, after he did some convincing—saw its potential for the local fire department. Because the truck was far away—in South Carolina—firefighters could not view the truck firsthand, but did their best, based on one fuzzy online photograph and a brief description, to determine the extent of rebuilding required and the cost of necessary parts and to estimate a total cost for the rebuilding effort.

While the department received the truck for free, it had to pay to have the truck hauled to Floyd, as well as for its repair, painting, storage, and maintenance. And that price wasn't looking pretty. "We talked to the insurance adjustors and they gave an estimate for repairs at $125,000," Chatfield said of the truck, originally valued at $300,000. Choosing to undertake the work (and cost) of rebuilding the old-fashioned way, the 20 volunteer firefighters rolled up their sleeves, got into contact with local businesses and residents who could lend a hand here or truck there, solicited discounts on some replacement parts, and collected the materials necessary for the repairs: a total of about $40,000.

The Work Begins

The firefighters themselves put an estimated 3,200 hours of labor into repairing the tanker: hours between fire calls, after regular workday shifts, on weekends, and even on days earned as vacation time. It was a labor of love but also of necessity. "We build most of our own trucks. It's the only way we can really afford to upgrade equipment," Chatfield explained, adding that there are very few new firetrucks in the surrounding area, and those departments purchased them at a higher cost than Floyd's rebuilt one.

Andrea Pendergast is a staff writer for the Charles City Press in Charles City, Floyd County, IA.

Luckily, the photo depicted the truck's damage as worse than it really was, and firefighters got to work right away. Beginning in April 2010, the department identified what parts needed replacement, ordered the replacement parts, and assigned personnel to undertake each repair. "Everybody's good at something," Chatfield said. "Everybody took turns; some guys are good at painting, others at wiring."

The most involved part of the process, Chatfield said, was downsizing and repairing the truck's water tank. Not only did the tank need to be cut down so that the truck would fit through the fire station's doors, but a plastic welder had to be purchased to make the repairs on the tank material. "That welder is not a common piece of equipment, and we had to teach ourselves how to use it," he remarked. Firefighters practiced their welding skills by laying out damaged pieces of the tank that couldn't be reused on the firehouse floor and welding seams until they were good at it. This also was a matter of economics, as a new tank would have cost $30,000.

> "We build most of our own trucks. It's the only way we can really afford to upgrade equipment."

The Floyd firefighters repaired the existing tank for $6,000. A new cab was also purchased and installed, and every part of the truck was repainted.

Floyd community members stopped in to watch the rebuilding process and donate their own time to help throughout the year. Local businesses donated materials, facilities, and expertise to the rebuilding effort.

Community Benefit and Response

The firefighters didn't just take on this project because they like to keep their hands busy, but because it's important for them to provide the community and surrounding area with up-to-date equipment as best they can. "We're just trying to keep the fire department in better vehicles for the community," said volunteer firefighter Kent Vrieze. "The better equipment we keep, the quicker our response time and more effective our services." This truck, in particular, will get used across the county. It has the biggest water tank of any truck in Floyd County.

With the support of the community, the Floyd Fire Department deploys a renewed firetruck. Photo: Andrea Pendergast, Charles City Press.

Less than 20 percent of the fire department's annual budget goes toward truck replacement, so even with the low-cost way its firefighters rebuilt the new truck, it'll take at least 8 years to pay off the expense. Donations are instrumental in keeping the volunteer fire department going, and since the department is a nonprofit group, such contributions are tax deductible.

The year-long collaborative effort "turned out better than we anticipated. We knew it'd turn out nice because we're pretty particular about what we do, but it came out even better than expected," Chatfield said. And Vrieze remarked: "It was a challenge, but I wouldn't hesitate to do it again."

Next…

To demonstrate that resolve, the firefighters have started yet another conversion effort, though on a smaller scale. The department recently acquired a smaller vehicle through the same program that will be converted into a rescue truck and hold its Jaws of Life and other rescue equipment. "The fire department here is a close-knit group. We've known each other for a long time, and we know that, unless we tackle these kinds of projects ourselves, we'll have the same old trucks forever," Chatfield said. Such ongoing efforts by the volunteers demonstrate their commitment to the highest level of service to their community. ■

BURNING QUESTIONS FOR MANAGERS: FUELS MANAGEMENT PRACTICES IN RIPARIAN AREAS

Kristen E. Meyer, Kathleen A. Dwire, Patricia A. Champ, Sandra E. Ryan, Gregg M. Riegel, and Timothy A. Burton

Vegetation treatment projects for fuel reduction in riparian areas can pose distinct challenges to resource managers. Riparian areas are protected by administrative regulations, many of which are largely custodial and restrict active management. Like uplands, however, riparian areas have been affected by fire suppression, land use, and multiple types of disturbance. Also, many streamside areas are part of the expanding wildland-urban interface (WUI) or wildland-urban intermix that may be at high risk of wildfire.

In some cases, manipulative treatments of fuels may be needed to maintain riparian biodiversity, restore or protect valued riparian functions, and reduce wildfire risk. A growing number of Federal, State, and local land managers are exploring options for managing fuels in streamside areas. Because vegetation treatments to reduce fuels in riparian areas are fairly new and untested, limited information is available on where, why, and what practices land managers are implementing (Stone and others 2010), and what management strategies are most effective in different riparian types.

A Survey of Riparian Fuels Treatment Projects

In spring 2010, we conducted an online survey to gather information about completed and proposed fuel treatments in riparian areas and wetlands on federally managed lands of the Interior West. This online survey builds on the findings of a 2007 phone survey of Forest Service fire management officers (FMOs) in 11 Western States.

> Managers face multiple challenges when planning and conducting fuels treatments in all vegetation types, but wetlands and riparian areas pose additional concerns.

Results of the phone survey showed that 43 percent of FMOs were conducting fuels treatments in riparian areas, primarily for hazardous fuels reduction, ecological restoration, or habitat improvement (Stone and others 2010). Our recent, expanded online survey included questions on wetland treatments and compiled responses from a range of resource professionals from four agencies.

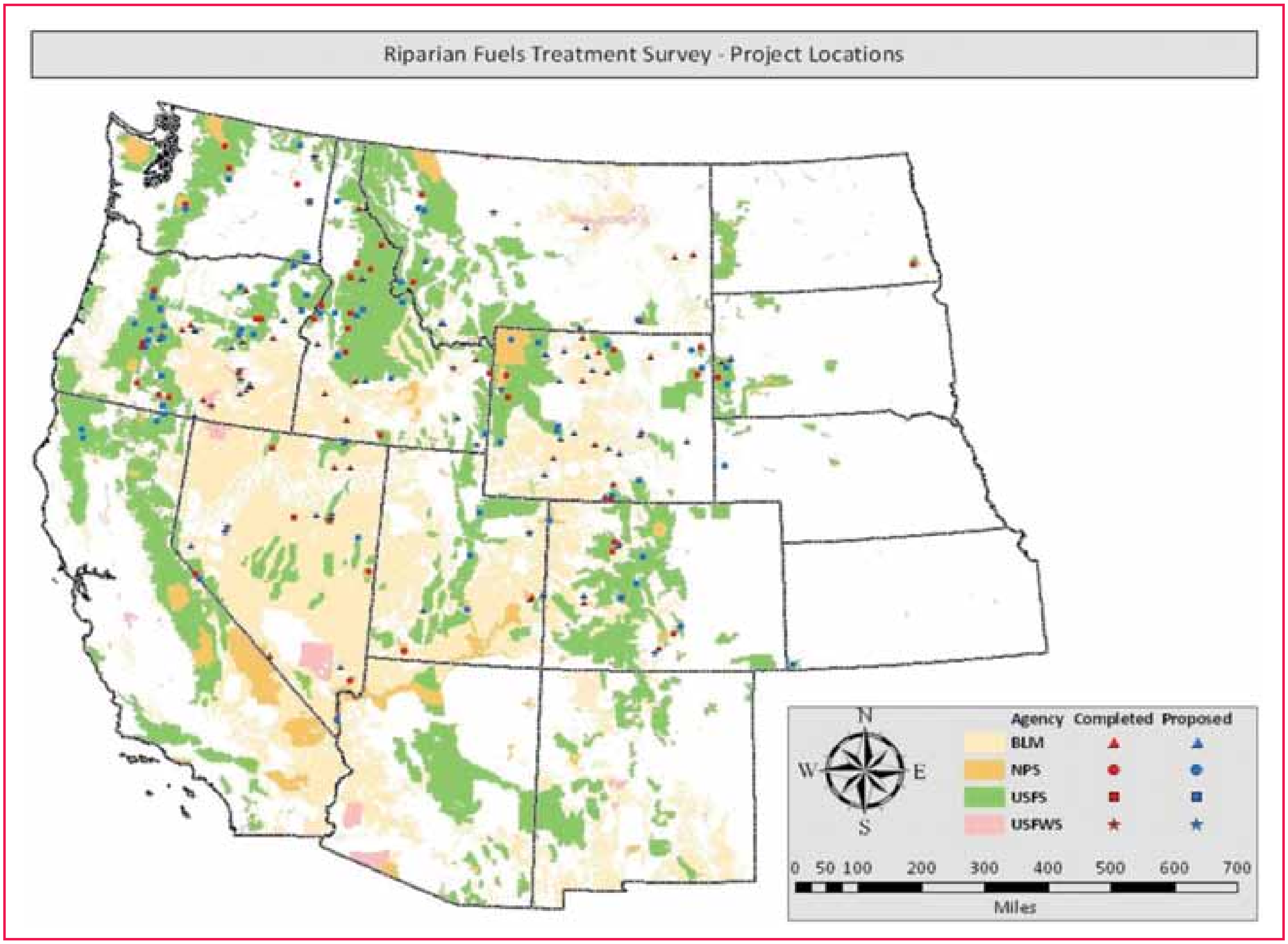
We were interested in individual project objectives and the short-term effectiveness of treatments in meeting them, types of treatments applied, types of riparian vegetation treated, pre- and post- treatment monitoring, and concerns or constraints affecting the planning and implementation of projects. Here, we present the results of the survey and briefly describe a case study that illustrates several distinct features in treating vegetation to reduce streamside fuels.

Who We Asked

The survey targeted fire program managers and other resource professionals from the Forest Service and the U.S. Department of the Interior, Bureau of Land Management (BLM), National Park Service (NPS), and U.S. Fish and Wildlife Service (FWS). The study area included lands managed by these agencies in the States of Colorado, Idaho, Montana, Nevada, Utah, Wyoming, and the eastern portions of Oregon and Washington. The Black Hills region of South Dakota and a small area

---

Kristen Meyer is a wildlife biologist for the Pike National Forest, South Park Ranger District, in Fairplay, CO. Kathleen Dwire is a research riparian ecologist, Patricia Champ is a research economist, and Sandra Ryan is a research geomorphologist for the Forest Service's Rocky Mountain Research Station, in Ft. Collins, CO. Gregg Riegel is an area ecologist and program manager in the Central and South Central Oregon Interagency Ecology Program in Bend, OR. Timothy Burton is a retired Bureau of Land Management fisheries biologist now working for Riparian Management Services, LLC, in Boise, ID.



Locations of completed and proposed riparian fuels treatment projects by agency. (Note: The online survey targeted Federal resource managers in the Interior West and northern Great Plains. Arizona, New Mexico, western Oregon and Washington, and most of California were not included.)

in northern California were also included. The survey was administered via a Web-based application and was sent to more than 2,000 potential respondents. The survey requested details about completed and proposed fuels management projects in wetlands and riparian areas.

The Response

There were 532 respondents (a 22-percent response rate), representing a variety of resource specialists, including fire managers, hydrologists, fisheries biologists, wildlife biologists, ecologists, and cultural resource specialists. Responses were received from all four agencies (BLM, NPS, Forest Service, and FWS) and from the 10 different States. However, participation in the survey was voluntary, and respondents may not be representative of the entire sampled population.

> A growing number of Federal, State, and local land managers are exploring options for managing fuels in streamside areas.

Of the 532 respondents, 249 described vegetation treatment projects that were either completed or initiated in riparian or wetland areas within the last 10 years. Of those 249 respondents, 105 had completed projects, 87 reported on projects planned or in progress, and 57 reported on both completed and planned projects. Nearly 27 percent of the completed and proposed projects were planned specifically in riparian or wetland areas, while the others included such areas as part of larger projects. Interagency participation was reported to be an important component for 23 percent of completed and 63 percent of proposed projects.

Fuel Treatment Objectives and Effectiveness

We asked respondents about five potential objectives that applied to their project (fig. 1a). We ranked each objective as primary, secondary, or tertiary. More than half of the respondents described projects with more than one objective, and nearly all had secondary and tertiary objectives. The most common primary objectives for both the completed and planned projects were hazardous fuels reduction (57 percent) and habitat restoration (55 percent). Virtually all of the FWS projects included habitat restoration as a primary objective. Treatment of invasive species was a primary objective in only a few projects and the least common objective overall.

Restoring the historic fire regime was the most common secondary objective and was reported as an objective for most projects. Protecting values at risk was an objective that included protection of campgrounds, roads, and other infrastructure located in the WUI or wildland-urban intermix; cultural resources; and sensitive ecosystems. In the "other" category, survey respondents noted the following additional project objectives: rangeland improvement, greater recreational access and opportunities for hunting and fishing, reduction of the influence of mountain pine beetle, salvage logging, and enhancement of aspen regeneration.

For completed projects, we asked survey participants to rank project effectiveness at meeting objectives using a five-point scale from "very effective" to "not at all effective." Depending on the objective and treatment, project effectiveness was quite varied (fig. 1b). Projects were most successful at reducing hazardous fuels, and this objective scored the highest effectiveness rating (average effectiveness = 4.53, on a five-point rating scale). The objectives "habitat restoration" and "protection of values at risks" were also effectively met by most projects (average effectiveness = 4.12 and 4.13, respectively). For "control of invasive plant species," it may be too early to determine effectiveness, as reflected in the higher number of "not sure" rankings. In general, respondents perceived most projects to be "somewhat effective" to "very effective" at achieving the objectives analyzed in this study.

> Most riparian treatments were part of predominantly upland projects that focused on larger scale, fuel-reduction efforts across portions of managed landscapes.

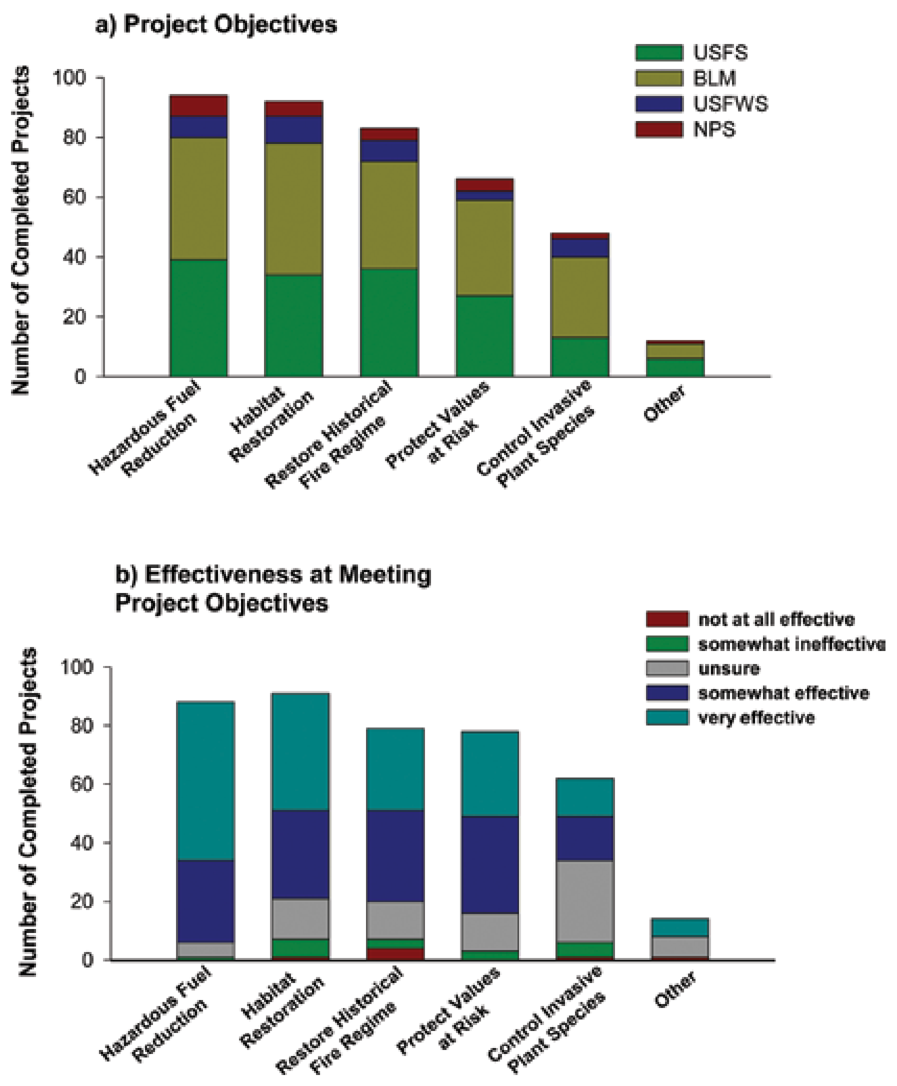


Figure 1—*(a) Project objectives by agency; and (b) effectiveness at meeting project objectives (5 point scale from "very effective" to "not at all effective").*

Fuels Treatment Methods

Prescribed fire was the primary tool for fuels treatments used by all agencies in riparian and wetland areas (fig. 2). The FWS used prescribed fire on all of the projects that it reported.

It was clear, though, that most projects combined treatment methods; more than two-thirds of the completed projects used multiple treatments. Combinations of treatments, such as using hand thinning and pile burning, were common and often supplemented with prescribed burning. Mechanical treatments (using heavy equipment) were also included in many projects implemented by the Forest Service and the BLM. Mastication and scattering following thinning treatments were also used, but less frequently than other methods. Additional treatments reported by the survey respondents were follow-up herbicide application or tamarisk beetle release, mowing, flooding to reduce cattail re-establishment (on FWS projects), and seeding of desirable species.

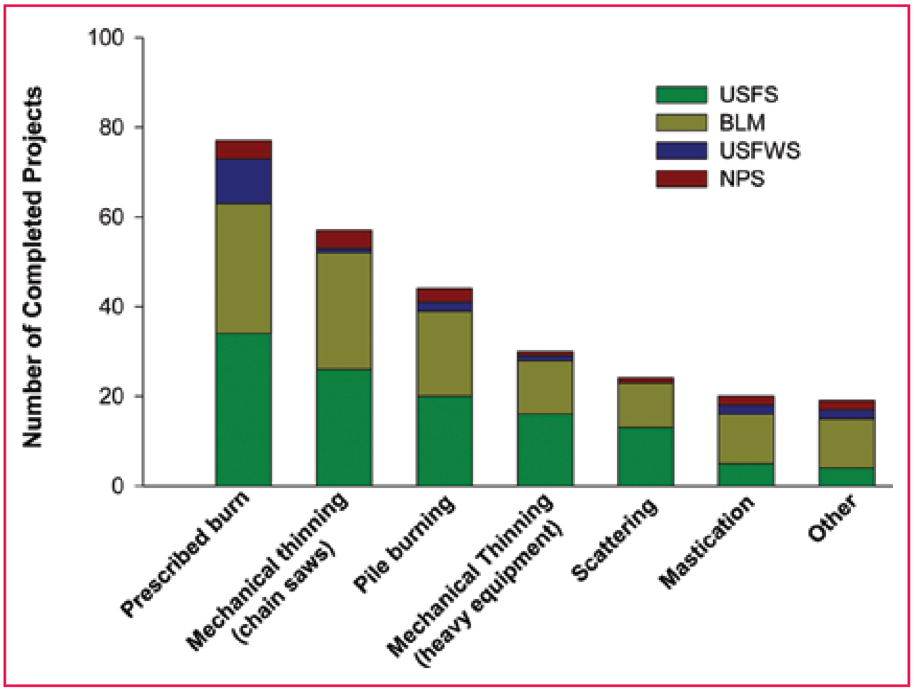


Figure 2—*Number of projects that used different types of treatments. Most projects used multiple treatments, all of which are tallied here.*

Tracking Riparian Vegetation Types

In the survey, we also requested information about riparian vegetation types in the fuels treatment project areas. Most projects, both completed and proposed, were located in conifer-dominated riparian areas, followed in frequency by willow-dominated areas (fig. 3).

There were trends among the four agencies, however, reflecting the ecology of the lands each administers. Projects in conifer- and willow-dominated riparian areas were most common on Forest Service lands, while projects in riparian areas dominated by upland shrubs were most common on BLM lands. Conifers were rarely present on the FWS projects, which were largely conducted in wetlands and riparian meadows.

Approximately 27 percent of the completed projects included some palustrine habitat (wetlands and marshes), and while these were located on public lands administered by all agencies, most were on FWS lands. Nearly 70 percent of the projects were conducted in riverine habitats, and the remaining 3 percent were located on the margins of lakes or ponds.

Cottonwoods occurred at numerous project sites, and a few projects focused on cottonwood restoration. Cottonwoods were not, however, present at many of the project areas (fig. 3). Other specific vegetation that was noted in treated areas included aspen and birch; boxelder; greasewood; upland shrubs, such as rabbitbrush and juniper (primarily on BLM lands); and invasive species, such as tamarisk, Russian olive, and whitetop.

Project Monitoring

Most of the respondents reported that project-related monitoring was planned or conducted for both completed (71 percent) and proposed (82 percent) projects to determine their effectiveness at meeting project objectives. In the survey, we asked questions regarding project monitoring, including duration, frequency, and methods used. Response rate ranged from 10 to 60 percent, depending on details on monitoring requested. In part, the varied response rate to specific questions reflected the discipline of the respondent; some survey participants (e.g., fire managers) were not directly involved with all aspects of monitoring and, therefore, did not respond to all questions.

Monitoring appeared to be focused on project effectiveness at meeting objectives rather than on ecological impacts of the treatments. The most common ecological variables monitored in the completed projects were vegetation attributes and fuels, both before and after treatment implementation (see the table). Terrestrial wildlife was monitored by 40 percent of the respondents. More than half of the respondents did no monitoring of water quality, erosion, or stream biota.

The most common monitoring methods were qualitative rapid assessment techniques and comparison of pre- and post-treatment photos. Only about one-third of the monitored projects actually collected samples for laboratory analysis (e.g., surface water or aquatic biota) or quantitatively sampled fuels and vegetation attributes. For most projects, duration of monitoring was limited to the first few years following treatment. Several respondents explicitly noted lack of resources (funding and staff) to support more extensive monitoring in the "comments" section.

> Combinations of treatments, such as using hand thinning and pile burning, were common and often supplemented with prescribed burning.

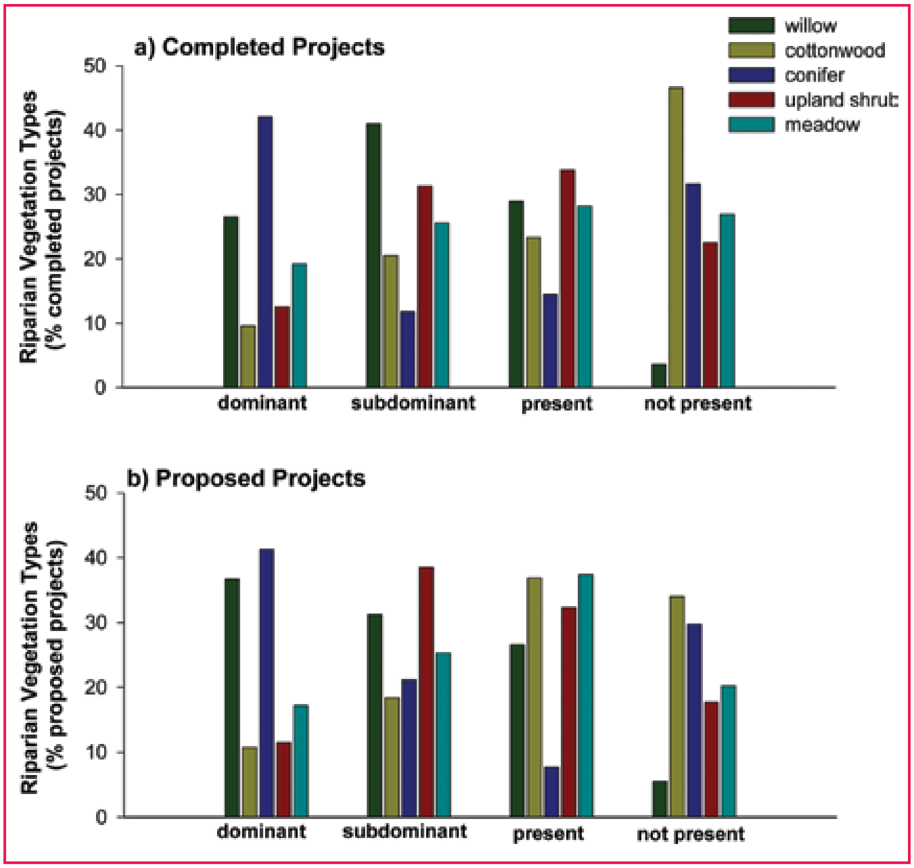


Figure 3—*Percentage of projects (a) completed or (b) proposed in five different riparian vegetation types. The categories for estimating abundance of riparian vegetation types within the study area were (1) dominant, > 50 percent cover; (2) subdominant, ≤ 50 percent cover; (3) present, occurred within the project area; (4) not present, did not occur within the study area.*

Constraints To Conducting Fuels Treatments

Managers face multiple challenges when planning and conducting fuels treatments in all vegetation types, but wetlands and riparian areas pose additional concerns (fig. 4). Responses to the survey indicated that the most significant constraint for all agencies was the potential presence of threatened, endangered, or sensitive species in the project area. While this is also a major concern for upland fuels projects, inclusion of aquatic and riparian obligate species increases the number of species of concern.

Cultural resources were also an issue in planning fuels projects in riparian areas, particularly in the Great Basin region, where archeological sites are concentrated along stream-riparian corridors. BLM and Forest Service respondents from Nevada and Utah most frequently noted this constraint. Administrative policies, resource management plans, and lack of agreement among resource specialists were commonly encountered constraints among Forest Service, BLM, and NPS respondents.

Approximately 19 percent of the respondents, evenly divided between BLM and the Forest Service, recorded potential litigation as a constraint to riparian fuels projects. Limited support from line officers was the least common constraint noted (3 percent of survey respondents).

Survey respondents recorded several additional constraints, most notably funding. Budgets generally do not target vegetation treatments in riparian areas as a priority, so managers interested in treating

Summary of responses from the online survey to questions regarding project-related monitoring. Values are expressed as percentages of completed projects. (Note: Percentages do not add to 100 percent because some survey participants responded “not sure” and others did not respond to all monitoring questions.)

	Monitoring? (Percent of Respondents)		Type of Monitoring (Percent of Respondents Who Conducted Monitoring)			
Ecological Variable	Yes	No	Pre- and Post-Treatment Monitoring	Visual Rapid Assessment	Sample Collection	Quantitative Data Collection
Water quality and/or quantity	27	54	51	25	10	5
Erosion/runoff	29	56	59	61	0	6
Stream biota	19	62	29	20	33	0
Vegetation attributes (e.g., rare plants, invasives, utilization)	87	8	76	34	4	36
Fuel types and loads	71	21	76	40	5	21
Terrestrial wildlife	40	38	61	39	13	26
Other	26	60	27	50	0	17

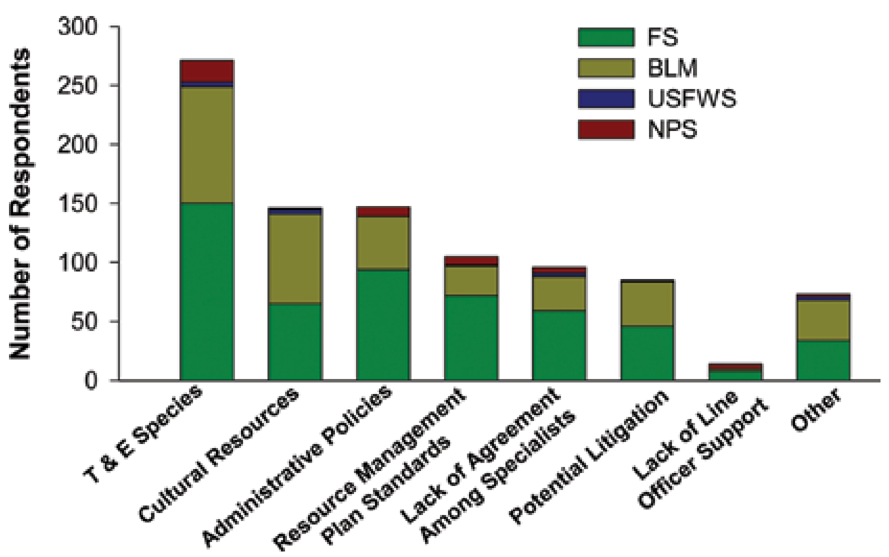


Figure 4—*Number of respondents (by agency) who recorded different constraints to planning and conducting fuel reduction treatments in riparian areas.*

> Budgets generally do not target vegetation treatments in riparian areas as a priority, so managers interested in treating riparian fuels include streamside area treatments as part of larger projects.

riparian fuels include streamside area treatments as part of larger projects. As noted above, approximately 70 percent of the projects (completed and planned) were part of predominantly upland projects.

Much of the funding available for fuels treatments is focused in the WUI. This was reflected in the survey results: 56 percent of the completed and planned projects reported by respondents are located in the WUI.

Other constraints noted by respondents included challenges in attaining the appropriate window of season and weather conditions conducive for prescribed burning; availability of adequate fire staff and equipment support; landownership patterns around riparian areas; visual and recreation conflicts; local environmental issues, politics, and public perception; and limited scientific information on effects of fuel treatments on riparian and aquatic ecosystems.

The Future of Riparian Treatments

Results from both the 2007 phone survey and the online survey show that most riparian treatments were part of predominantly upland projects that focused on larger scale, fuel-reduction efforts across portions of managed landscapes. This active management of riparian vegetation and fuels implies a trend toward incorporation of riparian corridors into broader scale (watershed-scale or larger) treatments. This has likely resulted from recent information on landscape-scale fire behavior, fire return intervals, and greater appreciation of linkages between riparian areas and uplands.

Managers are concerned about riparian fuel loads and perceive them to be high along many streams in the Interior West. They are reluctant to leave high-streamside fuel loads untreated while uplands are treated, so the managers include these areas to protect them from a potential high-severity fire and to exert some influence on fire behavior. In many cases, managers are also using fuel treatments as restoration projects both in uplands and riparian areas. This may be a consequence of funding—i.e., funds are available for fuel reduction, so managers make use of these resources to simultaneously restore habitat and historical fire regimes and, in some locations, to control invasive plant species. In these cases, prioritization of objectives is necessary, as some may be achieved more effectively than others (see fig. 1).

Despite increased level of interest in treating riparian areas, numerous constraints were identified in the online survey (fig. 4). Noteworthy concerns include the unknown or unpredictable effects of treatments to riparian and aquatic habitat, during both treatment and recovery phases, and the limited scientific research that has been conducted on the topic. Research results on the impacts of fire and fuel treatments on riparian functions and characteristics are restricted to a few localized studies in the Pacific Northwest in a small range of vegetation types (Arkle and Pilliod 2010, Beche and others 2005, Bisson and others 2003, Dwire and Kauffman 2003).

> This active management of riparian vegetation and fuels implies a trend toward incorporation of riparian corridors into broader-scale (watershed-scale or larger) treatments.

Limited scientific knowledge restricts the ability of managers and resource specialists to justify the need for riparian treatments and to make informed decisions when planning projects. Potential effects of prescribed fire and other treatments in riparian areas include reduced water quality due to erosion and sedimentation, decreased shade, spread of invasive species, loss or alteration of riparian habitat, and slow rates of riparian recovery. Our survey results indicate that the state of the practice has preceded the state of the science with regard to riparian fuel treatments, and that more sharing of experiences, "lessons learned," and communication of what measures worked and what measures failed would be beneficial for practitioners.

References

Arkle, R.S.; Pilliod, D.S. 2010. Prescribed fires as ecological surrogates for wildfires: A stream and riparian perspective. Forest Ecology and Management. 259: 893–903.

Beche, L.A.; Stephens, S.L.; Resh, V.H. 2005. Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone. Forest Ecology and Management. 218: 37–59.

Bisson, P.A.; Rieman, B.E.; Luce, C.; Hessburg, P.F.; Lee, D.C.; Kershner, J.L.; Reeves, G.H.; Gresswell, R.E. 2003. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management. 178: 213–229.

Dwire, K.A.; Kauffman, J.B. 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management. 178: 61–74.

Stone, K.R.; Pilliod, D.S.; Dwire, K.A.; Rhoades, C.C.; Wollrab, S.P.; Young, M.K. 2010. Fuel reduction management practices in riparian areas of the western USA. Environmental Management. 46: 91–100. ■

A Case Study: Project Collaboration, Considerations, and Constraints

In 2003, managers completed a prescribed burn in willow stands along Fontenelle Creek, Kemmerer Ranger District, Bridger-Teton National Forest, WY.

In western Wyoming, resource managers from the Forest Service, National Park Service, and Wyoming Game and Fish have been using prescribed fire to manage willow-dominated riparian areas for wildlife benefit for nearly 20 years. Prescribed fire can rejuvenate decadent willow stands, which generally respond favorably to fire and regenerate vigorously for several years following treatment, especially in response to spring burns prior to full leaf-out (Boggs and others 1990). The 2003 Fontenelle Creek burn was highly successful; the treatment was implemented as planned and willow regrowth exceeded expectations.

Fire managers who implemented this project have identified important considerations for conducting prescribed burns in riparian vegetation, particularly willow or graminoid-dominated communities. These considerations include moisture conditions and plant phenology. The ability to conduct an effective prescribed burn depends largely on soil and fuel moistures. As a result, treatments in willow-dominated bottomlands can be difficult to implement successfully until vegetation and soils dry out late in the growing season. However, in late summer, the plants are more vulnerable to damage, nesting birds may be more severely impacted depending on nesting season, and fires may be more difficult to control.

Vegetation regrowth follows a prescribed burn in willow stands along Fontenelle Creek, Kemmerer Ranger District, Bridger-Teton National Forest, WY. The top photo was taken following the 2003 spring burn; the bottom photo was taken in July 2010, 7 years post-treatment. Top photo by Dave Scott, Bridger-Teton National Forest, WY; bottom photo by Kristen Meyer, Pike National Forest, CO.

As a consequnce, scheduling restrictions that apply to upland treatments may need even more consideration in streamside areas. For example, in spring 2010, in another willow-dominated portion of Fontenelle Creek, fire managers attempted to conduct a burn similar to the 2003 treatment; however, they encountered high site-moisture conditions and were not able to implement the burn.

Although it was not an issue for the Fontenelle Creek project, one ecological constraint that may influence treatment success in riparian vegetation is browsing pressure by native ungulates, including elk, deer, and moose, which can be very heavy in some locations (Kovalchik 1987). High levels of herbivory by native ungulates can reduce growth and limit reproduction of willow species (Case and Kauffman 1997), particularly following fire, when resprouting shrubs are exposed, accessible, and highly visible (Dwire and others 2006). Relative costs and benefits—both ecological and financial—of riparian prescribed burns need to be considered within the context of management goals over time. Projects focused on riparian areas require detailed planning that includes consideration of the unique fuel and moisture characteristics of streamside areas, phases of post-treatment responses, and well-defined target conditions.

References

Boggs, K.; Hansen, P.; Pfister, R.; Joy, J. 1990. Classification and management of riparian and wetland sites in northwestern Montana. Missoula, MT: University of Montana, School of Forestry, Montana Forest and Conservation Experiment Station, Montana Riparian Association.

Case, R.L.; Kauffman, J.B. 1997. Wild ungluate influences on the recovery of willows, black cottonwood and thin-leaved alder following cessation of cattle grazing in northeastern Oregon. Northwest Science. 71: 115–126.

Dwire, K.A.; Ryan, S.E.; Shirley, L.J.; Lytjen, D.; Otting, N.; Dixon, M.K. 2006. Influence of herbivory on regrowth of riparian shrubs following a wildland fire. Journal of the American Water Resources Association. 42(1): 201–212.

Kovalchik, B.L. 1987. Riparian zone associations: Deschutes, Ochoco, Fremont, and Winema National Forests. R6 ECOL TP-279-87. Portland, OR: USDA Forest Service, Pacific Northwest Region.

BETWEEN TWO FIRES: A NARRATIVE

Stephen J. Pyne

In 2011, Steve Pyne embarked on a new project to tell the story of wildland fire in the United States. The undertaking will extend the range of his previous study, *Fire in America,* not only historically, but stylistically, by splitting the task into two books. One will tell the grand narrative over the past 50 years, and the other will gather essays on specific events, places, and people. Here he explains the logic behind that strategy.

The last thing most fire officers or land managers want is another "-ology" to integrate into their operations. But here's one that they might want to consider even though it will never join an incident management team or find a roost in a superintendent's office. It's the study of narrative, called (unimaginatively) "narratology."

The term is as new as it is ugly and both qualities can be blamed on postmodern literary theory. But the concepts behind it are ancient: Aristotle explained them more or less completely in his *Poetics*. They have to do with what ordinary people call "story" and academic parlance terms "narrative." They describe the principles that underwrite how we organize and understand events over time.

"Time" is, in turn, among those everyday concepts that everyone recognizes but can't formally define. Each academic discipline has its own understanding: mathematics thinks about time as sequences of numbers; physics, as a flow of energy; biology, as the pace of organic growth; and so on. History, literature, and philosophy imagine time according to the various genres by which it is expressed (Whitrow 1981).

Theorists of history are inclined to distinguish between chronicles, annals, and bona fide narratives. Chronicles are chronologies with captions. Annals are more elaborately annotated timelines that do not attempt to list all events or actors but only those that matter most to the annalist and his audience. Narratives are texts in which a theme—a principle, a character, an event—is arranged such that it has a beginning, middle, and end, and that organization animates some moral concern through a plot paced by conflict. A dispatch log for a fire would be a chronicle. A firefighter's journal of that fire would more resemble an annals. A retelling of a fire around a theme—say, John Maclean's *Thirty-mile Fire*—would be a narrative (White 1990).

So, why should a narrative be of interest to the fire community? Because it is story that gives cultural meaning to historical and accruing experiences. Firefighters don't recount their actions and memories as data sets; they tell stories. Journalists don't ask about facts and figures; they ask, "Where's the story?" The particulars have significance only through their context, and when that context involves events, people want them arrayed in ways that allow those particulars to play off one another and animate a message. That is what narrative historians do with the shards of the preserved past. Boxes of documents mean little of themselves. Information has to be organized in ways that give meaning and value to the subject. Story is an instinctive way to shape that material, and when given rigor by formal discipline it becomes narrative.

These considerations apply no less to fire science. The record of fire-scarring on trees is a chronicle: to be endowed with significance other than data, it must assume the shape of a narrative with a thematic beginning, middle, and end, at which point the presentation ceases to be science and becomes literature. The rationale for the transformation is complex, but the simplest explanation is that modern science assumes that nature is open-ended, while literature insists that narrative must have closure. In other words: while science denies that nature is teleological—having an end toward which action moves—literature insists that texts must be. This conversion moves a text from science to art.

Steve Pyne is a professor in the faculty of Human Dimensions, School of Life Sciences, at Arizona State University in Tempe, AZ.

Firefighters don't recount their actions and memories as data sets; they tell stories. Journalists don't ask about facts and figures; they ask, "Where's the story?"

Both scholarships place bounds on their material. Science specifies the realm in which its models apply—change those founding conditions or borders and you need a new model. So it is, too, with narrative history: what sets the relevant boundary conditions are those historic events when a narrative begins and ends, for this is what determines the narrative arc in the way that anchor piers delimit the span of a bridge. Move either the starting or the ending point and the story will change—or, as Aristotle put it: the choice of an ending will determine the beginning.

There is, in brief, no single story of American fire any more than there is only one scientific model to account for fire's presence. The story we tell depends on where (and why) we begin and end the narrative and what theme we want to express. Start in the Pleistocene, and you get one plot; start in 1492 or 1880 or some other year, and you get another. Start in 1910 and end with the centennial of the Big Blowup, and you get a narrative arc that rises and falls with fire suppression efforts. Start in 1960, and you announce a new beginning for which fire suppression is a background setting, not a driver.*

That the American fire scene has experienced astonishing changes over the past few decades—and perhaps even new categories of fire—is not a proposition many fire managers would dispute. But it is doubtful that the existing narratives can stretch to cover them. The storied span will fail. To reset the narrative arc, the boundaries must be moved, and this is why I have decided not to simply extend *Fire in America* to the present but to write another work that can tell the contemporary story in a different way.

Fire in America has two design flaws that argue against writing a simple extension or Hollywood-style sequel. One limitation is that it trails off in the late 1970s. A third of modern American fire history lies outside its scope, and, to understate the obvious, the past 35 years have been eventful. As the saying goes, "it's not the years, it's the mileage." The second limitation is that *Fire in America* is not a genuine narrative but a hefty annals or, at best, a hybrid. It tries to merge story-telling and analysis into one text, and analysis—in the form of potted histories on specific themes—dominates. On both counts, I see no reason to pick up the text in the mid-1970s and continue the old topics and schizophrenic approach. To do so would say, in effect, that nothing substantial has changed or *can* change.

I don't think that last view is true, and an update of the old story (which someone else is at liberty to write) is not an enterprise that I find especially useful. Half of modern American fire history has been spent trying to take fires out of the landscape, and half has been devoted to trying to put at least some of them back in. We are approaching the 50th anniversary of that historic tipping point. We need to see how the fire revolution has played out. Those events deserve their own informing narrative.

My solutions are to move the anchor points and to split the dual personality. In the new work, I'll begin in 1960 and end in 2011 with the National Cohesive Wildland Fire Management Strategy and the outbreak of fires in the Southwest. Instead of trying to weave narrative and analysis into a single tapestry, I'll write two books. One, *Between Two Fires*, will be the grand narrative—call it the play by play. The other, *To the Last Smoke*, will sample with scores of essays something of the actual conditions, practices, events, and places that comprise the American fire scene—call it the color commentary. I'll post the essays online as the project progresses and, then, edit them within an anthology.

The trickiest problem is how to deal with irony. The ironic mode is the voice of Modernism and has been the default position for intellectual inquiry throughout the 20th century. It would be only too easy to conclude the grand narrative with ironic condescension, to say that, after a century of lessons learned, libraries of scientific papers, calendars crowded with conferences and training courses, enough hardware to take on the military of half the world, we now have record fires, bottomless costs, and continued ecological unrest. That's where a narrative of America's fire century would trend if it flowed, unresisted, through the channels of intellectual taste and academic training.

---

*For examples of how this works, see my book, *Voice and Vision: A Guide to Writing History and Other Serious Nonfiction* (Harvard University Press, 2009; paperback 2011).

I refuse to accept that resolution. I won't live to see a post-ironic culture, but I do think it's time to give irony some leash laws. There are other outcomes possible because such an ending is a literary construct, not a necessary historical reality. Rather, I propose that we are now passing between two fires, just as we were a century ago and will be a century hence. There are, in fact, several "two fires." There are nature's fires and ours; wildfires and prescribed fires; fires that burn surface biomass, and fires that combust fossil fuels. These fires differ from those of the past as the future's will differ from today's. But we will always find ourselves caught between whatever competing flames the age kindles.

> There is no single story of American fire any more than there is only one scientific model to account for fire's presence. The story we tell depends on where (and why) we begin and end the narrative and what theme we want to express.

I started my career as a smokechaser in 1967; I will likely retire when the manuscript is completed. It will relate the narrative of the two fires that my generation has passed between. The next generation will confront its own flames, and it will have to devise a narrative particular to that experience. Nature is open-ended. It's narrative that must find closure.

Acknowledgement: Project research commenced in January 2011 and will conclude in October 2014. The USDA Forest Service and U.S. Department of the Interior are splitting the costs of this effort, with the Joint Fire Science Program contributing 12 percent. Dr. Lincoln Bramwell, chief historian of the Forest Service, is overseeing the project. I wish to thank Bramwell for suggesting I write this introduction to the project and the logic behind it. ■

The Hazards of Staging Vehicles in *the Black*: Two Incidents

Paul Keller

Chances are good that, if you're reading this, you've had experience operating and parking vehicles in "the black." Likewise, you're probably well aware that "the black" refers to the combustible material or vegetation that has gone through ignition, burning, and smoldering stages. In other words, this "black"—on which you could pull up and park your fire vehicle—might not be completely out, or "cold."

The consequences can be unfortunate. In two recent incidents that occurred with different fire agencies in separate parts of the country, fire vehicles that were parked in *the black* and left unattended caught fire. At the time of ignitions, the focus was elsewhere: both crews were engaged in suppression actions away from their vehicles.

For the Record

The firefighters involved in these events have shared their experience in two subsequent reports:

- Long Fire CA-CNF Engine Burn Damage Facilitated Learning Analysis, <http://wildfirelessons.net/documents/CNF_Engine_Damage_FLA.pdf>, and
- *Plug Hat Fire, Damage to Government Vehicle Non-Serious Accident Investigation Report,* <http://wildfirelessons.net/documents/Plug_Hat_Fire_Damage_Government_Vehicle.pdf>.

This is the site where a Bureau of Land Management (BLM) initial attack squad vehicle was parked and caught fire on the 2010 Plug Hat Fire on the BLM's White River Field Office lands in northwest Colorado. Photo: Plug Hat Fire, Damage to Government Vehicle Non-Serious Accident Investigation Report, 2010.

> "Where are your drip mix and saw fuel stored? Do those gear boxes leak?"

The *Long Fire CA-CNF Engine Burn Damage Facilitated Learning Analysis* gives details:

> "This is the second incident this summer in which a wildland fire vehicle has caught fire while unattended and parked in *the black*. There have been many vehicles over the years burned in a similar fashion. It is the hope that both firefighters and managers will use this report in a learning environment. This FLA could not have been completed without the cooperation and willingness of the engine crew members in sharing their story."

Unexpected Lessons

Any vehicle's tires—made from petroleum products—can ignite at relatively low temperatures. Combining this fire-prone tire condition with flammable tire dressings can significantly increase ignition risk.

Paul Keller is the technical writer-editor for the Wildland Fire Lessons Learned Center in Tuscon, AZ.

The black can provide that ignition source. Because this combustible vegetation can still contain heat, driving or parking on this surface can cause damage to any static object introduced into its proximity.

That's why, whenever operating equipment in or around the burned fire perimeter, it's important to take the time to ensure the safety of the immediate surroundings. Four recommendations can help avoid equipment damage when operating and parking vehicles in *the black*:

- Once your vehicle is parked and secured, do a complete "walk-around"—verifying that your vehicle is safe and secure from all potential hazards.
- Check to make sure that no hot debris is lodged between dual rear tires.
- Engine crews and water tenders should consider wetting down the staging area prior to parking equipment in the black. (In some regions, this was once common practice.)
- Remember to always "Look up, look down, and look around."

The Black

When parking in *the black*, we must ensure that we do not operate from a false sense of security. We must always consider *the black* to be just that: combustible material that has gone through ignition, burning, and smoldering stages. This material may still contain heat and could cause damage to another static object introduced to the environment.

It is part of responsible operations to ensure *the black* is cold and out before static objects, such as tires, packs, and other equipment, are set there.

As emergency responders, we might not always have the perfect parking areas ready to park or stage equipment. However, it is our responsibility to take the time to SLOW DOWN, properly mitigate the situation, and enhance the safety of the environment to the best of our ability to provide for maximum protection and safety of our crews, ourselves, and our equipment.

—Long Fire CA-CNF Engine Burn Damage Facilitated Learning Analysis

Bringing Fuels to the Fire

Both vehicles that caught fire while parked in *the black* during 2010 fire operations—the focus of the previously mentioned reports—were carrying flammable liquids. "Where are your drip mix and saw fuel stored? Do those gear boxes leak?" asks Travis Dotson, Fire Management Specialist with the Wildland Fire Lessons Learned Center. Dotson stresses the importance of asking and addressing these types of questions long before you are actually operating or parking your vehicle. Gear boxes located directly above a vehicle's tires—where ignition from *the black* typically occurs—are most at risk to fire spread.

Any vehicle's tires—made from petroleum products—can ignite at relatively low temperatures. Combining this fire-prone tire condition with flammable tire dressings can significantly increase ignition risk.

The initial attack squad vehicle's outside-rear dual tire that caught fire when parked in the black on the 2010 Plug Hat Fire. Photo: Plug Hat Fire, Damage to Government Vehicle Non-Serious Accident Investigation Report, 2010.

Because a fully involved vehicle fire poses a variety of significant suppression hazards, many wildland fire agencies are not allowed—by policy—to attempt to extinguish a fully involved vehicle fire. In some parts of the country, however, wildland engine crews are prepared to routinely respond to vehicle fires for initial attack purposes to prevent these fires from spreading into adjacent vegetation.

The bottom line: we should all understand our own agency's policy regarding the direct suppression action on vehicle fires before being faced with that situation.

Preserving the Aftermath

If you are involved in a wildland fire vehicle fire—an incident within an incident—you need to remember

Gear boxes located directly above a vehicle's tires—where ignition from the black typically occurs—are most at risk to fire spread.

Lessons Learned

"I want to tell any up-and-coming driver to just slow down and take the extra time to check around when you are parking."

"Our crews need to be more careful about the tire treatment and dressing we use: some of the ones we use are flammable."

—Engine Crew Members sharing their lessons learned in the Long Fire CA-CNF Engine Burn Damage Facilitated Learning Analysis

Both vehicles that caught fire while parked in the black *during the 2010 fire season were carrying flammable liquids. Photo: Plug Hat Fire, Damage to Government Vehicle Non-Serious Accident Investigation Report, 2010.*

Fire damage spread in the initial attack squad vehicle compartment from the tire that ignited while the vehicle was parked inside the burn perimeter—in the black*—on the 2010 Plug Hat Fire. Photo: Plug Hat Fire, Damage to Government Vehicle Non-Serious Accident Investigation Report, 2010.*

the importance of helping to preserve the scene after the ignition is put out. An undisturbed accident scene is vital to an accident analysis and will enable a thorough "lessons learned" review of how the accident occurred.

One of the findings in the *Plug Hat Fire, Damage to Government Vehicle Report* addressed this concern: "Employees appear to be unaware of the administrative processes for accident investigations. This resulted in loss of site preservation, disturbing the accident scene, and not allowing for conclusive findings of the ignition source."

Lesson Learned

The crews affected by the two 2010 incidents won't forget this lesson. The challenge for other fire crews is to learn it without experiencing the negative consequences.

In June 2011, using these two 2010 incidents and their "lessons learned" reports as catalyst, the Wildland Fire Lessons Learned Center developed the video "Operating and Parking Vehicles in *the Black*." This 9-minute presentation is featured as part of the Center's *Firefighter: Remember This* video series. The video is available for viewing at <http://www.youtube.com/watch?v=ko51_QtAFDs>. ■

INFRARED: A CRITICAL TOOL FOR FIRE MANAGERS

Ken Frederick

The National Infrared Operations (NIROPS) program, headquartered at the National Interagency Fire Center in Boise, ID, is the primary provider of operational infrared (IR) imaging services for wildland fire management across the country. The national IR program combines advanced IR detection and imaging technology with "roll-up-your-sleeves" fireline experience. The program staff members' familiarity with wildland fire informs their knowledge of what firefighters, fireline supervisors, and incident management teams need from IR data. What's more, the program staff continually works to increase efficiency and incorporate advances in IR technology.

The Program Takes Off

NIROPS was launched in the 1970s using equipment and technology developed during the Vietnam conflict. The program started with five technicians, a Piper Navajo aircraft, and an HRB-Singer IR line scanner. To mount the scanner, technicians literally cut a hole in the bottom of the aircraft fuselage and mounted the scanner above the hole. With the pilot flying a grid pattern over fires at 6,000 to 10,000 feet (1,829 to 3,048 m) above ground level, a technician operated the scanner. The Navajo was nonpressurized, and pilots and technicians donned oxygen masks when flying IR missions over high-elevation fires.

> Infrared interpreters map the fire's heat perimeter and calculate the fire's acreage; they also map heat intensity, scattered heat locations, and isolated heat sources.

The IR images were captured on silver nitrate film. After the airplane completed its mission and landed, the film was removed from the scanner and given to a photointerpreter for analysis. The interpreter drew the IR "hot spots" by hand on a fire area map for transfer to and use by fire managers. It was a slow and cumbersome process, but it gave fire crews on the ground something they had never had before: a reliable, mapped representation of the fire's location and intensity.

Today, the program uses two scanner-equipped aircraft: a Cessna Citation jet and a King Air B200 turboprop. These aircraft have higher service ceilings, greater speed, and almost twice the range of the 1960s-era Navajo. The program logs an average of 800 IR scanning missions over wildfires annually, and program aircraft and technicians can conduct IR scans on as many as 25 fires in a single night of work.

The NIROPS scanner is mounted in the bottom of the aircraft fuselage. In this Citation aircraft, it is located just to the right of the steps. Photo: Ken Frederick, National Interagency Fire Center.

Ken Frederick is a public affairs specialist with the Bureau of Land Management at the National Interagency Fire Center in Boise, ID.

The Mechanics of Infrared Scanning

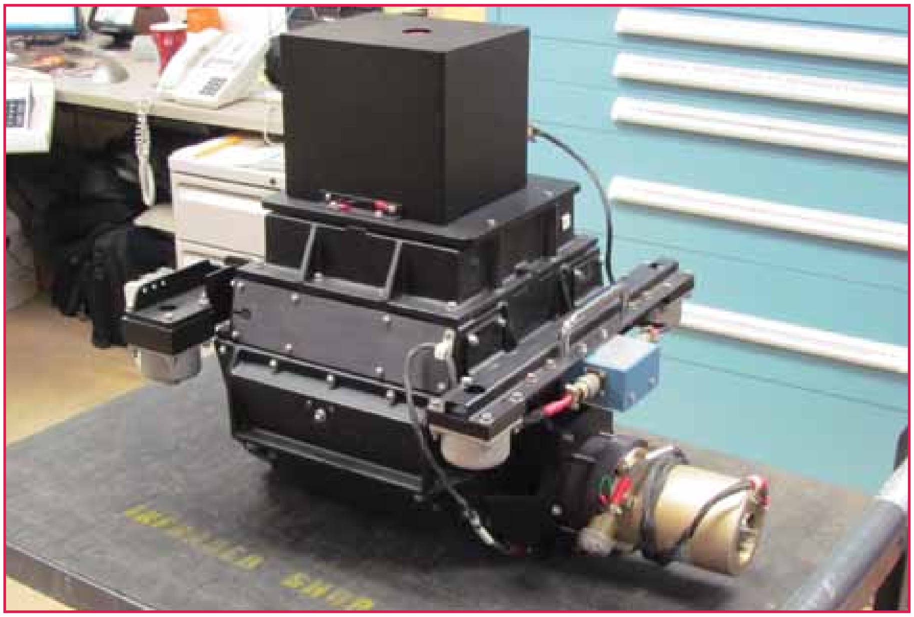
The IR systems used today by NIROPS employ a Kennedy line scanner capable of scanning a very large area in a short amount of time. IR light is energy emanated from heat sources at a wavelength invisible to the human eye; a scanner detects that energy and displays it in a visible form.

From 10,000 feet (3,048 m) above ground, the scanner "looks" at a long, narrow, rectangular section of the Earth's surface measuring 6.2 miles (10 km) by 12 feet (3.6 m) and generates a thermal image of that strip of ground. The scanner "looks" at 200 overlapping segments of ground along that strip *per second*, scanning each piece of ground 2.5 times every second. The scanner assigns a red pixel at each location where it senses a temperature of about 100° Celsius (212° F) above the surface's background temperature. The system can sense and record a spot of heat measuring less than the size of a paper plate. Each pass the aircraft makes over a fire is stored as a data file.

Most IR missions are flown at night. As temperatures fall after sunset, the cooler background helps heat signatures stand out. Also, air operations over a fire are typically halted after dark, reducing potential transient sources of heat from the scans. As most IR missions are flown at higher altitudes than aerial fire operations, IR missions do not complicate air traffic patterns over a fire.

From Scan to Map

Without the ability to record the heat concentrations sensed by IR scanning and transfer that information to a map in a meaningful way, IR technology would be of little value to ground crews and fire managers. Ortho-rectification and geo-location are two processes to accurately locate the scan data on a map and make IR data meaningful to the incident command team at the fire scene.



NIROPS uses a Kennedy line scanner to record infrared data from 10,000 feet (3,048 m) altitude. This compact piece of equipment performs a critical job for incident management teams. Photo: Ken Frederick, National Interagency Fire Center.

Ortho-rectification consists of digitally removing or compensating for distortions in applying the digital information to a map that result from such things as uneven terrain where the fire is burning and changes to the scanner's position relative to the ground caused by the aircraft's attitude. The "attitude" of the aircraft refers to the aircraft's altitude, speed, direction, pitch, yaw, and roll. The distortions caused by these variations affect the locational accuracy of the IR imagery and must be corrected in mapping. If, for example, the aircraft experiences a sudden drop in altitude during a scan, a global positioning system receiver in the scanner records this drop, and the ortho-rectification software compensates for that change by adjusting the image resolution. Likewise, pitch, yaw, and roll are tracked through the scanner's internal instrumentation.

An infrared technician checks a scanner image on the data processing platform inside NIROPS' Citation jet. Photo: Ken Frederick, National Interagency Fire Center.

The data processing platform linked to the IR scanners also contains terrain elevation data referenced by latitude and longitude, which enables the software to identify cliffs, peaks, slopes, valleys, and other terrain features in mapping the scan data.

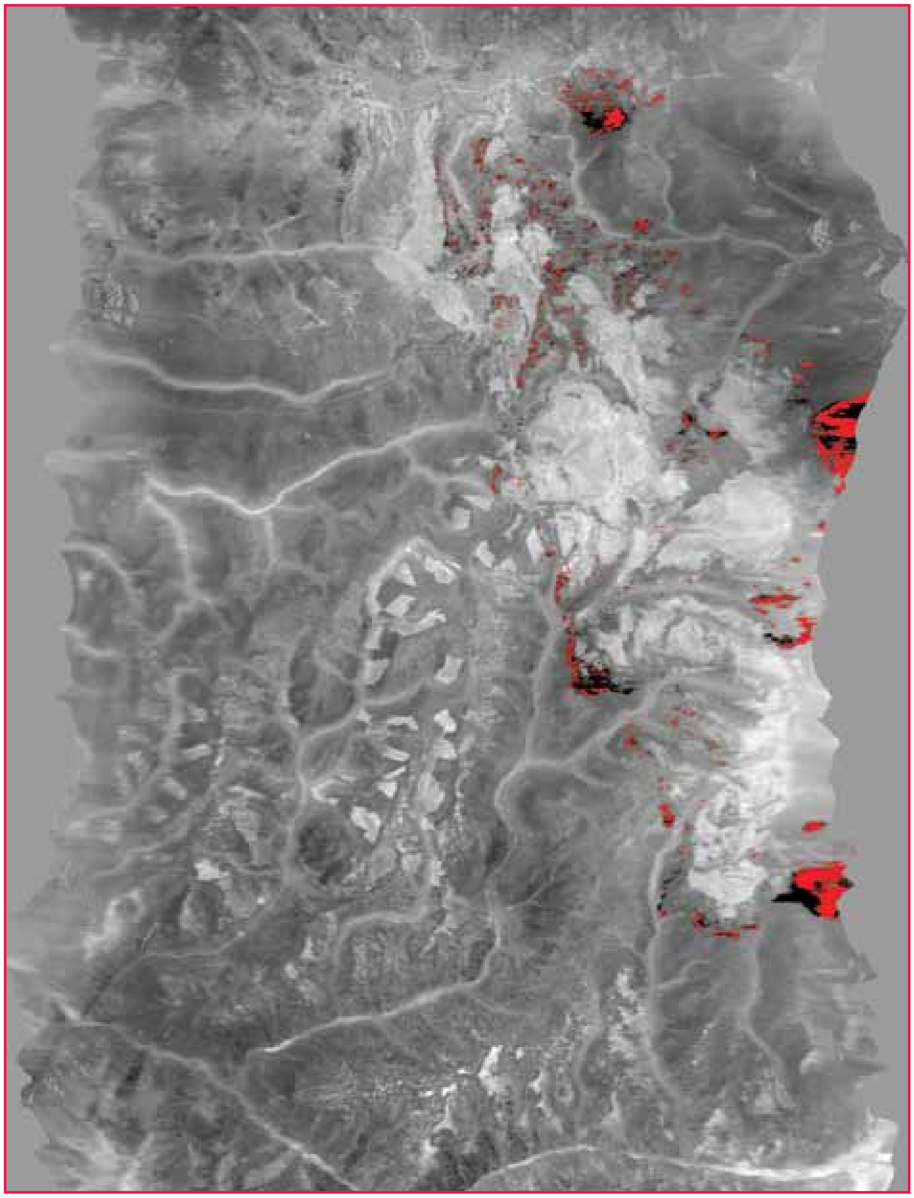
The result of ortho-rectification is a geometrically correct image that is ready for the next step: geo-location. *Geo-location* is the process of attaching a latitude and longitude identifier to each pixel in the IR imagery. This step is automatically performed by software in the on-board data processing platform. Geo-location makes it possible for IR data to be plotted accurately on a map for fire planners and firefighters on the firelines.

According to NIROPS technicians, new on-board processing platforms have improved the resolution of IR images and their processing speed on the order of a hundred-fold over the past 10 years. The data quality is also enhanced by customized software in the processing platform that filters out unwanted signals and other electronic noise.

After the scans are finished and the ortho-rectification and geo-location processes are completed, the IR technician on board the aircraft uploads the data files to a remote file transfer site—often while the aircraft is in route to its next fire. Technicians use Twitter to let IR interpreters know when passes over certain fires are completed and files are available and ready for analysis.

Infrared Image Interpretation

IR interpreters are specialists who examine IR imagery and make sense of it by applying it to a map. “Infrared interpreters play a key role,” said Tom Mellin, the Forest Service’s remote sensing coordinator in the Southwestern Region and the national IR program manager. “Interpreters take the raw data that comes off the airplane, produce GIS [Geographic Information System] files and maps from those data, and get the products to incidents as rapidly as possible.” Situation unit leaders on incidents need the maps before the morning briefing—some as early as 4:00 a.m.



An ortho-rectified infrared image of the Salt Fire, which burned in August 2011 on the Salmon-Challis National Forest in Idaho, shows areas of fire activity in red within the contours of the landscape. The infrared interpreter would use this type of file to create maps for use by incident personnel. Photo: Forest Service, National Infrared Operation Program.

“First and foremost,” Mellin said, “the interpreters perform a quality assurance function. They check the files for good ortho-rectification, for information gaps, and for any other problems.”

The IR interpreter’s primary job is to map heat data. The interpreters map the fire’s heat perimeter and calculate the fire’s acreage; they also map heat intensity, scattered heat locations, and isolated heat sources. Interpreters usually create maps as shapefiles—GIS data layers that are the *lingua franca* of mapmakers. Sometimes, the interpreters create paper maps, but more often, their products are entirely digital.

Interpreters have to determine whether heat signatures (recorded as red pixels) are associated with the main fire or whether the heat is emanating from another source. In addition to identifying new, unreported fires, IR scans can detect campfires, oil rig operations, and idling vehicles, and the interpreter must be able to distinguish between various heat sources.

Sometimes, IR interpreters make interesting discoveries. When an interpreter recently examined images from an IR mission over a fire in central Idaho, he noted an unusual hot spot well outside of the fire perimeter. The spot was unusual because he plotted its location in the middle of a riverbed. After doing some geographic detective work, the interpreter concluded that the hotspot really was in the middle of a river—it was a previously unknown hot spring flowing directly into the river.

IR interpreters also produce KMZ files, which show a fire's heat perimeter in Google Earth™. "Incident personnel appreciate being able to see how the fire overlays the topography," Mellin observed. "It's a fantastic product."

Once interpreters have done their work and created the necessary maps, they post the map files to another file transfer site from which the situation unit at the fire can download them. If they are located close enough to a fire operation, interpreters can deliver the maps or files directly to the incident command post.

Information at the Fire Scene

Saying that a situation unit leader appreciates IR products is like saying a duck appreciates water. Buddy Bloxham is a battalion chief with CALFIRE's San Benito/Monterey Unit, and he serves as a situation unit leader on CALFIRE Incident Command Team 10. He is also an IR interpreter. In recent years, as a situation unit leader, he has been a frequent user of NIROPS products.

> Most teams use IR imagery for perimeter mapping, but in some cases, teams will use IR imagery for detection of new starts or to get a better handle on where a fire's heat is in relation to available fuels.

"Infrared imagery is critical in some cases," Bloxham said, "especially when we have unknown spot fires smoldering. Detecting those fires as quickly as possible can be a critical step in containing a fire and keeping our fire personnel safe." Most teams use IR imagery for perimeter mapping, but in some cases, Bloxham said, teams will use IR imagery for detection of new starts or to get a better handle on where a fire's heat is in relation to available fuels.

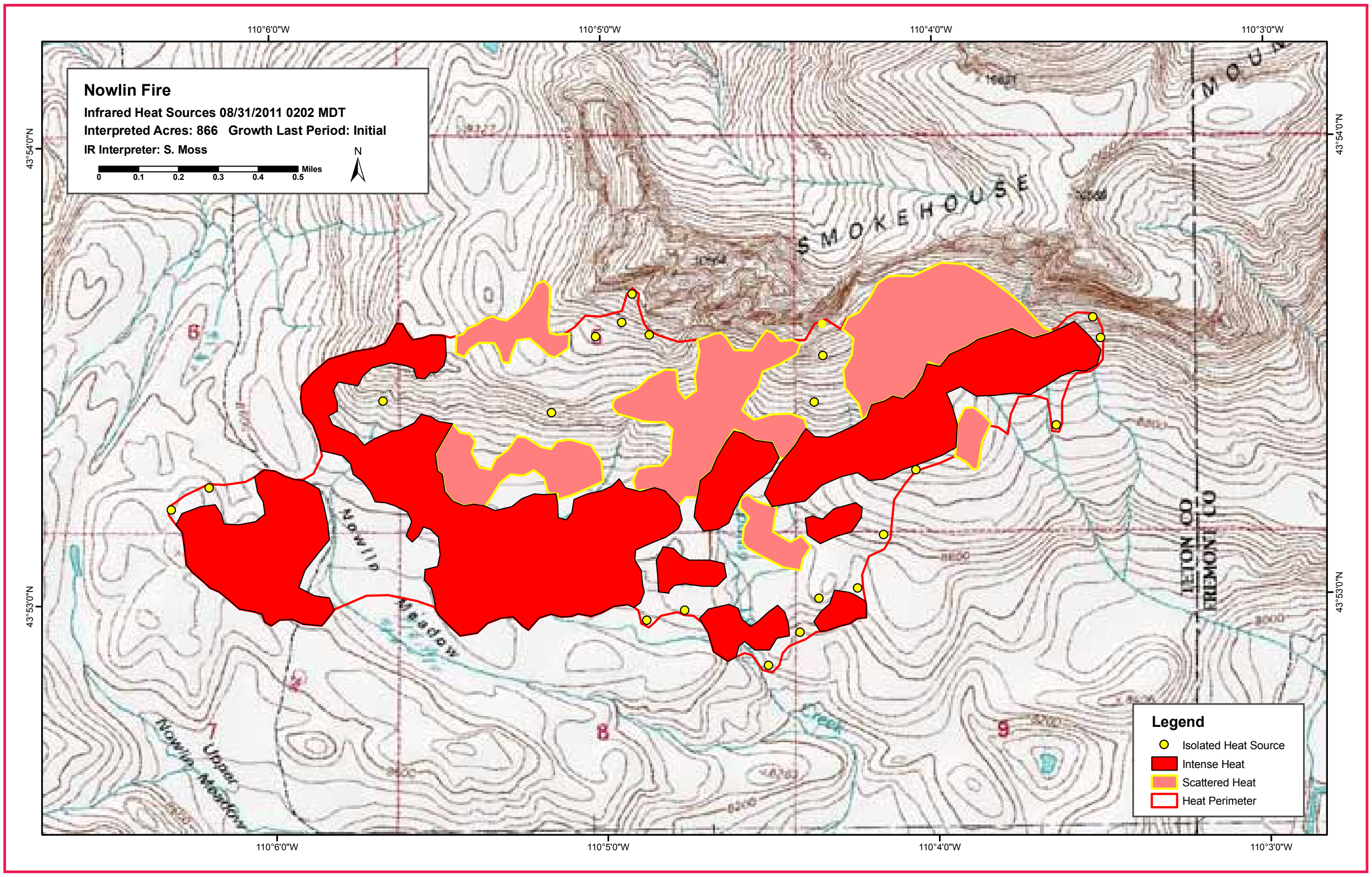
"NIROPS brings a lot to the table," added Bloxham. "They understand our needs for this information. As long as I place an order by their cut-off time, I'll get a flight overnight, and I'll have a product by 5:00 the next morning. We work occasionally with some other IR providers, and they just aren't operationally ready. It can take them 24 hours or longer to get us imagery."

GIS information available today greatly compliments IR imagery. GIS layers that show transportation routes, topography, vegetation density and composition, fuel conditions, and fire history can be exceptionally important sources of information for fire managers. Once these layers are digitally matched up with IR data, they provide a new dimension of spatial understanding and predictability of a fire. For example, planners can use this kind of intelligence to select fireline locations, assess which tactics are likely to be most effective, guide resource ordering decisions, and help determine where spike camps should be set up. IR information can also help confirm predictions on the rate and direction of fire spread—key information for fire managers and law enforcement alike when fires are burning in the wildland-urban interface.

NIROPS Staff

Woodrow Smith and Charles Kazimir are the permanent electronics technicians who provide operational management of NIROPS. Smith began his Federal career as a seasonal firefighter and Kazimir as an electronic technician for the U.S. Department of Defense. Smith and Kazimir fly the majority of scanning missions during fire season. During a typical day before a mission, Smith and Kazimir validate the mission request with the ordering unit, meet with the pilots to plan the mission flight, and inform the ordering unit as to when the IR flight will be completed. When fire activity is at a high operational tempo, the National Interagency Coordination Center at NIFC will order a national IR mission coordinator whose job is to receive, prioritize, and schedule IR flight requests from incidents across the country.

In the off-season, NIROPS conducts training for IR interpreters, upgrades scanning and processing equipment, and tests new technology. NIROPS works closely with the



A topographic map of a portion of the Bridger-Teton National Forest 10 to 15 miles (16 to 24 km) east of Grand Teton National Park is overlaid with polygons showing fire locations and intensities during the Nowlin Fire, started by lightning in late August 2011. The red line connecting the polygons shows the perimeter of the fire and yellow circles show isolated heat sources. Image: Forest Service, National Infrared Operation Program.

Forest Service's Remote Sensing Application Center (RSAC) in Salt Lake City, UT, to research and develop new equipment and methods that might benefit the program. Smith and Kazimir continuously review technical literature to become aware of new technology that might be useful to the program. The staff develops methods to test and prove new components and applications.

Along with Smith, Kazimir, and the national IR program manager, Tom Mellin, the success of NIROPS depends on the work and dedication of a large number of specialists who work in wildland fire and aviation units. Six pilots, based in Ogden, UT, fly IR missions on a rotational basis during periods of fire activity. The National Interagency Incident Communication Division at NIFC provides four trained electronics technicians to fly IR missions as needed. Finally, the program depends on the skills of more than 50 IR interpreters from various Federal, State, and local agencies. These specialists—many of whom possess firefighting experience—are the critical links necessary to get IR data into the hands of fire managers and firefighters.

"Having fought fire certainly helps our role in NIROPS," Smith said. "We know how important infrared intelligence can be. Infrared imagery to a firefighter out on the ground is not an exercise in theoretical physics. If an incident orders IR imagery, that means they need information to better understand where heat concentrations exist on their fire and how that energy is going to interact with fuels and weather."

Kazimir echoes Smith's sentiments. "Our goal is to give firefighters information that says something is burning in a certain spot and give them a tool to help them locate that fire efficiently. We do 90 percent of our work at night," he added. "It's a grind, but you know what? Those crews out there on the line in 102° F (38.8° C) heat aren't on a picnic either."

IR imagery is an indispensable tool for understanding and tracking the behavior of wildland fire. The NIROP will continue to provide top-flight IR services for wildland fire managers across the Nation.

For more information about NIROPS, go to <http://nirops.fs.fed.us> or call (208) 387–5647. ■

WATER QUALITY EFFECTS FOLLOWING A SEVERE FIRE

Charles C. Rhoades, Deborah Entwistle, and Dana Butler

> We don't fully appreciate how much high-severity wildfires alter forest watersheds and aquatic resources, or the longevity of those effects.

On June 8, 2002, the Hayman Fire ignited in the Upper South Platte watershed of the Colorado Front Range. That year, total precipitation and the winter snowpack in the area were approximately half of long-term annual averages, and low fuel moisture, low relative humidity, and strong, gusty winds triggered rapid rates of fire spread and long-range spot fires. Coupled with these extreme climatic conditions, the dense, continuous horizontal and vertical fuel structure created by decades of fire exclusion allowed the fire to advance for 24 days and burn through 138,000 acres (55,800 ha) of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) forests before being declared contained on July 2 and extinguished on October 30, 2002. It was the largest fire in recent Colorado history.

High-severity crown fire killed the overstory forest and consumed forest floor across 40 percent of the Hayman burn. In first- to third-order watersheds within the burn perimeter, moderate- or high-severity fire influenced 25 to 62 percent of upland areas, and up to 96 percent of riparian ecosystems (Kershner and others 2003).

The fire's location, 47 miles (75 km) from 2.7 million citizens in the Denver metropolitan area, created immediate public anxiety about protection of human safety and private property in the expanding residential areas of the Front Range foothills. The fire also generated concern for long-term protection of Denver's supply of clean water and focused attention on watershed response to the fire.

Monitoring Critical Watersheds

As in many of the forested watersheds that supply 90 percent of Colorado's drinking water, water quality concerns in the upper South Platte watershed began long before the Hayman Fire ignited (Hutson and others 2004). Elevated stream temperature and sediment levels had been identified as specific problems for South Platte tributaries that supply water for the Denver metropolitan area and support popular sport fishing sites (Colorado Water Quality Control Division 2002). Prefire streamwater nitrate, the form of nitrogen associated with surface water eutrophication and human health risks, was well below drinking water guidelines but exceeded the draft numeric

Ponderosa pine stand burned in 2002 by the Hayman Fire. Photo: Forest Service, Rocky Mountain Research Station.

Chuck Rhoades is a research biogeochemist at the Forest Service, Rocky Mountain Research Station in Fort Collins, CO. Deborah Entwistle is a hydrologist for the Canyon Lakes Ranger District on the Arapaho and Roosevelt National Forests in Fort Collins, CO. Dana Butler is a hydrologist for the Pikes Peak Ranger District on the Pike and San Isabel National Forests in Colorado Springs, CO.

standards proposed by the U.S. Environmental Protection Agency (EPA) for minimally disturbed streams in the Western Forested Mountains Ecoregion (U.S. EPA 2000).

Stream monitoring that began prior to the fire made it possible to assess fire effects and changes in streamwater properties, including changes in streamwater chemistry, temperature, and turbidity (an index of sediment loss) in burned and unburned catchments for a range of burn severities and watershed characteristics.

We monitored stream water before the fire and at monthly intervals for 5 years afterward—beginning in the month the fire was contained—and compared the measured values. The Hayman Fire affected half of the original monitoring sites, so our assessment compared prefire and postfire flow-weighted streamwater concentrations in three burned and three unburned watersheds. We established four additional sample locations following the fire to allow comparisons of the unburned drainages with drainages affected by varying fire extents.

Study Results

Wildfires such as the Hayman Fire periodically disturb watersheds in Colorado's montane forest zone, yet we don't fully appreciate how much high-severity wildfires alter forest watersheds and aquatic resources or the longevity of those effects.

Streamwater temperature (fig. 1), nitrate concentrations, and turbidity all increased following the Hayman Fire and remained above prefire levels for 5 years. The year following the Hayman Fire, average water temperatures in burned catchments were 5 °C higher in the spring and 6 °C higher in the summer compared with the seasonal averages for unburned streams. Streamwater warmed earlier in burned basins, and aquatic ecosystems were warmer for a prolonged period.

Nitrate concentrations and turbidity both increased in proportion to the extent of burned forest area, up to four times prefire levels. Streamwater nitrate concentrations fluctuated seasonally, with the highest peaks coinciding with spring snowmelt (fig. 2). Extensively burned basins had higher nitrate peaks than both unburned basins and basins burned to a lower extent. Nitrate concentrations remained elevated between seasonal peaks, especially during the third and fourth postfire years. In extensively burned basins, streamwater nitrate concentrations did not decline over the course of the study.

As with nitrate concentrations, turbidity increased during spring snowmelt in unburned streams (fig. 3). Where severe fire occurred on greater than 45 percent of a basin, turbidity responded more often and to a greater degree, compared with either unburned or lesser burned basins. Higher turbidity samples were as likely to occur during the summer as the spring snowmelt season. Stream turbidity showed no sign of decline in consecutive postfire years. Unlike stream nitrate concentrations, the highest mean and maximum turbidity measurements occurred during the summer seasons of 2005 and 2006 in response to storm events.

Immediate and Persistent Effects

Five years following the Hayman Fire, streamwater temperature, nitrate concentrations, and turbidity had not returned to preburn levels or levels measured in unburned

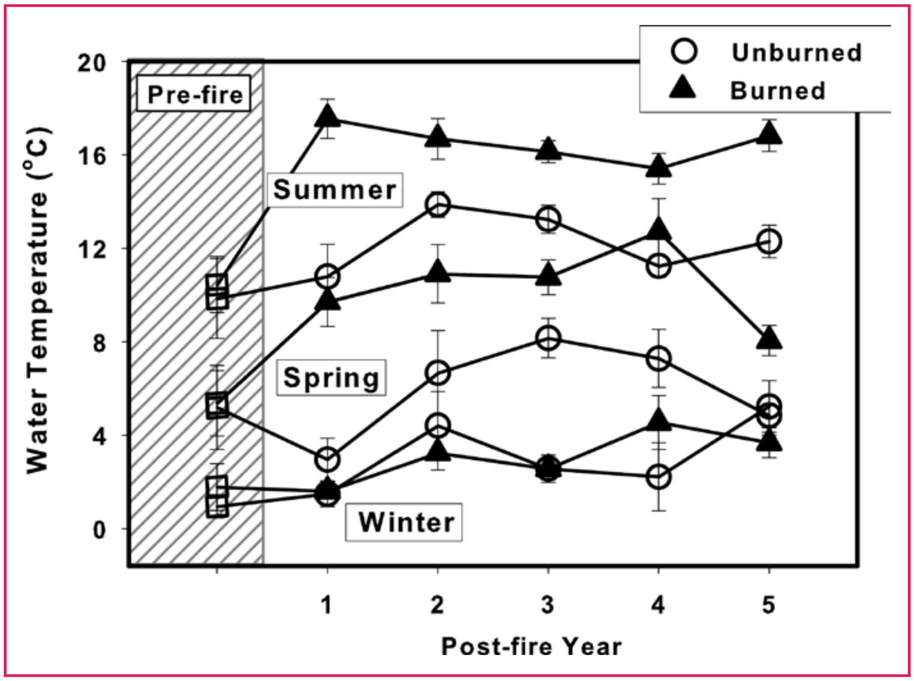


Figure 1—*Streamwater temperature of three burned and three unburned watersheds in the Upper South Platte watershed. Bars show means and standard errors for 4-month periods during the year preceding and the 5 years following the fire. Winter: November–February; Spring: March–June; Summer: July–October.*

basins. Fire effects associated with the loss of forest vegetation and altered soil processes typically reach a peak a few years after wildfire before declining towards preburn conditions (Minshall and others 1989; Wan and others 2001; Ranalli 2004; Certini 2005). Severe and extensive wildfires, however, initiate changes in terrestrial nutrient cycling that endure for decades before forest composition and soil processes return to prefire conditions.

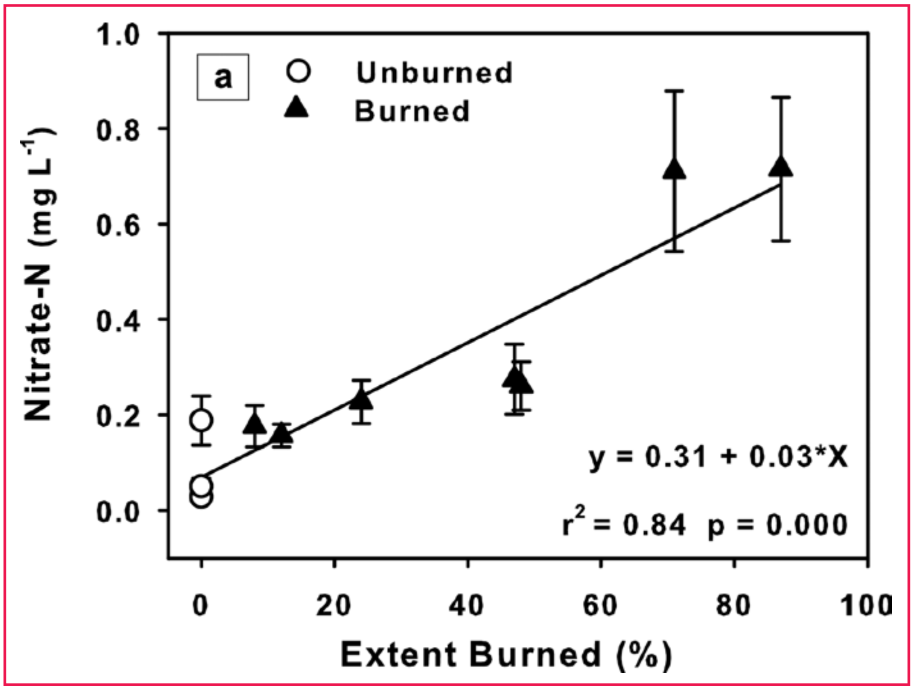


Figure 2—*Linear relationship between mean streamwater nitrate for individual basins during post-fire years and (a) the extent of each watershed burned and (b) the area affected by high-severity combustion during the 2002 Hayman Fire.*

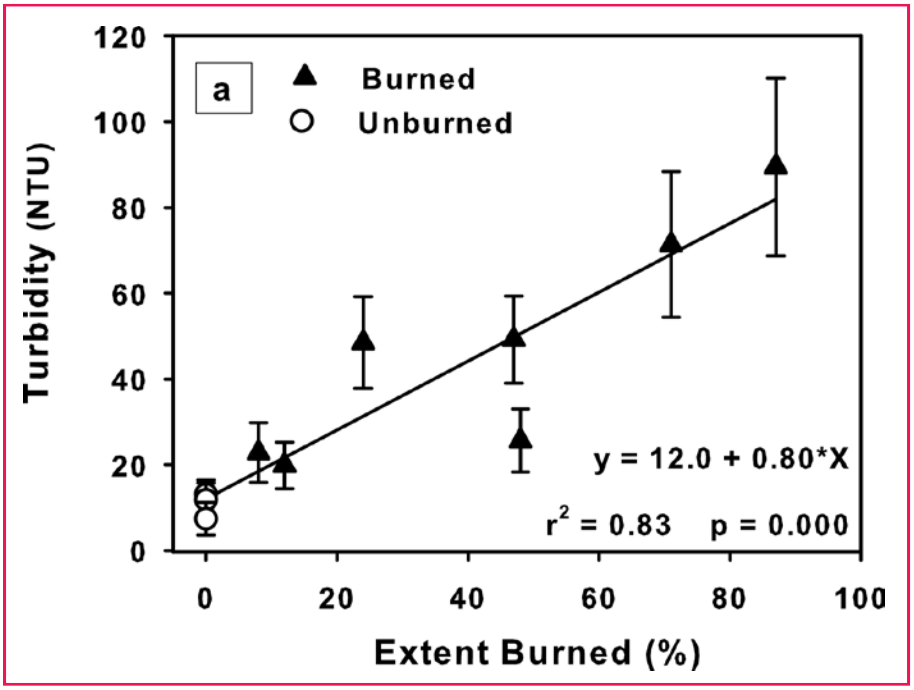


Figure 3—*Linear relationship between mean streamwater turbidity for individual basins during post-fire years and (a) the extent of each watershed burned and (b) the area affected by high-severity combustion during the 2002 Hayman Fire. NTU: nephelometric turbidity units.*

The slow recovery of forest vegetation after the Hayman Fire helps explain the slow return of streamwater temperature, nitrate, and turbidity to prefire levels. The extent of exposed soil declined with time since the fire but remained more than double the prefire condition after 4 years, and the loss of seed reserves and barriers to colonization of extensive high-severity burn areas is expected to delay forest establishment (Fornwalt and others 2010). In spite of the rapid recovery of understory vegetation in some areas, the extent of litter loss and the slow recolonization by forest vegetation may influence for decades the uptake, turnover, and export of nitrogen, as well as sediment delivery from watersheds burned by the Hayman Fire.

As a point of comparison, following the Yellowstone fires, streamwater nitrate concentrations remained higher than background levels for 5 years (Robinson and Minshall 1996). Higher radiation inputs to streams caused by the combustion of forest overstory and riparian vegetation increased stream temperatures for 2 to 6 years before shade from regenerating shrub and tree canopies returned them to prefire levels (Minshall and others 1989).

Water Quality Implications

Sustained postfire changes in streamwater may threaten aquatic resources in the Upper South Platte. For example, in basins burned extensively by the Hayman Fire, peak nitrate concentrations remained more than 100-fold above nitrate concentrations typically found in minimally disturbed western forested mountain streams throughout the study area and occasionally more than 10-fold higher than EPA-proposed total nitrogen concentrations (U.S. EPA 2000). The highest postfire nitrate concentration did not exceed 25 percent of the EPA's drinking water standard, though intense summer rainstorms occurring between monthly sample dates may have increased discharge and nitrate above drinking water thresholds in extensively burned basins (Larsen and MacDonald 2007). Based on findings from a study of the temperature sensitivity of salmonid populations in southern Wyoming (Rahel and others 1996), the measured 4 °C increase in summer streamwater temperature measured after the Hayman fire could be expected to reduce fish habitat by about half.

Postfire Management Response

Owing to the slow pace of tree colonization and forest regrowth, recovery of the watersheds burned by the Hayman Fire will continue for decades. Similar to the streamwater responses we document here, postfire forest succession will likely vary among basins according to the extent and degree of disturbance.

In the lower montane ponderosa pine forests of the Rocky Mountain West, the impressive effects of the Hayman Fire and other large wildfires have become synonymous with the consequences of historic fire exclusion coupled with recent climatic conditions (Westerling and others 2006; Flannigan and others 2009). Use of mechanical treatments and prescribed fire to reduce hazardous fuel loads, such as those that contributed to the Hayman Fire, are being widely implemented on Forest Service lands under the auspices of the *Healthy Forest Restoration Act* (USDA/DOI 2005).

Compared with wildfire effects, these management activities typically create relatively minor changes in water quality (Richter and others 1982; Stephens and others 2004). In spite of current public support for hazardous fuel treatments, active management of national forest lands remains controversial (Beschta and others 2004, Steelman and DuMond 2009). The large extent of forest area designated for fuel-reduction treatments, projections for longer fire seasons, increasing frequency of large, severe fires (Westerling and others 2006), and the slow pace of watershed recovery from high-severity wildfire all underscore the need for comprehensive, long-term monitoring of watershed and aquatic conditions and appropriate management strategies (Stone and others 2010).

> Five years following Colorado's Hayman Fire, streamwater temperature, nitrate concentrations, and turbidity have not returned to preburn levels in watersheds affected by extensive, high-severity wildfire.

Further Details

This article was extracted from Rhoades, C.C.; Entwistle, D.; Butler, D. 2011. The influence of wildfire extent and severity on streamwater chemistry, sediment and temperature following the Hayman Fire, Colorado. International Journal of Wildfire Science. 20:430–442.

References

Beschta, R.L.; Rhodes, J.J.; Kaufmann, J.B.; Gresswell, R.E.; Minshall, G.W.; Karr, J.R.; Perry, D.A.; Hauer, F.R.; Frissell, C.A. 2004. Post-fire management on forested public lands of the Western United States. Conservation Biology. 18: 957–967.

Certini, G. 2005. Effects of fire on properties of forest soils: a review. Oecologia. 143:1–10.

Colorado Water Quality Control Division. 2002. Colorado's 2002 303(d) and monitoring and evaluation list. Denver, CO: Colorado Department of Public Health and Environment.

Flannigan, M.D.; Krawchuk, M.A.; de Groot, W.J.; Wotton, B.M.; Gowman, L.M. 2009. Implications of changing climate for global wildland fire. International Journal of Wildland Fire. 18: 483–507.

Fornwalt, P.J.; Kaufmann, M.R.; Stohlgren, T.J. 2010. Impacts of mixed severity wildfire on exotic plants in the Colorado Front Range. Biological Invasions. DOI 10.1007/s10530-009-9674-2.

Hutson, S.S.; Barber, N.L.; Kenny, J.F.; Linsey, K.S.; Lumia, D.S.; Maupin, M.A. 2004. Estimated use of water in the United States in 2000. Circular 1268. Reston, VA: U.S. Geological Survey.

Kershner, J.L.; MacDonald, L.; Decker, L.M.; Winters, D.; Libohova, Z. 2003. Fire-induced changes in aquatic ecosystems. In Graham, R.T., ed. Hayman Fire case study. RMRS-GTR-114. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. p. 232–243.

Larsen, I.J.; MacDonald, L.H. 2007. Predicting postfire sediment yields at the hillslope scale: testing RUSLE and Disturbed WEPP. Water Resources Research 43, W11412. DOI:10.1029/2006WR005560.

Minshall, G.W.; Brock, J.T.; Varley, J.D. 1989. Wildfires and Yellowstone's stream ecosystems. Bioscience. 39: 707–715.

Rahel, F.J.; Keleher, C.J.; Anderson, J.L. 1996. Potential habitat loss and population fragmentation for cold water fish in the North Platte River drainage of the Rocky Mountains: response to climate warming. Limnology and Oceanography. 41: 1116–1123.

Ranalli, A.J. 2004. A summary of the scientific literature on the effects of fire on the concentration of nutrients in surface waters. Open-File Report 2004-1296. Reston, VA: U.S. Geological Survey.

Richter, D.D.; Ralston, C.W.; Harms, W.R. 1982. Prescribed fire: Effects on water quality and forest nutrient cycling. Science. 215: 661–663.

Robinson, C.T.; Minshall, G.W. 1996. Physical and chemical responses of streams in Yellowstone National Park following the 1988 wildfires. In Greenlee, J.M., ed. The ecological implications of fire in greater Yellowstone. Fairfield, WA: International Association of Wildland Fire. p. 217–221.

Steelman, T.A.; DuMond, M.E. 2009. Serving the common interest in U.S. Forest Policy: a case study of the Healthy Forests Restoration Act. Environmental Management. 43: 396–410.

Stephens, S.L.; Meixner, T.; Poth, M.; McGurk, B.; Payne, D. 2004. Prescribed fire, soils, and stream water chemistry in a watershed in the Lake Tahoe Basin, California. International Journal of Wildland Fire. 13: 27–35.

Stone, K.R.; Pilliod, D.S.; Dwire, K.A.; Rhoades, C.C.; Wollrab, S.P.; Wollrab, S.P.; Young, M.K. 2010. Fuel reduction management practices in riparian areas of the western USA. Conservation Biology. 46: 91–100.

U.S. EPA. 2000. Nutrient criteria technical guidance M: Rivers and streams. Publication 822-B-00-002. Washington, DC: U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. Available at <http://www.epa.gov/waterscience/criteria/nutrient/guidance/rivers/> (accessed November 2011).

USDA/DOI. 2005. The healthy forests initiative and healthy forest restoration: interim field guide. FS-799. Washington, DC: U.S. Department of Agriculture, Forest Service, Technology Development Program and U.S. Department of the Interior. Available at <http://www.fs.fed.us/ projects/hfi/field-guide/web/index.php> (accessed August 2006).

Wan, S.; Hui, D.; Luo, Y. 2001. Fire effects on nitrogen pools and dynamics in terrestrial ecosystems: A meta-analysis. Ecological Applications. 11: 1349–1365.

Westerling, A.L.; Hidalgo, H.G.; Cayan, D.R.; Swetnam, T.W. 2006. Warming and earlier spring increases Western U.S. forest wildfire activity. Science. 313: 940–843. ■

Success Stories Wanted!

We'd like to know how your work has been going! Provide us with your success stories within the state fire program or from your individual fire department. Let us know how the State Fire Assistance (SFA), Volunteer Fire Assistance (VFA), the Federal Excess Personal Property (FEPP) program, or the Firefighter Property (FFP) program has benefited your agency. Feature articles should be up to about 2,000 words in length; short items of up to 200 words.

Submit articles and photographs as electronic files by email or through traditional or express mail to:

HR Communications, Ltd.
Attn: Rick Harroun
Managing Editor
1801 Old Reston Avenue
Suite 302
Reston, VA 20190
Tel. 571-266-4102
Fax 571-266-4106
E-mail: FMT.editor@hrcltd.com

If you have any questions about your submission, you can contact one of the FMT staff at the email address above or by calling 202-205-1090.

INCIDENT REMOTE AUTOMATIC WEATHER STATIONS: UPGRADING ONSITE FIRE WEATHER DATA COLLECTION

Herb Arnold

Weather analysis plays a significant and enduring role in wildland fire management. The long-term weather data gathered by the permanent interagency remote automatic weather stations (RAWS) network provides the baseline for almost all preparedness planning and supports all decisions made in conjunction with the National Fire Danger Rating System. Just as the permanent RAWS network is instrumental in supporting preparedness and fire danger analysis, so do portable stations play an important role supporting suppression and fire behavior analysis during ongoing incidents.

Onsite Weather Data from RAWS

Portable weather stations, often among the first and most urgently needed equipment requested by incident management teams (IMT), provide environmental information essential for all suppression and prescribed burn operations. The Fire Remote Automatic Weather Station (Fire RAWS kit, National Fire Equipment System [NFES] item 5869) has met this need since the late 1980s and become a common sight at wildland fire locations. This equipment and its accompanying technicians are made available via standard resource order through the National Interagency Coordination Center.


The Original Fire RAWS, a tough and reliable portable weather station developed in-house by the Remote Sensing Unit at NIFC. This image evokes the lineage of the "grandfather" to the current Incident RAWS. Photo: BLM, 1985.

The Fire RAWS was a custom-built portable station designed and assembled by the Remote Sensing and Fire Weather Support Unit at the National Interagency Fire Center (NIFC) in Boise, ID. Using the same sensor suite from permanently sited, full-sized RAWS, the Boise technicians developed and fabricated a rugged, portable kit to handle the tough requirements of wildland fire operations. This equipment provided accurate measurement of local winds, temperature, humidity, fuel moisture, fuel temperature, and precipitation, and reliably distributed that data via satellite for meteorological and fire weather analysis. Not long after introduction, voice radio interrogation and alarm capabilities were added to offer instant weather information to an expanded audience via local incident radio networks. Each kit, upon return from deployment, received comprehensive recalibration and refurbishment.

The New Generation: Incident RAWS

The original "fleet" of Fire RAWS kits served a long and useful career, but the 2011 fire season brought a significant upgrade to this important type of firefighting equipment. Now, a worthy successor to the original Fire RAWS is available from the Great Basin Cache with a new name: the Incident RAWS (IRAWS). Technology has made huge strides since the original Fire RAWS was developed, and many commercial manufacturers now offer rugged, deployable portable

> The Fire RAWS was a custom-built portable station designed and assembled by the Remote Sensing/Fire Weather Support Unit at the National Interagency Fire Center.

Herb Arnold is the manager for the Remote Sensing and Fire Weather Support Unit, U.S. Department of the Interior, Bureau of Land Management at the National Interagency Fire Center in Boise, ID.

weather stations. After a long and exhaustive evaluation, the Great Basin Cache purchased 50 "Quick Deploy" weather station models from Forest Technology Systems, Inc. These units have improved satellite and radio communication capabilities compared to the older Fire RAWS and are lighter and easier to erect. Significantly, the improved processing power of the datalogger allows programming functions to be performed directly on the instrument, without the need for a supporting laptop computer. These new kits are dispatched in company with trained electronics technicians and retain the fire equipment catalog code of NFES 5869.

Barely out of their packing cases, IRAWS were promptly called upon to support wildland fire management. In June of 2011, NIFC deployed several kits to the Wallow fire in Arizona. During a challenging phase of the initial response, the fast-moving nature of this fire demanded a station be quickly moved in order for incident meteorologists (IMETs) to get the best weather data from a critically threatened area. The two-man crew was able to quickly disassemble, pack, transport, and re-erect the IRAWS in minimal time. Alan Hester, IRAWS technician, confirmed, "We got the station up and headed out just as we heard the roar of the fire approach. There's no way we could have gotten an old Fire RAWS up in the same time."

As with the Fire RAWS, the Remote Sensing Unit at NIFC refurbishes and completely recalibrates the IRAWS after each deployment to meet the National Fire Danger Rating standards for performance. The unit identifies and addresses all unavoidable effects of smoke,

Technology has made huge strides since the original Fire RAWS was developed, and many commercial manufacturers now offer rugged, deployable portable weather stations.

The Wallow Fire, AZ, burns on the horizon, within sight of a deployed IRAWS. Photo: Alan Hester, BLM, June 2011.

Three of the 50 new IRAWS kits are built up and tested at the Remote Sensing Unit at NIFC in preparation for the 2011 fire season. Photo: BLM, May 2011.

dirt, dust, use, and abuse from the rough conditions at a wildland fire. When deployed via trailer with spares and all-terrain vehicle (ATV) equipment, the accompanying technicians offer complete support to the IMTs and require only a desired location and the parameters for radio alarm warnings. Weather data will then flow automatically to the IMETs via a variety of Web-based applications (Real-time Observation Monitor and Analysis Network [ROMAN], Wildland Fire Management Information [WFMI], Western Regional Climate Center [WRCC]). By maintaining the highest standards in sensor performance and by supporting the kits with fire-qualified and experienced technicians, the IRAWS continue to offer wildland fire managers an accurate and dependable tool to determine fire weather conditions. They provide the essential data to make critical decisions and require virtually no resources from the IMT to do so.


RAWS technician Justin Carey attends to a deployed IRAWS at the Wallow Fire, AZ. Photo: BLM, June 2011.

The improved processing power of the datalogger allows programming functions to be performed directly, without the need for a supporting laptop computer.

How Do I Get One?

IMTs can request IRAWS through normal resource order procedures. Like Fire RAWS, IRAWS are categorized as national resources by the National Interagency Mobilization Guide. It is recommended that purchasers coordinate availability of IRAWS technicians ahead of time, as the technicians also perform field maintenance of the full-size, permanent RAWS network. A phone call to the Remote Sensing and Fire Weather Support Unit (208–387–5726) can help ensure an IRAWS request will be filled to meet the need at the right place and time. ■


Deployed to a grassy area during the Wallow Fire, AZ, this IRAWS was subjected to a burnover but continued to operate properly. Photo: Alan Hester, BLM, June 2011.

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 limited, long manuscripts might be abridged (with approval by the author) by the editor; *FMT* also prints short pieces on topics of interest to readers.

Mailing Articles: Send electronic files by email or traditional or express mail to:

HR Communications, Ltd.
Attn: Rick Harroun
Managing Editor
1801 Old Reston Avenue
Suite 302
Reston, VA 20190

Tel. 571-266-4102
Fax 571-266-4106
E-mail: FMT.editor@hrcltd.com

If you have any questions about your submission, please contact FMT at the telephone number above, or email your inquiry to firemanagementtoday@fs.fed.us.

Electronic Files. *Electronic files are preferred and may be submitted via email or traditional mail.* Electronic files must be submitted in PC format. Manuscripts must be submitted in Word, Word Perfect, or Rich Text format. Illustrations and photographs must be submitted as separate files: *please do not include visual materials* (such as photos, maps, charts, and graphs) *as embedded illustrations* in the electronic manuscript file. Digital photos may be submitted in JPEG, TIFF, or EPS format, and must be at high resolution: at least 300 ppi at a minimum size of 5x7 (additional requirements are listed in the Photo section below). Information for photo captions (subject and photographer's name and affiliation) should be included at the end of the manuscript. Charts and graphs should be submitted along with the electronic source files or data needed to reconstruct them, any special instructions for layout, and with a description of each illustration at the end of the manuscript for use in the caption.

Electronic files may be submitted via email to firemanagementtoday@fs.fed.us.

Paper Copy. Paper copies may be submitted. Type or print the manuscript on white paper (double-spaced) on one side of the sheet only. As paper manuscripts must be electronically scanned for use, print should be clear and at least 12-point type.

For all submissions, include the complete name(s), title(s), affiliation(s), and address(es) of the author(s), illustrator(s), and photographer(s), as well as their telephone and fax numbers and email. If the same or a similar manuscript is being submitted for publication 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. 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/fmt/>) 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 with appropriate titles.

Photos and Illustrations. Figures, illustrations, and clear photographs (electronic files, color slides, or glossy color prints are all acceptable) 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.

Release Authorization. Non-Federal Government authors must sign a release to allow their work to be placed in the public domain and on the World Wide Web. In addition, all photos and illustrations created by a non-Federal employee require a written release by the photographer or illustrator. The author, photo, and illustration release forms are available from General Manager Melissa Frey (mfrey@fs.fed.us), Managing Editor Monique Nelson (moniquelnelson@fs.fed.us), or on request to *firemanagementtoday@fs.fed.us*.

Superintendent of Documents **Subscription** Order Form

Order Processing Code:
*

S3

☐ **YES,** enter my subscription(s) as follows:

Charge your order.
It's easy! MasterCard VISA

To fax your orders: 202-512-2104
To phone your orders: 202-512-1800 or 1-866-512-1800
For subscription cost and to Order on Line: http://bookstore.gpo.gov

The total cost of my order is $__________. Price includes regular shipping and handling and is subject to change. International customers please add 25%.

Company or personal name (Please type or print)

Additional address/attention line

Street address

City, State, Zip code

Daytime phone including area code

Purchase order number (optional)

For privacy protection, check the box below:
☐ Do not make my name available to other mailers

Check method of payment:
☐ Check payable to Superintendent of Documents
☐ GPO Deposit Account ☐☐☐☐☐☐☐ – ☐
☐ VISA ☐ MasterCard
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
☐☐☐☐ (expiration date)

Thank you for your order!

Authorizing signature

Mail To: U.S. Government Printing Office - New Orders
P.O. Box 979050
St. Louis, MO 63197-9000