Fire Management today

Volume 72 • No. 1 • 2012

Leaders on the World Stage

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

Thomas L. Tidwell, Chief
Forest Service

Tom Harbour, Director
Fire and Aviation Management

Melissa Frey
General Manager

Monique Nelson, EMC Publishing Arts
Managing Editor

Mark Riffe, METI Inc., EMC Publishing Arts
Editor

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January 2012

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On the Cover:

In 2011, the Forest Service upgraded all of its traditional Modular Airborne Firefighting Systems (MAFFS) to the new MAFFSII system, improving the ability of military aircraft to fight fire and demonstrating the innovation and leadership of U.S. wildland fire agencies. Learn more about MAFFS II in the article, "Trial by Wildfire: MAFFS II Proves Effective During Early 2011 Fire Season."
Photo: Kari Greer.

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.

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

Wildland Fire Management Leaders on the World Stage

There is no doubt that the USDA Forest Service wildland fire organization is one of the largest, best-trained, and most well-equipped organizations in the world. With that said, however, we should be neither overbearing nor shy about our capabilities. We need to realize and understand that there is a true role for us on the "world stage," and with that comes a responsibility to balance our duties to others with our responsibilities to the natural resources we are charged to protect.

Wildland fire is a world-wide issue. With their associated underpinnings, wildfires occur in many nations around the world. While we must not lose sight of our primary responsibilities as stewards of our natural resources here in the United States, we have an obligation to reach out and provide assistance to our counterparts here at home and across the globe through training and direct assistance. We must be role models to others; we must serve as an example and exhibit behavior that will be becoming of our agency and ultimately emulated by others.

Learning, however, is not a one-way street. The Forest Service can learn from different approaches to fire, both here at home and around the world. We need to teach, and we need to learn. We need to help, and we need to be helped.

The Forest Service can learn from different approaches to fire, both here at home and around the world.

It has been a tradition within the Forest Service that Fire and Aviation Management has participated with Forest Service International Programs to reach out to our international counterparts and offer assistance when needed—both through training and preparation for wildfire and through on-the-ground assistance when wildfires and other disasters occur. Likewise, during some of our most difficult fire seasons, we have reached out to our counterparts around the world for assistance; and they have come calling.

We are and have been part of several key groups internationally. In recent years, we have provided incident command system (ICS) instruction in countries like Sri Lanka, Thailand, India, Indonesia, Cameroon, and Honduras, just to name a few. We have exchanged fire management knowledge with Russia and initiated ICS training programs in Spain and France. We have responded to wildland fire in Canada, Australia, Russia, and Greece, and have hosted study tours for Australia, New Zealand, South Korea, Greece, and Israel. We have participated in conferences in countries like Greece, Italy, Spain, Australia, and most recently, South Africa. Together with our partners from the U.S. Department of the Interior, we are part of the North American Forest Commission Working Group, which includes the United States, Canada, and Mexico.

I am proud of the key role the Forest Service has played in developing quadrennial international wildland fire summits, the most recent held in Sun City, South Africa, and I am looking forward to the next one, which South Korea will host 4 years from now. When we can be of assistance, we also work with the U.S. Agency for International Development to help the agency accomplish its mission.

Helping, and being helped, makes the Forest Service Fire and Aviation Management program better and provides context and scope to our program. Leaders step forward. The Forest Service is a world leader in fire; we need to redeem our appropriate role internationally as world leaders. ■

The International Program in Fire and Aviation Management

Dale Dague

Fire and Aviation Management (FAM) has established an international role in many countries. This experience, along with the recognized technical and professional experience of fire and aviation specialists in the Forest Service, provides the basis for the FAM international program.

The FAM international program effectively and efficiently supports international cooperation and development in firefighting capacity while meeting the agency's mission. The program's objectives are designed to achieve a coordinated agency-wide effort, ensure the efficient expenditure of appropriated funds, and assist FAM employees representing the United States Government and the agency in the international arena.

Reaching Out

The objectives of the FAM international program are to provide support through sharing information, training, and direct assistance when needed; to serve as role models to the global community; and to acquire knowledge and new ideas that will continue to improve our skills and abilities.

These objectives are linked to support of fire management efforts abroad, and FAM fulfills this international role through three avenues:

1. Support for international disasters, coordinated by the Disaster Assistance Support Program (DASP). DASP is a cooperative program between the U.S. Agency for International Development's (USAID) Office of Foreign Disaster Assistance (OFDA) and Forest Service International Programs.
2. Mobilization of fire suppression resources for emergency international wildfire assignments in support of bilateral arrangements, coordinated by the National Interagency Fire Center (NIFC); and
3. Programmatic FAM international activities, coordinated by FAM Washington Office.

The combination of these efforts helps countries develop and implement wildfire management strategies and capacity on other continents and ensures effective firefighting cooperation between neighboring countries in North America.

Disaster Assistance Support Program

The Forest Service International Programs DASP was created in 1985 to provide USAID OFDA with technical support in disaster response management, planning, operations, preparedness, and prevention. This partnership was originally forged to leverage the Forest Service's significant expertise in emergency management systems in order to build and improve OFDA disaster response capabilities.

FAM works with DASP to identify personnel skilled in logistics, operations, planning, programming, assessment, and response to support USAID's response to international disasters. FAM also provides wildland firefighting equipment,

A C-130 aircraft offloads firefighting supplies in Russia, August 13, 2010. Photo courtesy of the U.S. Embassy, Moscow.

Dale Dague is the branch chief for emergency and disaster operations and international fire with the Fire and Aviation Management branch of the Forest Service in Washington, DC.

specialized equipment, and other supplies from our warehouses and caches.

Through DASP, USAID OFDA deployed an interagency technical assessment team in August 2010 to assist and support the Government of Russia in their response to catastrophic wildfires. FAM coordinated with DASP throughout that response. As a result of that team's assessment, DASP coordinated with FAM to provide firefighting and specialized equipment, funded by USAID OFDA.

During December 2010, USAID OFDA, through DASP, deployed FAM personnel to the destructive wildfire in Israel.

Also in 2010, FAM provided all-hazard support as part of USAID assistance to Haiti following a devastating earthquake. FAM provided hardware in the form of 300 handheld radios and 5 signal repeaters and communications training and assistance through 2 radio technicians.

Mobilization of Firefighting Resources

Where firefighting systems and language commonality exist, FAM can provide active firefighting support. FAM operates under national-level agreements with Canada, Mexico, Australia, and New Zealand. These provide for the transfer of firefighting resources when requested. The first agreement was established with Canada in 1982, and the United States has exchanged resources with Canada in 29 of the 30 years of the agreement. An agreement was established with Mexico in 1983 and, in addition to cooperating on wildfire incidents,

A wildfire backing in ground fuels underneath a canopy of eucalyptus trees in Hobart, Tasmania, during the fires of October 2006. Photo: Ian Stewart, Tasmania, Australia.

FAM provided support to the devastating magnitude 8.1 Mexico City earthquake in 1985.

Agreements were established with Australia and New Zealand in 2001 following the devastating fires in the Northern Rockies in 2000. That year, the United States was depleting its resources and needed additional assistance. As they were not in their own fire season during our summer (their winter), Australia and New Zealand sent resources to help in 2000, and it worked so well that a bilateral arrangement was developed in 2001. Mobilizations for such interactions are handled through the NIFC.

Additionally, we have border agreements between Canada and the Forest Service Northern, Pacific Northwest, Northeast, and Alaska regions, and between Mexico and the Forest Service Southwest and Pacific Southwest regions that allow each nation to initiate initial attack on lands within 10 miles (16 km) of the international border. Either country's firefighting resources can cross the border to suppress a wildfire within the 10 mile zone of mutual assistance upon request or notification of the appropriate jurisdiction. Such local mobilizations are handled through the corresponding local emergency operations center.

Programmatic FAM International Activities

In addition to operations in response to fire and other disasters, FAM maintains certain programmatic activities on an ongoing basis to strengthen communications, training, and support of firefighting agencies in other parts of the world. These programs, referred to as "capacity building," provide expertise to other countries, training to foreign firefighters during operations in this country, and resource assessment and management strategies to equivalent agencies in other countries through the United Nations Food and Agriculture Organization (UN–FAO). In this way, FAM takes a proactive role in addressing natural disturbances in partnering countries.

Building Capacity Through Training

FAM provides international capacity-building support to many other countries in coordination with International Programs; USAID Research, Technology, and Development; and U.S. Department of the Interior to build fire management capacity in countries or ecosystems designated as a high-priority or focus area. Many of these efforts result from the recommendations provided by USAID/OFDA assessments that were coordinated through DASP.

This was the case in 2007, when FAM personnel responded to the wildfires in Greece at the request of DASP to provide an operational assessment. As a result of the recommendations provided in the assessment, five firefighters with the Hellenic Fire Brigade were invited to work with the Little Tujunga Hotshots on the Angeles National Forest in the Pacific Southwest Region during the summer 2008 for training in handcrew organizations. These firefighters returned to the Pacific Southwest Region later in 2008 to provide assistance during the outbreak of wildfires. During 2011, FAM personnel traveled to Athens, Greece, to conduct handcrew and Incident Command System (ICS) training to participants from the Hellenic Fire Brigade. In addition, aviation personnel received Air Tactical Group Supervisor training at the Wildland Fire Training Center in McClellan, CA, in coordination of firefighting support aircraft. These are all skills that could be applied during future operations in their home country.

As part of capacity-building, FAM also supports the Disaster

Patricio I. Sanhueza, Chile Corporacion Nacional Forestal

Patricio I. Sanhueza, Chief of Fire Operations for Chile's Corporacion Nacional Forestal (CONAF) at the national headquarters in Santiago, Chile, began his firefighting career with CONAF in 1974 as a student-volunteer on a hand crew. In 1979, he was contracted by CONAF as a forester and started his professional career in fire management. During the summer of 1986, CONAF sent him on a temporary assignment to work and train with the Forest Service on the Lassen National Forest in Chester, CA. Sanhueza spent 4 months on the Chester Helitack crew learning wildland firefighting and helicopter operations.

In 1986, Patricio Sanhueza spent 4 months training and working with the Chester Helitack crew on the Lassen National Forest, CA. Now he is Chief of Fire Operations for Chile's Corporacion Nacional Forestal. Photos courtesy of Patricio Sanhueza, Santiago, Chile.

When Sanhueza returned to Chile, he translated training materials into Spanish and taught helitack training. He established the first helitack operations concept for CONAF, which now has seven helitack modules, and later taught helitack operations to the other Chilean private protection units and his neighbors in Brazil, Uruguay, and Colombia. Sanhueza also returned to Chile with new firefighting concepts (ready to go: any time, anywhere!!) and an increased awareness of wildfire safety. After his stay in the United States, he helped complete substantial improvements to firefighter protection gear, translated the 10 Standard Firefighting Orders and Watch Out Situations into Spanish, and instituted them within CONAF, among other improvements.

Sanhueza still speaks fondly of his time on the Chester helitack crew and the many friends he made on the Lassen National Forest. It was an extremely positive experience for him, for his American colleagues, and for the many CONAF firefighters who served on details in the United States during the next decade.

Mitigation Program of International Programs. The Disaster Mitigation Program builds capacity in incident management in nations around the world. FAM provides specialists in National Incident Management System component systems, primarily the ICS, Multiagency Coordination System, and Emergency Operations Centers. Notable large-scale capacity building partnership programs are ongoing in Ethiopia, India, Thailand, and the Philippines.

There are also several successful exchange programs currently in place, including the Mexico support program in the Pacific Southwest Region and the program in the Northern Rockies Region that trains South Africa fire managers. These projects, funded by USAID, build the visiting countries' capacity in wildland fire and incident management.

Assistance in Program Development

Capacity-building assistance is provided to nations that are politically and economically stable, have a genuine interest in solving their fire management problems, and demonstrate a willingness to sustain their programs financially over a long time period. Programs are developed to meet a cooperator's needs, are consistent with their ability to effectively implement new programs, and are sensitive to cultural and economic conditions.

When appropriate, FAM fire managers travel to nations that request an exchange of knowledge and information in all aspects of fire management. When these requests for assistance are received by International Programs, FAM determines the skills necessary to provide the support and requests are forwarded to region/area FAM contacts for distribution to field units. Travelling personnel receive appropriate instruction and orientation prior to travel and complete a trip report upon return to the home unit.

Study Tours

Study tours provide a better understanding of fire problems in other countries. Recently, FAM hosted study tours for fire managers from Portugal, Oman, Lebanon, Ethiopia, and Greece. Study tours for fire managers from South Africa, Spain, and France are also planned for the near future.

Study tours between the United States and Mexico, Canada, Australia, and New Zealand fire managers originated in 1951 and have been conducted biannually since 1980. In 2012, Australia and New Zealand fire managers will visit North America to participate in the next study tour.

North American Regional Cooperation

The North America and Australia study tours, along with many other initiatives, are sponsored by the North America Forest Commission Fire Management Working Group, created in 1962 as one of six regional forest commissions sponsored by the UN–FAO. (The other five are the Latin American and Caribbean Forest Commission, the Near East Forestry and Range Commission, the European Forestry Commission, the African Forestry and Wildlife Commission, and the Asia-Pacific Forestry Commission.) Through active participation in the Fire Management Working Group, the North American regional member nations of Mexico, Canada, and the United States exchange experiences and technological advances and promote mutual assistance in the development of strategy and appropriate actions to resolve fire management issues in North America.

The Fire Management Working Group advises the UN–FAO on regional forest policies, reviews and coordinates policy implementation, exchanges information with the other regional members, and recommends appropriate solutions to technical problems. Representatives of the three nations meet annually to promote mutual assistance; share experience, information, and technology; and work on common efforts. The most recent project

South Korean fire and forestry government officials tour the Eldorado National Forest and the McClellan Training Center in the Pacific Southwest Region in October 2008. Photo: Teri Mizuhara, California Department of Forestry and Fire Protection, Camino, CA.

was to produce an ICS glossary in English, Spanish, and French for the UN–FAO. The efforts of the working group have resulted in bilateral programs, international agreements, support of the international wildland fire conferences, and national agreements to share firefighting resources.

A Tradition of Global Involvement

FAM, along with the Fire Management Working Group and other international partners, promotes the exchange of experience and technology for wildfire management within the global wildland fire community by sponsoring the International Wildland Fire Conference series. The conferences were previously held in the United States in Boston, MA, in 1989; Vancouver, Canada, in 1996; Sydney, Australia, in 2003; Seville, Spain, in 2007; and Sun City, South Africa, in 2011. FAM is currently involved in planning activities for the 6th International Wildland Fire Conference to be held in 2015 in South Korea.

As part of the Wildfire 2011 conference, the international wildland fire community had the opportunity to learn about the South African wildfire program. Here, South African firefighters build fireline on a wildfire. Photo: Bruce Sutherland, courtesy of Wildfire 2011 and Working on Fire, Cape Town, South Africa.

FAM's international role will continue to serve as the basis for sharing our experience and knowledge with the global community. FAM will also continue to share resources under our international agreements, collaborate with our North American neighbors in fire management efforts regionwide, and provide support for mutual exchange in the international conference series. We will also continue to provide support to those communities that have a desire to build their own capacities in fire management.

Firefighters from South Africa attend the opening ceremony for the Wildfire 2011 international conference in Sun City, South Africa in May 2011. Photo: Bruce Sutherland, courtesy of Wildfire 2011 and Working on Fire, Cape Town, South Africa.

FAM participation in support of international fire management activities provides the opportunity for us to share our technical and professional experience with our international partners, provides us with the opportunity to learn from others, and strengthens our own fire management skills and abilities. Through international participation, we acquire knowledge and new ideas that will continue to improve the technical and professional abilities of our own personnel and the Forest Service FAM program as a whole. For example, past efforts have led to changes in the United States, such as the lightning detection and mapping system and our adoption of international fire prevention symbols.

International activity is anticipated to increase due to increased global wildfire activity, and the Forest Service expects to become more active in the future providing additional opportunities for our personnel to share their knowledge, be exposed to new ideas, and learn new skills. ■

Call for International Cooperation at Wildfire Conference in South Africa

Evelyn Holtzhausen

International cooperation and strengthening of wildland fire science and management skills are key to stemming the escalation of wildland fires, according to an accord drawn up by the 5th International Wildfire Conference held in South Africa May 9–13, 2011.

The accord comes after nearly 500 wildfire experts from 61 countries met at Sun City near Johannesburg, South Africa.

The conference produced the document following mammoth discussions in which regional delegates pledged to work together in taking steps to control the growing danger of wildfire in their communities and across the world.

The accord appealed to the global community to work together to confront an issue that was affecting all humankind. The appeal was supported by United Nations Secretary General Ban Ki-moon, who sent a message to the conference delegates appealing for "a global spirit of cooperation."

The conference was also video-linked to a special session of the Third Global Platform for Disaster Risk Reduction, which was meeting concurrently in Geneva, Switzerland.

Johann Goldammer of the Global Fire Monitoring Center and facilitator of the discussions said he was delighted that delegates had agreed on a set of principles that would guide the global wildfire community in coming years.

"We have reached the point where we all acknowledge that we face a global crisis and we can work together to find solutions," he said.

In the accord, the delegates highlighted the need for the wise use of fire in the sustainable management of natural and cultural ecosystems.

> "We have reached the point where we all acknowledge we face a global crisis and we can work together to find solutions."

They expressed strong concern at the escalation of wildfires, many unprecedented in size in the modern era. These were having a severe impact on communities, the environment, and the world economy, the accord stated.

The delegates acknowledged the benefits derived through sharing information and concluded that there was a critical need for research to look at new ways of dealing with the emerging issues.

The accord identified areas of concern, pointing out that society had altered the natural environment and fire regimes, and, consequently, humans were becoming more vulnerable to wildfire.

It called for an increase of fire management efforts on terrain contaminated by radioactivity, unexploded land mines, and chemical deposits. Regions affected by nuclear fallout—Chernobyl (1986) and Fukushima (2011)—were of grave concern to the global wildfire community and needed special consideration.

More effort had to be made to secure the long-term survival of peat bog and wetland ecosystems that were subjected to drainage and climate-driven desiccation, as they would be vulnerable to wildfire.

The accord appealed for increased effort to reduce unnecessary burning on croplands, fallow lands, and other lands to reduce the negative impact of greenhouse gases and carbon emissions in the regional, arctic, and global environments.

The conference ended with the baton being passed to the South Korea delegation, which will host the 6th International Wildfire Conference in 2015. ■

This article was compiled and issued by HWB Communications Pty Ltd of Cape Town, South Africa, of behalf of the Wildfire Conference 2011. The South African Government was a major sponsor of Wildfire 2011, the 5th International Wildland Fire Conference.

Evelyn Holzhausen is Chief Executive Officer of HWB Communications in Gardens, South Africa.

A Hands-On Prescribed Fire Workshop for Agency Line Officers

Greg Seamon

The Prescribed Fire Training Center (PFTC) is an interagency center located in Tallahassee, FL. Founded in 1998, PFTC hosts week-long workshops for agency administrators and resource specialists and 21-day sessions for fire practitioners. The center's mission is "to provide opportunities for Federal, State, local, and tribal government agencies and other organizations to build skills and knowledge of prescribed fire, *with an emphasis on field experience*." This mission emphasizes practical experience in field operations as a basis for developing and conducting successful prescribed fire programs and building support for prescribed fire programs among agency administrators, program managers, resource specialists, and the general public.

Diverse Staff, Targeted Students

The interagency composition of the staff has been a strong component of PFTC's success. The composition of the cadre for this workshop has changed over the years, but the interagency component has remained. The cadre has consisted of representatives from the Forest Service; the U.S. Department of the Interior, U.S. Fish and Wildlife Service, National Park Service, and Bureau of Land Management; the Department of Defense; the Florida Division of Forestry; The Nature Conservancy; and private consultants.

Greg Seamon is the fire training specialist for The Nature Conservancy at the National Interagency Prescribed Fire Training Center in Tallahassee, FL. He has 31 years of experience in prescribed fire working for The Nature Conservancy and the National Audubon Society.

Lori Bell, Forest Service attendee, and Patrick Morgan, Forest Service cadre, during a prescribed burn with the Georgia Forestry Commission in 2009. Photo: Greg Seamon, The Nature Conservancy.

The idea for offering a workshop on prescribed fire for agency administrators and line officers came from multiple sources. Attendees to PFTC's 21-day training sessions expressed the common view that prescribed burning on their home units was limited by the line officers' lack of experience and a need for direction in existing fire programs. Additionally, agency administrators expressed a desire to become more familiar with their role in building and supporting a prescribed fire program. Since 2002, the center has offered eight workshops on prescribed fire specifically for agency administrators.

Past class size has varied from 12 to 30 participants. Participants have come from throughout the country—Alaska to Florida, New Hampshire to California—representing a cross-section of agencies—the

> "I like the interagency composition of PFTC, the commitment to mission, and the truly outstanding staff."
> —Rob Fallon, District Ranger, Allegheny National Forest

Forest Service, U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs, Bureau of Land Management, Department of Defense, The Nature Conservancy, State programs, and one international participant (see Tables 1 and 2 for a breakdown of attendees by agency and State). Participants have commented positively on the interagency composition of the groups and the cadre. Marcia Garcia, deputy district ranger from the Santa Fe National Forest, commented, "The blend of people from different agencies was great."

Table 1—*Agency participants since 2002.*

Agency	Number of Participants
Bureau of Indian Affairs	5
Bureau of Land Management	4
U.S. Department of Defense	5
National Park Service	6
Forest Service	90
U.S. Fish and Wildlife Service	12
The Nature Conservancy	1
States	3
International (Belize)	1

Table 2—*State participants since 2002.*

State	Participants	State	Participants	State	Participants
AK	2	KY	1	OK	1
AL	1	LA	1	OR	3
AR	1	MA	1	PA	2
AZ	15	MI	3	SC	1
CA	6	MN	1	TN	3
CO	8	MS	2	TX	2
FL	8	MT	2	UT	8
GA	3	NC	2	VA	4
IA	1	NE	3	WA	1
ID	5	NH	1	WI	1
IL	1	NM	8	WV	4
IN	2	NV	4	WY	8
KS	3	OH	3	Belize	1

> Many attendees applauded the opportunity to share experiences from their home unit with other participants and to build a professional network as they move forward in their careers.

Building Each Workshop

In building the curriculum, there are certain core subject areas, such as burn plans, the role of the agency administrator, and interagency collaboration, but the final agenda and discussion topics are determined after a discussion with attendees on the first day of the workshop. Each participant submits a list of five expectations for the training; additionally, a portion of the first full day is spent gathering more input on attendees' specific needs and expectations. The cadre then works to incorporate those requests into curriculum. Jim Ozenberger, deputy district ranger on the Hiawatha National Forest, commented, "PFTC continually sought students' expectations and developed their curriculum around those expectations. We met and exceeded all of our expectations." Keith Lannon, district ranger on the Cherokee National Forest, stated, "I was impressed with the staff's ability to modify the course schedule on the fly to meet the needs of the participants."

The relaxed atmosphere of the presentations, discussions on topics of interest, and the mix of classroom and field activities promote active participation. In addition, cadre group leaders rotate through groups each day during field exercises and change the makeup of the groups to encourage interaction among the participants in a personal setting. Many attendees applauded the opportunity to share experiences from their home unit with other participants and to build a professional network as they move forward in their careers. The focus on interagency cooperation highlights similarities among the various agencies, as the majority of the attendees work from the same burn plan template in the new Interagency Prescribed Fire

Planning and Implementation Guide in Forest Service Manual 5100 (2008).

Addressing Agency Administrator Training Needs

This workshop has been sanctioned under the Forest Service Manual, Chapter 5140.7.2, to qualify as the line officer training requirement for approving prescribed fire plans. For U.S. Fish and Wildlife Service line officers, this workshop meets the Interagency Standards for Fire and Fire Aviation Operations for line officer and agency administrator training for approving prescribed burn plans. Other Department of the Interior agencies are considering recommending this training for staff who approve prescribed fire plans as well. Mandatory or not, the workshop offers a unique, interactive curriculum that diversifies and strengthens any line officer's skills.

Training is also tailored to address the specific training needs of agency administrators. While no two workshops contain exactly the same material, recurring themes include: understanding the elements of the burn plan and the Go/No Go checklist, the roles and responsibilities of the agency administrator in managing a successful fuels management program, ways to gain and maintain public acceptance and support for prescribed fire use, and understanding agency and personal risks and liabilities associated with prescribed fire programs and how to mitigate them.

Taking It to the Field

Emphasis in the weeklong workshop is on practice. "This is a model training program. The hands-on experience of burning is a powerful example of learning by doing," said John Fry, chief of resource management at Cumberland Island National Seashore, after participating in two burns during the 2011 workshop. Though weather always has an impact on what type of field activities are possible, the workshop endeavors to include burn planning and live-fire operations to the greatest extent possible.

Participants conduct pre-burn planning during 2010 workshop at Wekiwa Springs State Park, FL. Photo: Greg Seamon, The Nature Conservancy.

Chad Hudson, district ranger on the Ocala National Forest, and Jeff Rivera, district ranger on the Apache-Sitgreaves National Forest, pause during the prescribed burn at Blackwater River State Forest, FL, in 2011. Photo: John Fry, National Park Service.

Over the years, the workshop has conducted live-fire exercises with a number of cooperators, including the U.S. Fish and Wildlife Service, the Forest Service, the U.S. Department of Defense, the National Park Service, the Florida Division of Forestry, Florida State Parks, and the Georgia Forestry Commission. The center ensures that all cadre are red-carded at crew boss or higher levels, and participants are escorted by staff members wherever they go along the fireline. All participants are required to wear full personal protective equipment (PPE) for these exercises.

"As an agency administrator, I now have a better idea of what to look for in a burn plan when I review it and what to expect on burn day."
—Donna Peterson, Deputy Superintendent, Papago Agency

One field day is spent burning with a cooperator and focuses on ignition techniques to meet ecological objectives. Participants have the opportunity to drag a torch along the perimeter or within a burn unit and experience operations from the point of view of the fire staffs on their home units. Another day, participants fill the overhead role (burn boss and firing boss) on a prescribed burn: they are required to make ignition decisions for the burn—usually a small, low intensity burn with a 1- to 2-year rough. Participants have a "safety net" of experienced staff for support but are expected to communicate with other students and direct the operation themselves. As Tina Lanier, district ranger on the Lewis and Clark National Forest, expressed: "I thought this was by far the best fire training and one of the best line officer training sessions I've been through. The course structure of building from the ground up was a very effective way to learn. It helped me put in perspective and see the big picture."

Other field days have been spent visiting line officers and fire staff in existing programs and discussing how to run an effective prescribed fire unit. As a result of such discussions, "I feel much more comfortable with burning and the issues associated with it, especially risk management and how to mature a burn program," said Tobin Roop, superintendent at Salinas Pueblo Missions National Monument.

Classroom Discussions and Activities

Back in the classroom, one valued roundtable discussion examines prescribed fire case studies from around the country. These case studies highlight the role of the agency administrator and the actions they took. As Donna Mickley, district ranger on the Rogue-Siskiyou National Forest, stated, "There is nothing more valuable than the real-life scenarios the cadre was able to share with us. Those are the most teachable moments."

Gloria Nielsen, district ranger on the National Forests of Alabama, ignites a prescribed fire on Ocala National Forest at the 2010 workshop. Photo: Greg Seamon, The Nature Conservancy.

An extension of this discussion is a half-day of sandtable role-playing exercises. The activity is focused on the role of the agency administrator as it evolves over the course of the simulated operation. Rondi Fischer, district ranger on the Monongahela National Forest, accurately captured the views of the majority of participants when she said, "I hate role playing exercises, but this one was so well-planned and well-facilitated that I really enjoyed it and got a lot out of it." Participants rotate through three different roles: agency administrators, observers, and outside influencers. Half of the workshop participants engage in the sandtable exercise at one time. This group is separated into three smaller groups at the beginning of the scenario. One group will begin as agency administrators involved in a prescribed fire and may fill the role of a district ranger, forest supervisor, fire staff officer, regional forester, etc. A second group will observe the decisions made by the administrator group and discuss those actions among themselves. The third group plays the roles of outside influencers such as media representatives, elected officials, recreation users, etc. This group interacts with the administrator group. Cadre fill the roles of burn boss, crew, dispatch and scenario facilitators. Each group rotates through each set of roles. There is a brief discussion of what took place prior to each rotation and a longer after action review at the conclusion of the exercise.

Simultaneously with the sandtable exercise, the other half of the group participates in a discussion of unit burn plans. Prior to training, each attendee submits a burn plan from their home unit for discussion, a group of cadre members reviews the burn plans, and the merits and weak points of each are discussed.

Wrap-up

As part of an internal assessment, organizers gather and analyze responses from attendees at the conclusion of every workshop. The attendees typically express a better understanding of agency administrator responsibilities regarding prescribed fire, a greater appreciation for the components of a burn plan, an opportunity to build professional relationships, and increased confidence in implementing and guiding a successful prescribed fire program.

Linda Jackson, District Ranger on the Prescott National Forest, summed up her training by saying, "this was the best line officer workshop I have attended in my 7 years as a line officer. This was well worth attending and I will highly recommend it to others." Other positive comments came from Drew Milroy, natural resource manager at Westover Air Reserve Base, who said, "If there is a secret, executive level list of best Federal courses, this one should be on it." Anne Morkill, project manager for the Florida Keys National Wildlife Refuges, added "This course gave me the knowledge and the confidence in managing a complex fire management program on my refuge and to demonstrate that confidence to my staff and the public." "Absolutely one of the best courses I have ever taken in 22 years with the Forest Service," stated Jerry Ingersoll, deputy forest supervisor on the Humboldt-Toiyabe National Forest. "The course provided a mix of lecture, discussion, hands-on experience, modeling, and role playing that could not have been better designed or implemented anywhere."

Though this workshop requires a commitment of 9 days (including travel), participants report that the knowledge and experience they gained made it worthwhile. Lori Wood, district ranger on the Dixie National Forest, said simply, "Every line officer would benefit from this workshop." ■

"This is a model training program. The hands-on experience of burning is a powerful example of learning by doing,"

A group of participants in the 2010 workshop study a prescribed burn scenario in a sandtable exercise. Photo: Mike Dueitt, U.S. Fish and Wildlife Service.

2004 workshop attendees on a field trip to Panther National Wildlife Refuge, FL, discussing post-fire monitoring and meeting burn objectives. Photo: Prescribed Fire Training Center.

West Fire Pre-Fire Defense Planning

Derrick Davis

The West Fire in unincorporated Kern County, CA (located approximately 100 miles (160 km) north of the city of Los Angeles), provided clear lessons in the value of fire planning and preparation. Although the fire resulted in some loss and damage to structures and to the watershed, fuelbreaks and firesafe zones created prior to the fire served to limit the spread of the fire and the loss of property within the fire boundaries.

The West Fire burns in dense piñon pine fuels. Photo: Nick Smirnoff.

The Fire

The West Fire started on July 28, 2010, at 14:14 hours. The fire was human-caused and started along Blackburn Canyon Road 3 miles south of Highline Road (fig. 1). Units arriving first reported a fast-moving vegetation fire, 1–2 acres (0.4–0.8 ha) in size, with an immediate structure threat. Within the first 15 minutes, the fire was exhibiting extreme fire behavior, with moderate-duration crown runs and spotting 0.5 mile (0.8 km) ahead of the main fire and around several structures. The fire was burning in a northerly direction, down-canyon, which is not typical behavior for this area, as the typical wind pattern is west-to-east. The fire cut off one-way access roads into the fire area to emergency equipment.

The Community

Old West Ranch is a community located southeast of the town of Tehachapi, west of Willow Springs Road, and north of Oak Creek Canyon. It comprises between 150 and 200 residences. Of these, approximately 60 are considered full time residences and the rest are used part-time by vacationers. The elevation of the topography at Old West Ranch ranges from 4,500 to 6,800 feet (1,372 to 2,073 m).

The community itself is considered a rural community. In fact, only a small portion of the residences have access to metered services (i.e., water, electricity, cable, and phone). The road system is unpaved, primarily dirt, and not much wider than one lane in most areas.

The vegetation types range from oak woodlands in the lower elevations to a scrub oak–piñon pine and grey pine fuel type higher up. Fuels in this area are very dynamic due to the heavy mortality rate (over 40 percent) in the piñon–grey pine stands, and, on average, the fuel loading is in excess of 100 tons per acre (224 metric tons/ha). Other than a small lightning-caused fire

> The CWPP identified Old West Ranch as one of the areas at risk, and, in the next several years, many hours were spent mapping potential wildfire areas and planning strategic vegetation management projects in preparation of a potential wildfire event.

Derrick Davis is a captain in the Air and Wildland Division of the Kern County Fire Department, Kern County, CA.

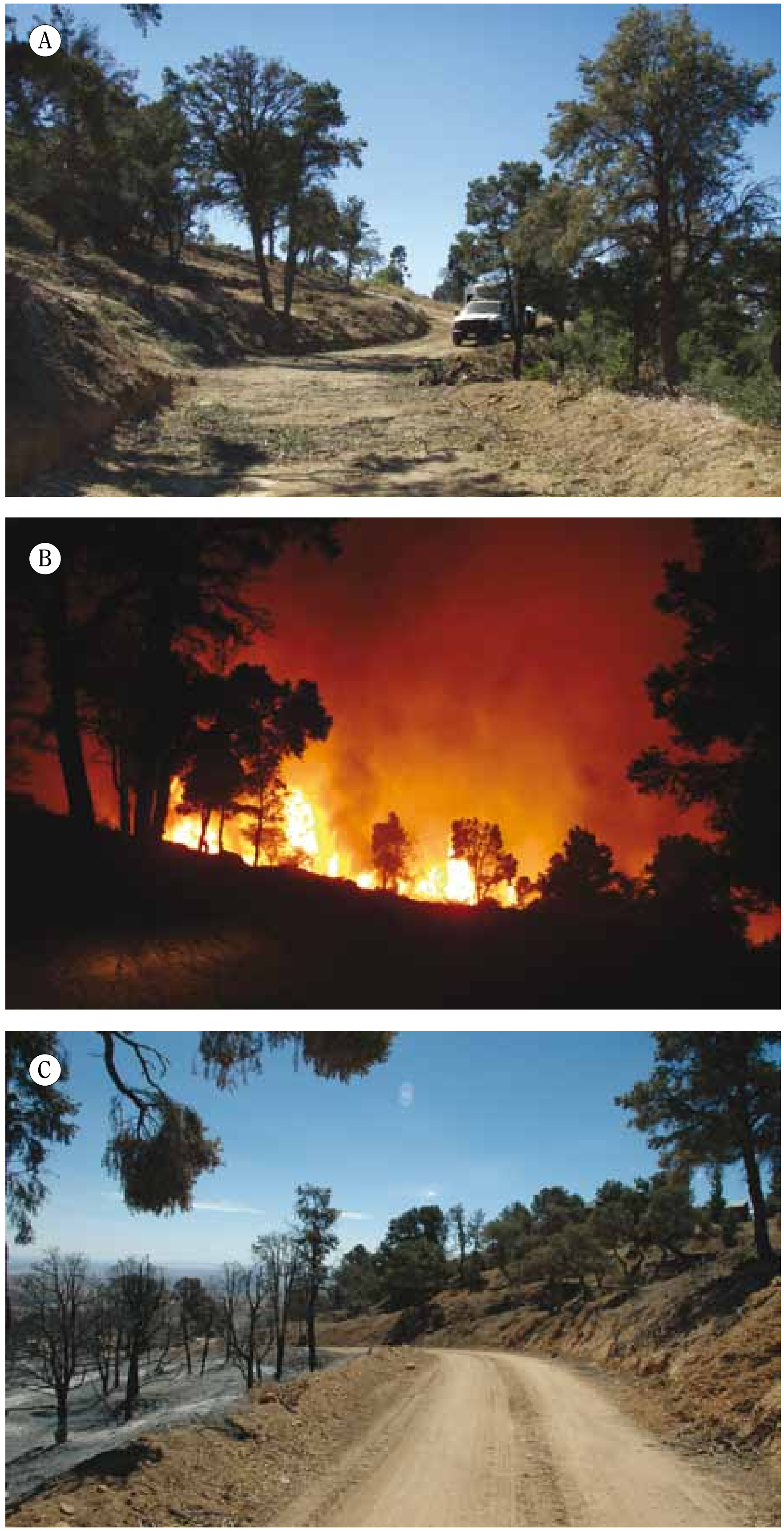
in 2005, the area had no recorded fire history in over 110 years.

Preparation for a Potential Fire

The prefire management process has been ongoing in Old West Ranch for several years. In 2006, the Kern County Fire Department, along with the U.S. Department of the Interior, Bureau of Land Management and the Greater Tehachapi Fire Safe Council, developed and adopted a community wildfire protection plan (CWPP). The CWPP identified wildland-urban interface areas and created mitigation plans to reduce the threat of wildfires to county communities. The plan identified Old West Ranch as one of the areas at risk, and, in the next several years, many hours were spent mapping potential wildfire areas and planning strategic vegetation management projects in preparation of a potential wildfire event.

Vegetation Mapping and Clearing

Vegetation management projects within the community of Old West Ranch began in 2004 with the first grant to the local Fire Safe Council. Kern County Fire Department crews spent the next two summers clearing overgrown vegetation along the major access roads in the community as part of a project called the Blackburn Canyon Escape Route. The project involved removing dead and overgrown vegetation, limbing up existing live trees, and removing dead trees within 25 feet (7.6 m) of the road on both sides. The object of this project was to reduce the fuel buildup along the side of the access roads to allow the residents a safe way to evacuate the community in the event of a fire and allow emergency vehicles a safe way into the area.



The fuel break helped suppression efforts in the West Fire: (a) a section of the fuel break before the West Fire; (b) the fire burns toward a section of the break during the night; and (c) the fire was contained at a treated section of road. Photos: Derrick Davis.

In 2010, another grant funded the Blackburn-Mendiburu project. This project cut a 150-foot-wide (46 m) shaded fuelbreak along Wildhorse Ridge to the south of the community of Old West Ranch, a distance of 10 miles (16 km). Kern County Fire Department crews, with the help of a fuel masticator, were able to complete the majority of the clearing in 12 weeks.

Both of these projects proved effective in subsequent efforts to control the West Fire. The shaded fuelbreak along Wildhorse Ridge stopped the southern progression of the fire with no reinforcement, and the escape route project proved to be invaluable in the safe evacuation of residents and the safe access of emergency equipment to the fire.

Dip-Tank Installation

Realizing that the nearest water source for aircraft was greater than 5 air miles away, planners decided to have dip tanks installed in the project area. The dip-tank program began in 2005, when several old tanks used for water storage were donated to the Kern County Fire Department. The fire department's Air & Wildland Division had the tanks refabricated so that helicopters could dip water out of them for firefighting. Several months of planning went into the strategic placement of the tanks; communities and areas that had no water accessible for aerial fire suppression were given first priority. In 2006, two tanks were placed into service within the community of Old West Ranch: one on the north end of the community, at a glider port, and the other at the east end of the community, along Wildhorse Road.

Realizing that the nearest water source for aircraft was more than 5 air miles away, planners decided to have dip tanks installed in the project area.

Placement of water tanks throughout the area helped to concentrate helicopter operations effectively. Photo: Derrick Davis.

Water tanks were placed to make reloading safe for the equipment involved in operations. Photo: Derrick Davis.

Area Mapping

The Kern County Fire Department developed a process of wildland prefire mapping to provide accurate information to emergency responders from out of the area. The detailed maps include color-coded roads, the type of engines suited to each road, the locations of useable water sources (i.e., water tanks, ponds, pools, and hydrants) and their capacity, water refill rates, and the type of fittings required to tap the water sources. These maps also show the location of structures, with accurate addresses, existing safety zones, and any other specific information that would be needed during structure defense (fig. 1).

Post-fire maps helped analyze the role of fuel breaks in fire suppression efforts and in areas where fuel breaks slowed the fire's progress (fig. 2).

Building Defensible Space

The presence of defensible space was the key to structure survivability during the West Fire. During initial attack, firefighters were battling an intense, fast-moving wildfire, with flame lengths in excess of 150 feet (46 m) and numerous spot fires 0.25 to 0.5 miles (0.4 to 0.8 km) ahead of the main fire. There was no established water system in the community, so limited water supply, extreme fire behavior, and spot fires made it difficult to adequately defend all structures. Kern County Fire Department enforces California Public Resources Code, Section 4291 (PRC-4291), which requires that all structures have a minimum buffer of 100 feet (30 m) of defensible space around them.

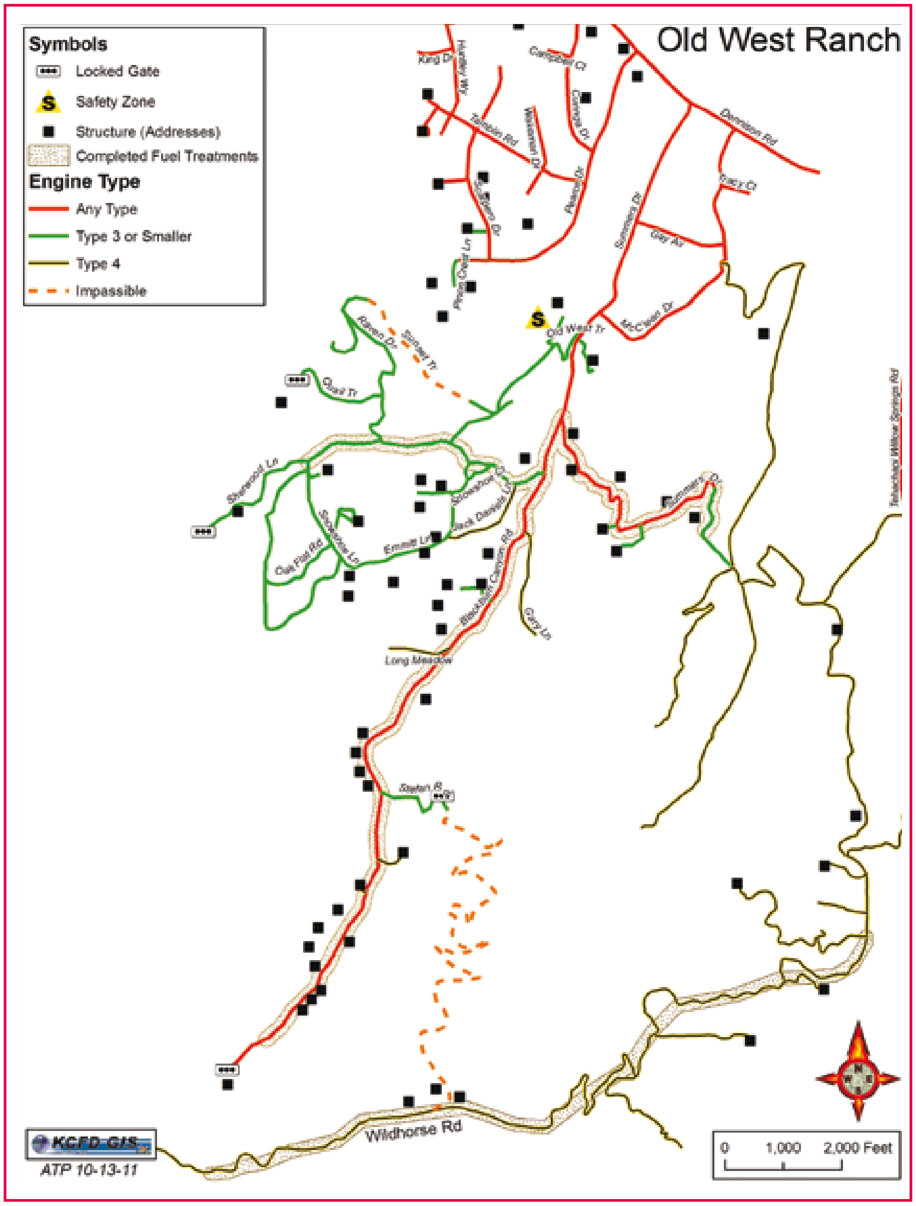


Figure 1— *Maps were created to guide access throughout the mitigation area and identify the location of structures.*

In this case, this minimum proved to be adequate in some areas and insufficient in others due to the intensity of the fire.

Defenses Put To Use

Once the fire broke out, responders realized that the road situation was the biggest issue because there was only one way in or out of the canyon. Without the brush clearing project, the roads would have all been compromised and would not have allowed safe access for emergency responders.

The fuel break along the ridge stopped a crown fire through piñon pine with no resources in place. As a stand-alone fuel break, it performed as hoped.

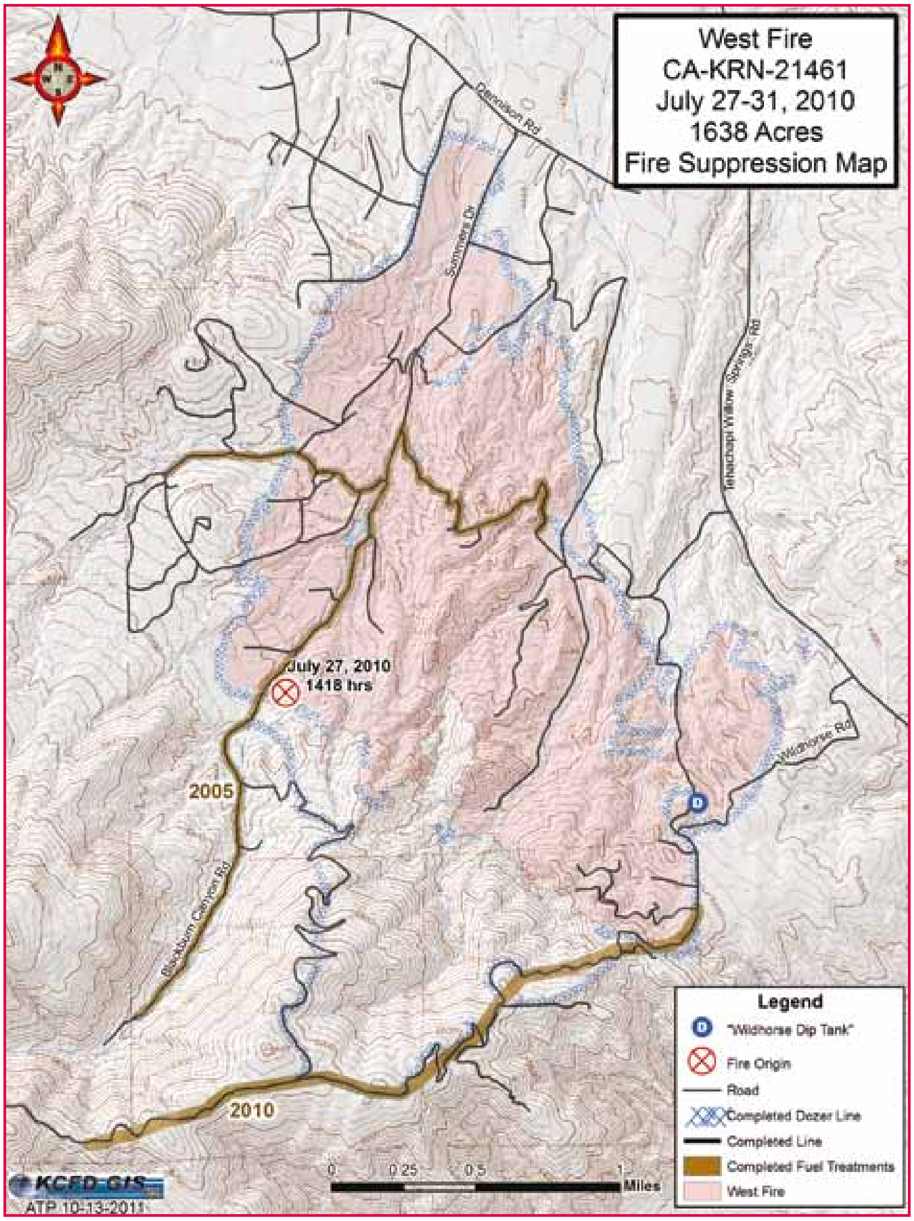


Figure 2— *A fire map indicates the location of fuel breaks (orange areas along roads) and water sources.*

> The detailed maps include color-coded roads, the type of engines suited to each road, the locations of useable water sources (i.e., water tanks, ponds, pools, and hydrants) and their capacity, water refill rates, and the type of fittings required to tap the water sources.

Residences throughout the fire area suffered from the density of fuels and fire intensity. Due to the extreme fire behavior, even some residents who had completed hazard reduction on their property lost their homes. The houses that survived belonged to owners who had gone above and beyond the minimum requirements outlined in PRC-4291.

Conclusions

The West Fire proved to be challenging in many ways, yet the role and value of fire planning was evident throughout. The ability of fire suppression forces to limit the size of the West Fire and the damage caused by the fire reinforced the importance of:

- Interagency collaboration and participation;
- Community and Fire Safe Council partnership;
- Planned vegetation management;
- Preestablished dip sites for helicopters;
- Community prefire mapping;
- Adequately staffed fire crews and the effective use of helicopters and dozers; and
- Defensible space appropriate to nearby fuel loading conditions.

It is not possible to anticipate where and when a fire will occur, but it is possible to assess where severe fire behavior might result from an ignition. These are areas that merit fuels treatment and other preparations. A commitment to planning and mitigation measures proved well-placed in the Old West Ranch community. ■

Knowledge Exchange for Fire Research: A Two-Way Street

Elise LeQuire

The best available science is of little use if it gathers dust on the shelves of library stacks or is deeply embedded on an obscure Web site. A key part of the Joint Fire Science Program (JFSP) mission is to ensure research on wildland fire science is readily available to practitioners in a useful format so it can help support sound management decisions. The JFSP has made great inroads in this arena on a national level, but managers short on time often have to sift through an overload of information that may not be specific to their region. In the next few years, the JFSP wants to break the conventional mold of science delivery by creating ecologically coherent, regionally based consortia and encourage practitioners to take part in driving the research agenda. The key to the program's success is establishing mutual trust between scientists and managers and opening pathways of communications that run both ways.

The JFSP is firmly established as a driver of fire-related research. Since the JFSP was formed in 1998, the number of completed projects has accumulated. By 2007, the JFSP had funded more than 350 projects on wildland fire science research, and between 1998 and 2005 the JFSP had invested more than $100 million in fire-related research projects, according to a 2007 report to the JFSP by Jamie Barbour, focused science delivery program manager for the Forest Service Pacific Northwest Research Station, titled "Accelerating Adoption of Fire Science and Related Research."

Barbour writes that the JFSP "has long recognized that investments made in fuels management and wildland fire science need to be accompanied by science interpretation and delivery." Since its inception, the JFSP has funded projects with a strong technology-transfer component. That original commitment to information exchange between scientists and practitioners received an even stronger boost in 2008, the 10th anniversary of the JFSP, which was marked by a thorough program review. "The 10-year review was positive," says John Cissel, JFSP program manager. "Everybody, including Congress, likes what we are doing."

A key part of the Joint Fire Science Program (JFSP) mission is to ensure research on wildland fire science is readily available to practitioners in a useful format so it can help support sound management decisions.

One of the review team's primary recommendations was to spend more energy and resources on fostering a two-way communication process between scientists and those who ultimately benefit from knowledge gained: the practitioners who apply fire science on the ground. This would entail spending more energy and resources on delivery and adoption activities. "We needed a boost in our allocation for delivery and to push it closer to the ground, expanding existing partnerships, and improving our effectiveness by building on those groups," says Cissel.

To achieve these goals, in its 5-Year Investment Strategy announced in August 2009, the JFSP Governing Board outlined a roadmap to increase funding for science delivery. As a result, delivery and outreach investments have nearly tripled and represent one-quarter of the total JFSP budget.

Barbour's report and another 2010 report submitted to the JFSP by Vita Wright, science application specialist at the Forest Service Rocky Mountain Research Station, "Influences to the Success of Fire Science Delivery: Perspectives of Potential Fire/Fuels Science Users," suggest that new strategies are needed to increase adoption of the best available science. The JFSP has responded with a plan of action to improve on traditional means of getting information into the hands of users. The plan involves breaking the conventional mold of communication roughly based on the traditional teacher/student relation-

Elise LeQuire is a freelance science and environmental writer based in Maryville, TN, and a frequent contributor to publications of the Joint Fire Science Program.

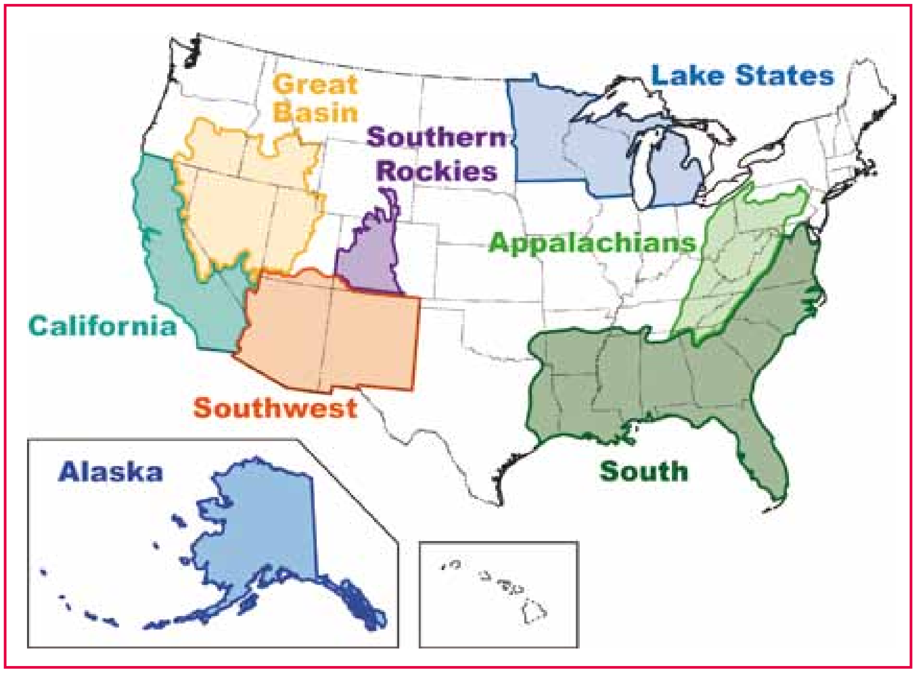
ship: a teacher standing in front of a class and teaching the students. Instead, the ultimate customers, the managers, should drive the research agenda, and not vice versa, and knowledge exchange should be a two-way street with feedback loops and open communication channels that can be forged only in an environment of mutual trust, honesty, and respect.

In response to the 10-year review, and in light of the budget priorities of the Governing Board, in August 2009, the JFSP solicited proposals for the development of several regionally based consortia, defined by coherent ecological boundaries. In the first phase of funding, eight were chosen: Alaska, the Appalachians, California, the Great Basin, the Lake States, the Piedmont and Southern Coastal Plain, the Southern Rockies, and the Southwest. Six additional consortia are currently under consideration.

"We are banking on the consortia to be a primary avenue for information dissemination," says Paul Langowski, vice-chair of the JFSP Governing Board. "The initial efforts of the first eight consortia were so well received by the management and science communities that the board decided to solicit proposals for additional consortia in 2010 rather than wait until a formal evaluation of the initial consortia."

Information Overload

"We get a firehose of information, and it's often delivered with the fognozzle on." That comment from one practitioner aptly captures the reaction of managers to the amount of information that bombards them.



The Joint Fire Science Program has initiated eight regional consortia, defined by ecological boundaries, for the purpose of improving communication and exchange of information between scientists and managers.

The Joint Fire Science Program: Research Supporting Sound Decisions

In 1998, the U.S. Congress, with the support of the Administration, provided funding authority to support the aggressive use of fire and mechanical fuels treatments with the goals of reducing the occurrence of uncharacteristically severe wildland fires and improving ecosystem health. At the time, Congress directed five agencies within the U.S. Department of the Interior—the Bureau of Land Management, the Bureau of Indian Affairs, the National Park Service, the Fish and Wildlife Service, and the U.S. Geological Survey—and the USDA Forest Service to establish a Joint Fire Science Program (JFSP) to supplement existing fire research capabilities. The program was designed to provide a scientific basis and rationale for implementing fuels management activities, with a focus on activities that will lead to development and application of tools for managers. To meet the needs of its partners, the JFSP has a mission to identify and meet information and technological support needs for wildland fuels management programs across these diverse agencies.

Regional consortia can help redirect the stream of information by using ecologically, rather than administratively, coherent boundaries, organized according to reasonable geographic and vegetation areas. "The consortia act as filters to weed out information that is not relevant to different ecoregions," says Tim Swedberg, JFSP communication director. "Filtering creates a trusted conduit that vouches for the information and delivers it in the best way possible."

"Our experiences with roundtables and road shows showed us that the local and regional interactions provided opportunities that we could not provide at a national level," says Langowski. "The regional consortia will help us ensure those connections for the future."

Breaking the Communication Barrier

Information overload isn't the only barrier to effective communication. Language barriers among the different cultures of academic researchers and field practitioners, with their different conventions and dialects, can inhibit open pathways of communication. Quite often managers and scientists actually agree on a concept but get hung up on vocabulary.

Active knowledge exchange involves a kind of courtship phase between scientists and managers. "Passive delivery is a science push. If the managers are dictating what they need, it becomes a pull," says Swedberg. "We are trying to foster a dialogue where scientists and managers help frame problems together." Foresters, for example, might use a technical term such as basal area, which is used to determine the volume of timber on a site. Wildlife biologists, on the other hand, might describe the need for clumping trees together to enhance habitat. By directly viewing a project together, on site, members of both cultures may discover that they are describing the same essential concept using a different vocabulary.

Delivery and outreach investments have nearly tripled and represent one-quarter of the total JFSP budget.

When Cultures Collide

The engines of university research are geared to promote prolific publication of peer-reviewed articles. The JFSP is unusual among granting agencies in that a large portion of its financial support is dedicated to activities that communicate the results and relevance of research projects to fire specialists and resource managers through workshops, presentations at meetings, demonstration sites, and other forms of outreach to managers and the general public. In addition, scientists and managers from the various agencies are often members of the research team, which can, in the best case scenario, allow management-driven research and ultimately adoption.

There are other barriers in getting the science to the end users, including the way research is funded. Research scientists are often under great pressure to complete a project while securing funding for their next one, which leaves little time for communicating research to managers and the public. Moreover, money or time is rarely budgeted for presentations outside the academic community. "The people on the ground don't attend scientific conferences," says Mike Babler, principal investigator (PI) for the Southern Rocky Mountain Ecoregion.

Prescribed burning in Florida's upland pine forests. The Southern Fire Exchange regional consortium includes fire-dependent yellow pine ecosystems that have been managed with fire much longer than other forested ecosystems in the South. Photo: Larry Korhnak, Univeristy of Florida.

Time and Space Constraints

In-person meetings, whether field trips, workshops, or conferences, are considered key components of consortia activities: these one-on-one encounters help cement personal relationships among participants and can lead to cooperative interaction confirmed with a handshake…or pave the way for informal phone calls. Limited time, meeting fatigue, and budget limitations, however, often make frequent meetings impractical. Personal and professional contact can be augmented by using new social media and by capitalizing on existing Web sites to offer a central resource where information can be accessed quickly.

Topical webinars can be convened in real space and time, transmitted for participants seated at their office or home computers, and archived for later viewing by those unable to attend at the appointed time. Several consortia are creating blogs and online discussions through their Web sites. Some are implementing an "ask an expert" corner where managers can find quick answers from a specialist in their area. Newsletters announcing research news or webinar topics can be dropped directly into a subscriber's email inbox and are being adopted by most of the consortia.

In the organizational phase, each consortium used feedback from constituents and partners through formal and informal surveys, questionnaires, personal interviews, and phone calls to help decide how best to utilize the new media, existing strengths, and history of regional partnerships to achieve goals. Also, the consortia were given free rein to devise unique approaches and encouraged to think outside the box. While all consortia face similar challenges and are adopting similar approaches to address them, each one has also forged a variety of tools tailored to achieve specific needs and build upon the existing partnerships and resources in their areas.

Regional Consortia

The Appalachians

The geographic area of the Consortium of Appalachian Fire Managers and Scientists (CAFMS) encompasses the central and southern Appalachians, stretching south along the Eastern Continental Divide from Pennsylvania to Georgia and Alabama. Due to their ancient age, the forces of erosion over millions of years, and repeated glaciations, the Appalachians are home to some of the most ecologically diverse and sensitive species on the planet.

Compared to western regions and the Southern Coastal Plain, and despite a strong tradition of people using fire to shape the landscape before and after European settlement, fire science in the Appalachian region is relatively new. "Most fire science programs in the Appalachians didn't get started until the mid-1980s," says Tom Waldrop, CAFMS PI and research forester with the Forest Service, Southern Research Station. Fire in the Appalachians is also a very complex grouping of different species, different fuel loads, different moisture regimes, and complex fire behavior, says Waldrop. One high priority for the consortium is understanding how smoke behaves when prescribed fire is ignited from multiple points.

The Appalachian consortium is building on a number of existing networks. The backbone of the consortium is the U.S. Fire Learning Network (FLN), which includes the Appalachian FLN and the Southern Blue Ridge FLN. These FLNs are supported by the National Fire Plan through a conservation partnership forged in 2007 among The Nature Conservancy, the Forest Service, State agencies, and private landowners. These networks are part of a national effort to demonstrate research results to the public and other managers through specific demonstration projects. The FLN has been primarily driven by managers with extensive practical experience who are good at finding innovative ways to use fire in the landscape. The consortium wants to encourage technology transfer between these experienced managers and fire scientists from area universities, the Forest Service Southern and Northern Research Stations, and other State and Federal cooperators.

For more information, visit <http://www.cafms.org/>.

Piedmont and Southern Coastal Plain

The Southern Fire Exchange (SFE) spans 11 States in the southeastern Piedmont and Coastal Plain from Virginia to Texas. This region includes fire-dependent yellow pine ecosystems that have been managed with fire much longer than other forested ecosystems in the South. In addition, there are pockets of distinct vegetation communities, including wetlands embedded within a pine-dominated landscape. When the accumulated organic soils burn, they can create long-duration smoldering fires with significant smoke emissions, says Leda Kobziar, PI with the SFE and assistant professor of fire science and forest conservation at the University of Florida, Gainesville.

A high priority of landowners and forest managers in the region is more research on smoke modeling and weather forecasting targeted to the specific conditions of the region, where smoke and fog combined—so-called "superfog"—can reduce visibility on highways to zero, leading to smoke-caused accidents. Existing smoke models need further testing and validation for accuracy in coastal areas where smoke may either blow out to sea or inland, depending on sea breezes. "We need to support the development of modeling science, improve its accuracy, and connect the users to those who are designing the models," says Kobziar. "We need to do a better job of predicting where the smoke is going to go."

For more information, visit <http://www.southernfireexchange.org/>.

The Lake States

The northern Lake States of Michigan, Minnesota, and Wisconsin are divided into three ecological provinces: Prairie Parkland consisting of prairie and forests, Laurentian Forest with mixed conifer and deciduous forests, and Eastern Deciduous Forest. Nearly 30 percent of the forested area is considered fire-dependent, including jack pine, mixed red pine, and eastern white pine; peatland forest ecosystems; and less common types such as coastal pine and sedge-dominated wetlands. "The Lake States Fire Science Consortium will focus most of its efforts on these fire-dependent systems," says Charles Goebel, PI for the consortium and associate professor in the School of Environment and Natural Resources at Ohio State University.

The Lake States consortium is planning a guidebook that will be based on 1- to 2-hour interviews with leaders across the region. During the planning stage, consortium organizers recognized that a great deal of substantial knowledge on fuels, prescribed fire, and management is not readily available if it is published at all. Much of the knowledge resides in the memories of professionals who may be close to retirement. Transcripts of the interviews will be posted online and eventually distilled into a guidebook of expert knowledge available on the consortium Web site.

For more information, visit <http://www.lakestatesfiresci.net>.

Southern Rockies

The Southern Rocky Mountain Ecoregion (SRME) Consortium comprises a distinct ecoregion, with mountains ranging in elevation from 3,700 to 14,400 feet (1,100 to 4,400 m) across four zones: alpine, subalpine, upper montane, and lower montane/foothill. The geographic scope, which includes Colorado and south-central Wyoming, was defined using The Nature Conservancy's ecoregional conservation approach as outlined in Designing a Geography of Hope: A Practitioner's Handbook to Ecoregional Conservation Planning (Groves et al. 2000)."The Nature Conservancy takes a non-confrontational approach, partnering with landowners and public agencies," says Mike Babler, PI for the consortium and Colorado fire initiative program manager with The Nature Conservancy.

The SRME is counting on support from a number of existing organizations in the region with a history of working together. For example, the Front Range Roundtable was formed after the 2002 fire season, which included the Hayman Fire, the largest fire in recorded history in Colorado. The roundtable is a collaboration of 30 entities from Federal, State, and local agencies; scientific institutions; and community and environmental groups. "There is a lot of information on the ecosystems of the Front Range and a high degree of interest because of the large population affected by wildfire," Babler says. "We want to make sure these conversations are based on the best available science and to raise awareness of forest health and public safety by engaging the public in management decisions.

For more information, visit <http://www.srmeconsortium.org>.

The Southwest

The boundaries of the Southwest Fire Science Consortium (SWFSC) are defined ecologically as the biotic communities of the Southwestern United States, including Arizona, New Mexico, and southern Utah. From desert scrub to high-elevation alpine tundra, a total of 20 biotic communities are found in the region, which is diverse both ecologically and culturally, with a large portion managed by tribal nations in addition to State and Federal agencies.

Fire regimes in the area are likewise diverse, ranging from forested systems, such as ponderosa pine that evolved with frequent fires, to sensitive desert systems where fire was historically not a significant part of the natural landscape. "Fires could burn every year in a system not designed to burn at all and which has very few adaptations to fire," says Andrea Thode, consortium PI and associate professor at the Northern Arizona University School of Forestry.

The consortium is collaborating with the nationally based Wildland Fire Lessons Learned Center (LLC), <http://www.wildfirelessons.net/Home.aspx>. The LLC is a multiagency effort to document and archive information on past experience in fire management in a variety of media, from written case studies to video interviews with managers who explain what went right or wrong in a particular situation. The consortium will partner with the LLC to create products tailored to the needs of fire managers in the Southwest. The aim is to ensure that the accumulated wisdom of seasoned personnel remains available over the long term for the benefit of younger and less experienced professionals.

For more information, visit <http://www.swfireconsortium.org>.

Alaska

With an area of 586,400 square miles (1,519,000 km^2), Alaska is the largest and the most sparsely populated State in the country. Ecologically, Alaska has more in common with northern Canada than with the 48 contiguous States; both encompass large areas of boreal forest and tundra situated in high latitudes. In addition, while climate change is a global concern, these northernmost regions of North America are already feeling the heat from a warming climate.

"The effects of global warming are more pronounced in northern latitudes and are occurring more rapidly than in other parts of the planet," says Sarah Trainor, PI with the Alaska Fire Science Consortium and research assistant professor in the School of Natural Resources and Agricultural Sciences at the University of Alaska, Fairbanks (UAF). Since the 1950s, Alaska has registered a 3.4° F rise in average temperatures, and the average annual extent of burned areas is expected to double by mid-century. As a result, fire scientists and managers are already learning to deal with the effects of climate change, present and future, on fire and ecosystems in Alaska. In its research agenda, the consortium sets a high priority on gaining more and better information on how fire under a climate change scenario will affect vegetation in tundra, shrubland, and treeline ecosystems.

For more information, visit <http://www.akfireconsortium.uaf.edu>.

Saguaro cactus and buffelgrass. In some sensitive desert ecosystems, fire was historically not a significant part of the natural landscape. Photo: Government stock image.

Great Basin

The Great Basin, once known as the "Big Empty," lies within an ecological boundary that crosses the borders of five Western States in a basin and range topography. The ecosystem has been irrevocably altered by the spread of cheatgrass, introduced by settlers and still marching across the landscape today. "Our ecological boundary encompasses the largest area of cheatgrass in the country," says Mike Pellant, PI for the Great Basin Science Delivery Project (GBSDP) and coordinator of the Bureau of Land Management (BLM) Great Basin Restoration Initiative.

"Here in the Great Basin, we don't argue about the issues," says Pellant. "Everything is related ecologically, and people have been working with common boundaries and common threats for a long time."

The Great Basin Science Delivery Project (GBSDP) Steering Committee realized that the combined wisdom and experience of older scientists and managers is often lost as those people near retirement. In addition, as young scientists and managers advance through the ranks, they often transfer to other parts of the country. This turnover of young and old can disrupt the continuity of experience gained over time. The GBSDP is establishing restoration cadres by recruiting younger to mid-level people with the drive and potential to be leaders in their field and linking them with scientists and managers who, due to long-term experience, are at the mentoring level. "I am part of that generation," says Mike Pellant, PI of the consortium. "We only have a finite amount of time, so we need to find people in the right stage of their career and transfer the information and experience to the new generation."

For more information, visit <http://greatbasin.wr.usgs.gov/gbrmp/SD_about.html>.

California

California is an ecologically diverse State with a large number of distinct ecoregions, a high population density that continues to expand into fire-prone ecosystems, and rising costs of fuels treatments and fire prevention and suppression. To make the statewide approach more manageable in light of this ecological diversity and the State's size, the California Fire Science Consortium is organized with a strong central hub and four distinct ecoregions, each with their own strengths and needs: the Northern California Region, Sierra Nevada Region, Desert Region, and Central and Southern California Region. Each of these nodes has its own leader and team of scientists and managers to focus on local activities, seminars, and field outings. A fifth team is organized to address the wildland-urban interface, which is found throughout the State and is expanding due to continued development in fire-prone ecosystems.

The consortium plans to engage indigenous communities who have occupied their ancestral lands continuously since European settlement. This is not only a way to share fire management resources on tribal lands but also to provide a platform for tribes to share their own cultural history of fire with researchers. "These communities have a wealth of knowledge that we would like to share," says Tim Kline, California Fire Science Consortium coordinator.

For more information, visit <http://www.cafiresci.org/>.

A healthy Nevada rangeland. Many areas of the Great Basin no longer have the plant diversity seen in this image due to the spread of cheatgrass. Photo: Mike Pellant, Bureau of Land Management.

Positive Feedback

Though a formal assessment of the original consortia has not yet been performed, informal feedback from managers, researchers, consortium organizers, members of the JFSP Governing Board, and agencies involved in JFSP projects has been overwhelmingly positive.

Jeanne Higgins, who in addition to her role as a member of the JFSP Governing Board is a line officer of a large Federal land base and thus personally and professionally interested in implementing the latest science to manage fire, is extremely pleased at how well the effort has developed. "Connecting appropriate, applied research with land managers is critical," Higgins says.

Erik Christiansen values the "face time" the JFSP programs and researchers have afforded at the national level through its numerous outreach efforts. Christiansen, who is the past chair of the National Wildfire Coordinating Group's Fuels Management Committee and current fuels program coordinator for the U.S. Department of the Interior's Office of Wildland Fire Coordination, recognizes, however, that it's hugely impractical for all of the research results to be funneled through a national coordinating group. "The regional consortia will help to ensure that local managers and practitioners are in close contact with the researchers specializing in their local areas, and that knowledge exchange has a better chance of occurring where it truly needs to: at the local level."

Paul Langowski, JFSP governing board member and branch chief for fuels and fire ecology at the Forest Service Rocky Mountain Research Station, agrees. "No matter how good the science is, if it never gets into the hands of managers or influences the way we do business, its value is minimal," he says. "That's where we see the biggest payoff for the consortia: getting geographically relevant science into the hands of the folks who are doing the work on the ground. The consortia provide JFSP with the opportunity to do just that. We could not replicate it at the national level, no matter the funding or staffing available," Langowski says.

Suggested Reading

Barbour, J. 2007. Accelerating adoption of fire science and related research. Final report to the Joint Fire Science Program. JFSP Project #05-S-07. Available at <www.firescience.gov/projects/05-S-07/project/05-S-07_final_report.pdf > (accessed September 2011).

Groves, C.; Valutis, L.; Vosick, D.; Neely, B.; Wheaton, K.; Touval, J.; Runnels, B. 2000. Designing a Geography of Hope: A Practitioner's Handbook for Ecoregional Conservation Planning, 2nd ed. The Nature Conservancy. Available at <www.parksinperil.org/howwework/files/goh2_v11.pdf> (accessed September 2011).

The JFSP Knowledge Exchange Consortia. Available at <www.firescience.gov/JFSP_Consortia.cfm> (accessed September 2011).

Wright, V. 2010. Influences to the success of fire science delivery: perspectives of potential fire/fuels science users. Final report to the Joint Fire Science Program. JFSP Project #04-4-2-01. Available at <www.leopold.wilderness.net/unpublished/UNP127.pdf> (accessed September 2011). ■

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

Trial By Wildfire: MAFFS II Proves Effective During the 2011 Fire Season

Jennifer Jones

The objective sounds simple: build a tank system that can be installed in a military airplane to convert it quickly into a large airtanker for dropping fire retardant on wildfires. But anyone involved with the Modular Airborne Firefighting Systems (MAFFS) program will tell you that this is one of the most complex operations in wildland firefighting. Dropping even a single load of retardant from a military airplane is the result of highly sophisticated aeronautic engineering, extensive training, and intricate interagency relationships.

This process becomes even more complicated when the tank system that has been used for some 40 years has been replaced by a new and improved one; when MAFFS haven't been activated for 2 consecutive years due to below-average fire activity; and when MAFFS are deployed before scheduled training due to an early, busy fire season. That was the situation in April 2011, when military C-130 Hercules aircraft equipped with new MAFFS II units were activated to serve as large airtankers and drop retardant on wildfires burning millions of acres in Texas, Arizona, and New Mexico.

Jennifer Jones is a Forest Service public affairs specialist at the National Interagency Fire Center in Boise, ID.

The Forest Service certifies military pilots and flight crews annually to fly MAFFS missions. Wildfire missions pose unique and complex challenges for the crews. Here, a large airtanker drops water during training near Boise, ID. Photo: Kari Greer.

The MAFFS Partnership

The MAFFS program is a partnership between the Forest Service and the U.S. military that began in the early 1970s. The Forest Service maintains eight active MAFFS units and one spare unit that can be inserted into military C-130s to convert them into large airtankers. The military provides the aircraft and crews at four sites: the 153rd Airlift Wing, Wyoming Air National Guard, in Cheyenne; the 145th Airlift Wing, North Carolina Air National Guard, in Charlotte; the 146th Airlift Wing, California Air National Guard, in Port Hueneme; and the 302nd Airlift Wing, Air Force Reserve, Peterson Air Force Base, in Colorado Springs, CO. As required under the Economy Act, the Forest Service reimburses the military for all costs associated with use of the aircraft.

The Governors of California, Wyoming, and North Carolina can activate the Air National Guard Airlift Wings in their States to use MAFFS to drop retardant on wildfires burning on State lands, near structures that are threatened, or for other emergencies. The National Multi-Agency Coordination (NMAC) group at the National Interagency Fire Center (NIFC) in Boise, ID, can request the U.S. Department of Defense to activate the Airlift Wings to drop retardant on wildfires burning anywhere in the country.

NMAC considers several criteria in deciding whether to activate MAFFS, the most important of which is the availability of the contracted civilian large airtanker fleet. An interagency agreement requires MAFFS to be operational within 48 hours of being requested; however, they are typically ready to begin flying in 24 to 36 hours.

MAFFS Use

The number of MAFFS flights each year varies with wildfire activity. From 2001 to 2010, military C-130s equipped with MAFFS delivered approximately 9.1 million gallons (34.4 million liters) of retardant on wildfires, an average of about 910,000 gallons (3.4 million liters) per year (fig. 1). While that is only about 3 percent of the total amount of approximately 285 million gallons (1.087 billion l) of retardant dropped on wildfires during that time period, MAFFS are highly valuable resources because they can be used to augment the contracted civilian large airtanker fleet.

"The MAFFS partnership is very important because it provides us with surge capacity that we can use to boost wildfire suppression efforts when we have a high level of activity during western fire season," said Karyn Wood, assistant director for operations and national MAFFS liaison officer with the Forest Service at NIFC. "It also ensures that we

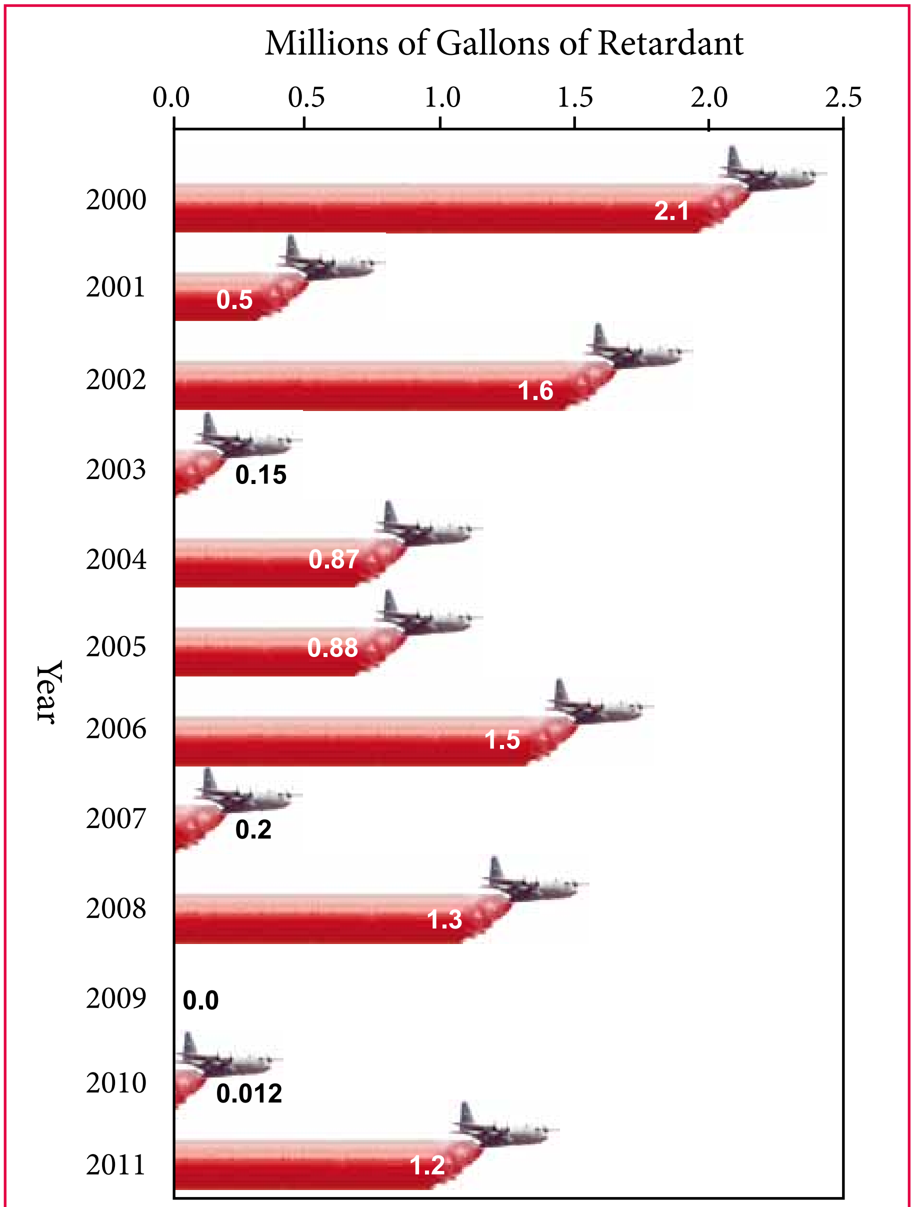


Figure 1—*Gallons of retardant dropped by MAFFS units, 2000–2011.*

have adequate large airtanker capability during the early spring and late fall 'shoulder' fire seasons."

The value of having MAFFS available during the shoulder seasons was clearly demonstrated in the spring of 2011 when Texas experienced one of its worst fire seasons in years and the biggest wildfires on record were burning in Arizona and New Mexico. The mandatory availability period for many of the contracted civilian large airtankers had not yet begun, so some of those aircraft were not available.

In April 2011, four military C-130s equipped with MAFFS were activated and sent to Dyess Air Force Base near Abilene, TX, to drop retardant on wildfires burning in that State. Two military C-130s equipped with MAFFS were also sent to Laughlin Air Force Base near Del Rio, TX, on an international mission to drop retardant on wildfires burning in Mexico. A few weeks later, military C-130s equipped with MAFFS were activated and sent to Kirtland Air Force Base in Albuquerque, NM, to drop retardant on wildfires burning in the Southwest, including the Wallow Fire in Arizona and the Las Conchas fire in New Mexico, the biggest wildfires in each State's histories.

The value of having MAFFS available during the shoulder seasons was clearly demonstrated in the spring of 2011, when the mandatory availability period for many of the contracted civilian large airtankers had not yet begun.

The flexible design of the C-130 allows it to deliver retardant precisely where needed under demanding flying conditions. Here, a C-130 delivers a load of water from a MAFFS II over open ground on a training flight in Idaho. Photo: Kari Greer.

The New Hardware

MAFFS are portable fire retardant delivery systems that can be inserted into military C-130 airplanes without major structural modifications. Military C-130s equipped with MAFFS can drop 3,000 plus gallons (11,355 liters) of retardant or suppressant per mission. Using compressed air to deliver retardant (unlike contracted aircraft that use gravity), they can discharge their entire load in under 5 seconds or make partial-load drops. Like contracted civilian large airtankers, military C-130s are guided to retardant drop sites by land and resource management agency lead planes.

The first MAFFS, known now as "legacy" systems, were developed in the 1970s. The Forest Service began the process of transitioning from the legacy systems to a new MAFFS II, several years ago, and the MAFFS II was first used to drop retardant on a wildfire in 2008. However, due to manufacturing delays and below-average fire activity in 2009 and 2010, it wasn't until 2011 that all of the legacy systems were replaced by MAFFS II.

"MAFFS II incorporate new design features and state-of-the-art technology that provide several key advantages over the legacy systems," said Scott Fisher, aviation management specialist with the Forest Service at NIFC. First of all, a MAFFS II system can be loaded on to a military C-130 in about 2 hours, compared to the 4 hours it took to install a legacy system. This enables military C-130s to start dropping retardant on wildfires sooner.

Second, unlike legacy MAFFS that used ground-based compressors to charge the propellant tanks—which limited the number of airtanker bases from which they could operate—MAFFS II include on-board compressors, which allows military C-130s to operate out of many land and resource management agency airtanker bases.

Third, MAFFS II can deliver a higher coverage level of retardant than legacy MAFFS, which enables them to be as effective in heavier fuel types as contracted civilian large airtankers. Finally, MAFFS II deliver retardant over the side of a C-130 instead of over the back ramp (as did legacy MAFFS), which decreases the amount of retardant that adheres to the airplane, reducing aircraft maintenance costs.

The People

Operating the MAFFS program requires about 80 military employees in a wide variety of jobs at the 4 Airlift Wings, including pilots, loadmasters, maintenance technicians, and support staff. Most are part-time members of the Air National Guard or Air Force Reserve who volunteer to participate in the MAFFS program. Such staffing considerations, combined with the fact that it is difficult to predict if, when, or where MAFFS will be required, makes maintaining readiness for retardant delivery a challenge.

A number of land and resource management agency employees—including incident management team members, lead plane pilots, dispatchers, and airtanker base managers—work with military personnel to conduct MAFFS missions. During activations, a MAFFS liaison officer (who functions as an air operations branch director) and other support personnel are assigned to operate coordination centers and facilitate communication between the military and land and resource management agencies.

The MAFFS II unit can be rolled into the C-130's cargo bay by way of the loading ramp at the back of the aircraft. In this view, the pipe at the operator's feet running to the right is the retardant intake line, the retardant tank is at the back, the white tank on the left is the foam injection tank, and the large, silver circular tank between the operator and the white foam tank is the pressure vessel. The delivery line is at the lower left, and the air return for the retardant tank is at the upper left. The operator's seat and control console face the delivery line. Photo: Kari Greer.

The release nozzle for the MAFFS II is located at the side of the aircraft so that the retardant avoids the turbulence immediately behind the aircraft. Photo: Kari Greer.

Training

Operation of a MAFFS-equipped C-130 requires numerous specialists, including the loading crew, flight crew, MAFFS crew, and ground control personnel. Here, the crew prepares to load the unit from outside the aircraft during training exercises. Photo: Kari Greer.

> Although military pilots, flight crews, and support personnel are highly skilled, trained, and experienced, training is important because dropping retardant on wildfires requires operating parameters that they do not typically follow.

The Forest Service certifies military pilots and flight crews (loadmasters, flight engineers, and navigators) annually to fly MAFFS missions. Certification typically occurs at an annual training session conducted in the spring at one of several suitable locations in the United States. In 2011, the training was held at Gowen Field, an Idaho National Guard installation located near NIFC in Boise, ID, and at the 146th Airlift Wing in Port Hueneme, CA.

The training includes both classroom and flight training for military and civilian pilots, flight crews, and support personnel. In one of the key components, practice training flights, military C-130s equipped with MAFFS drop water on targets in nearby forests or rangelands.

However, the training focuses not only on technical aspects of the MAFFS mission—loading the system and flying the aircraft—but also on the interaction of the military and land and resource management agencies in MAFFS operations. “The annual training provides an opportunity for the military pilots and flight crews to get back up to speed in flying this specific mission, working with lead plane pilots, and coordinating with land and resource management agency employees,” said Fisher. “It also gives support personnel a chance to get oriented in their jobs, which range from loading the MAFFS units onto the aircraft to receiving communications from dispatch and parking the aircraft.”

Although military pilots, flight crews, and support personnel are highly skilled, trained, and experienced, the training is important because dropping retardant on wildfires requires operating parameters that they do not typically follow. Military pilots normally fly C-130s at least 300 feet (91 m) above the ground, but when they are dropping retardant, they are flying at about 150 feet (45 m) above the ground. Decreasing the minimum operating altitude by 50 percent can create challenges, such as visual disorientation. The wildfire environment also contains unique hazards, such as mountainous terrain, dense air traffic, and poor visibility due to smoke, flames, and thunderstorms.

Lieutenant Colonel Kevin Harkey, a pilot with the 145th Airlift Wing in Charlotte, NC, estimates that he has flown over 100 MAFFS missions since 1994 and considers flying MAFFS missions as challenging as flying combat missions. “We’re operating the aircraft at maximum performance and pushing the limits of its capability the whole time: we’re taking off at our maximum gross weight, flying at half the altitude we usually do in mountainous terrain, and flying very slow—at close to stall speed—in an environment with unpredictable fire behavior,” said Harkey. “There’s very little room for error.”

The full deployment of the MAFFS II system after 2 years without any MAFFS flights and before annual training could have been a recipe for disaster in the spring of 2011. Instead, all of the civilian and military personnel involved in this highly complex endeavor rose to the challenge: military C-130s equipped with MAFFS II were activated six times (including one training activation and one international activation) for a total of 81 days, flying 441 sorties and dropping approximately 1.2 million gallons (4.5 million L) of retardant with no mishaps.

"This was one of the earliest times that we've been activated, and we dropped more retardant before our typical annual activation date than we usually do during an entire year," said Lieutenant Colonel Dave Condit, Deputy Commander, 302nd Air Expeditionary Group (AEG), the command element for MAFFS. "We were flying fires before and during our annual training, so we had to juggle both training and certification along with our actual fire missions."

> The new MAFFS II represents not only an advancement in technology, but also an evolution in the relationship between the military and land and resource management agencies.

A Bright Future for MAFFS II

The new MAFFS II system represents not only an advancement in technology, but also an evolution in the relationship between the military and land and resource management agencies. "We are starting to get into a new concept of operation in which we integrate more seamlessly with our interagency partners," said Condit. "I think that trend can be improved upon and continued." For example, when legacy MAFFS were in use, military C-130s had to go to MAFFS-specific bases to be reloaded. Now, military C-130s equipped with MAFFS II can go to existing agency airtanker bases that the military has certified and be loaded and dispatched by the same land and resource management agency staff as contracted civilian large airtankers.

MAFFS has been a win-win partnership between land and resource management agencies and the military for more than 40 years, and both partners believe it will continue far into the future. "We see a lot of value on the military side in that it's one of those missions we can employ to support other agency partners and the people of the United States right here in our own back yard," said Condit. With many experts predicting fire seasons to become longer and more challenging in many parts of the country due to fuel conditions, climate change, and wildland-urban interface issues, MAFFS will continue to be an important wildfire suppression resource for land and resource management agencies. ■

Wanted: MAFFS Liaison Officers!

When Modular Airborne Firefighting Systems (MAFFS) are activated, MAFFS Liaison Officers (MLOs) are sent to the bases where the C-130s are operating. They serve as a liaison between wildland fire management agencies and the military and provide guidance to the MAFFS mission.

To begin the process of becoming an MLO, find a current MLO to sponsor you and then attend an annual training session. After that, work as a trainee on a few MAFFS activations, serve as an assistant MLO for several more missions, and then become a fully qualified MLO. Experience serving in the military or working with the military is helpful, but not required, to become an MLO.

Lynn Ballard, public affairs officer on the Caribou-Targhee National Forest, served as a public information officer for MAFFS activations for several years before becoming an MLO. He believes that the most important traits for MLOs are good leadership skills and the ability to work well with other agencies.

"MAFFS is an important mission," says Ballard. "There are a lot of details to attend to as an MLO, so you work hard, but there is a lot of camaraderie and the military is a really good partner to work with."

If you are interested in learning more about becoming an MLO, contact Scott Fisher, aviation management specialist with the Forest Service Washington Office at the National Interagency Fire Center, at (208) 387-5968 or sfisher01@fs.fed.us.

Aviation Safety in a High-Traffic Operation

Jami Anzalone

The 2011 fire season in the Southwestern Region was extremely active. Several large "mega-fires" received national media attention, including the Wallow Fire in northern Arizona and the Las Conchas Fire in New Mexico. Both of these fires were the largest incidents that their respective States have ever seen. The addition of extensive firefighting air operations—up to 132 aircraft were involved in fire operations on the peak day—to existing air traffic posed many challenges and reinforced past lessons in aviation safety.

> During the fire season of 2011, near-midair collisions were a serious concern for aviation resources in the Southwest.

A Busy Sky

Airspace is complex during a typical day. Tracking military training flights, unmanned aircraft systems, commercial aviation, and general aviation requires attentive management. Adding the complication of firefighting operations makes for challenging conditions with the potential for serious consequences.

During the fire season of 2011, near-midair collisions were a serious concern for aviation resources in the Southwest. The Forest Service saw 10 reported instances of airborne aircraft in close proximity to each other. None were determined to meet the technical definition of a near-midair collision—500 feet (152 m) or closer—but each of them was worrisome.

The Forest Service aviation program has been in the process of applying the Safety Management System (SMS) to enhance aviation safety. SMS has a history of success in high-risk fields such as the nuclear power and medical care industries. Aviation worldwide has adopted SMS for air traffic, and the Forest Service is one of the leaders in the Federal service for its implementation.

There are four components to SMS: Policy, Risk Management, Safety Assurance, and Promotion. This article illustrates how each of these components applies to one particular close-call event in the course of firefighting operations during this busy fire season.

The Event

During operations, the Air Tactical Group Supervisor (ATGS), in a light fixed-wing aircraft, was over the fire providing airspace coordination for incident aircraft within the fire traffic area using an established airspace protocol that separates missions by altitude. Airtankers had been ordered and an aerial supervision module (ASM) consisting of a pilot and ATGS together in a separate twin engine fixed-wing aircraft was scouting the area for retardant drops. Two heavy helicopters were conducting water-dropping missions. A light helicopter departed its helibase with observers on board to conduct a reconnaissance of the fire area. The recon helicopter had been given a hard ceiling of 8,000 feet (2,438 m) to ensure separation with the airtankers. Initially, all of the aircraft were operating in the northeast quadrant of the fire.

In order to cross to the west side of the fire, the reconnaissance helicopter crew requested clearance to go above its designated ceiling. The ATGS gave this clearance. The helicopter crew completed its work on the west side and began to swing around the head of the fire by following the fire's edge north, then east, and finally south. The helicopter pilot contacted the ATGS and let him know of the crew's intended route back into the area where the other aircraft were working.

The reconnaissance helicopter pilot was briefed on the airtanker operations by the ATGS and asked to contact the ASM. The helicopter pilot made calls on the radio to the ASM, but did not receive a response. The ASM was briefed by the ATGS that the helicopter was coming back into the area, and that the crew would contact the ASM before doing so. When the helicopter slowly crested a ridge at 8,500 feet (2,590 m) as it continued south into the operational area, it flew into close proximity to the

Jami Anzalone is the regional aviation safety manager for the Forest Service, Southwestern Region, in Albuquerque, NM.

ASM, and both pilots changed their flight route to avoid a collision. The helicopter exited the area and concluded its reconnaissance flight.

Without quick reaction on the part of the two pilots, a collision could have occurred. But safe operations cannot depend on such responses, and the SMS was designed to deal with such situations. The following sections describe how.

Policy

Specific manuals, guides, and handbooks set forth aviation best practices and policy for different components of air operations. Recently, the Interagency Aerial Supervision Guide was adopted through interim directive as the prevailing direction for ASM and ATGS operations. The Interagency Helicopter Operations Guide has long been in place to set standards for helicopter operations. Revision of the FSM 5700 (reviewed in the fall of 2011) will solidify the groundwork for SMS and establish the agency's commitment to enhancing aviation safety. The incident action plan provides guidance and direction locally to operations. To develop best practices for such guidance, subject-matter experts often work in collaboration with aviation operations and aviation safety personnel to balance production with protection.

Risk Management

The Risk Management Workbook is a tool developed by subject-matter experts that identifies common risks and mitigations identified in previous aviation operations. It helps approving authorities to understand the risk level they are accepting with any given mission.

Prior to operations, some risks had been identified and, where possible, mitigated to an acceptable level. Briefings, maps, check-in points, and vertical separation of different operational components were all controls to reduce the risk presented by operating different aircraft types and performance levels in the same dynamic environment.

Some unforeseen risks were identified only afterward: having to monitor multiple frequencies at the same time, topographic obstructions to radio communication, and human factors. These were addressed and mitigated after the event.

In order to mitigate risk when entering another aircraft's operating zone, the helicopter pilot was given a control (to make contact with the ASM before entering the area) that was not followed. In the absence of that communication, the ASM was under the belief that the helicopter would stay below its assigned ceiling. Whether due to topographical obstruction to communication, radio-traffic interference, or human factors, the lack of follow-through put both aircraft at undue risk. This, then, became a topic for further risk identification and response.

Safety Assurance

The event was appropriately reported through the Aviation Safety Communique (SAFECOM) system, an online system through which aviation personnel can report hazards they encounter and provide lessons learned to others. Personnel have the option of filing reports anonymously. A positive reporting system is a key feature of any SMS, and land management agencies have long established reporting capability through SAFECOM.

An informal investigation of the event occurred to gather information on how the event unfolded and what could be done to prevent a recurrence in the future. The informal review established that, once the helicopter returned to the northeast quadrant of operations, it did not communicate with the ATGS about going above the operating ceiling once it had returned. The last exchange between the helicopter crew and the ATGS established the clearance to go above the helicopter's ceiling, but that clearance applied to a different area of the fire.

The Safety Assurance component of SMS provides oversight to check and see if established controls are working. Another oversight mechanism is the aviation safety and technical assistance team: individuals from operations, safety, aircraft maintenance, and an inspector pilot travel together in a group to visit ongoing aviation operations to provide assistance and oversight in the field while providing information about ongoing operations to leadership. Investigations provide opportunities to see what didn't work after an incident.

After the first five airspace close calls during the 2011 fire season, the region brought in an air safety investigator to analyze the events and trends and develop recommendations for prevention. The analysis involved reviewing statements of personnel involved and SAFECOMs and holding personal interviews and conference calls with various groups, including air operations branch directors, ATGSs, and ASMs.

Promotion

Regional leadership followed up safety investigations by promoting adoption of the mitigation recommendations throughout the region, wherever applicable. Promoting

Common Factors in Airspace Close Calls

When looking at all 10 airspace close-calls reported, investigators identified common factors. Of course, every event was different in some way, but by looking at them as a whole, patterns and lessons did emerge.

1. **Transitions.** The first common factor that emerged was that pilots encountered higher risk during mission transitions—for example: during a change in the ATGS; moving aircraft to another area of operations on the fire; changing the ASM for relief; changing radio frequencies due to high volume of users; or integrating a new type of aircraft or mission. The last event of the 10 came shortly after three mission transitions occurred at roughly the same time. Mitigating this risk could involve scheduling missions that are not time-critical—such as retardant drops for pretreatment—to avoid transition times.
2. **Unplanned Missions.** Another factor common to the close-calls involved unplanned missions that emerge throughout the day. Briefing the affected resources on mission changes is extremely important, but often, information necessary for situational awareness is lacking. Fire and Aviation is a "can-do" profession, and personnel tend to focus first on what is asked of them. We need to promote an awareness of changing missions and how revised missions affect other aircraft in the fire traffic area.
3. **Radio Traffic.** A third trend among incidents was the effect of high radio traffic volume on communications. Transmissions were "walked-on," distorted, and overlooked due to the high level of traffic on a specific frequency. The high amount of radio traffic also led to "one-sided communication" in which personnel would call "blind" and not wait for message confirmation. As a result, virtual fences, predefined flight routes, and fire traffic area protocols were not adhered to.
4. **Span of Control.** The number of aircraft being monitored by a single supervisor—the span of control—emerged as a fourth common factor in close-calls. Ground resources strictly maintain a one-to-five ratio of supervisors to technical personnel to keep track of everyone's whereabouts. It is easy to exceed that ratio when dealing with aircraft. As pointed out in several discussions of airspace events, the use of qualified helicopter coordinators can help spread the span of control workload and reduce the risk of untracked aircraft.

The risks associated with multiple aircraft on different missions in a relatively small airspace have already been identified and mitigations put in place by land management agencies. Not only do pilots need to follow these established procedures, but also as an organization, everyone concerned needs to ensure that, as situations change, all pilots are briefed and know the appropriate protocols for maintaining the lowest practical level of risk while getting the job done.

good risk decisionmaking helps units avoid operating at a higher level of risk than necessary.

Once an event is reported and reviewed through an informal investigation, a SAFECOM is made public to provide others with information and lessons learned for use in their own operations. In the case of the reconnaissance helicopter incident, the event was also presented locally to inform all aviation assets on the fire about the existing risk and the mitigations being put in place. On a wider scale, the region distributed the air safety investigator's analysis report on airspace close-calls. Aviation bases across the Southwest Region hosted discussions on the analysis. One of the pilots involved, who performed with great airmanship in avoiding the collision in this incident, was nominated for a national award in recognition of his contribution to aviation safety. Promoting the good risk decisionmaking is as important as discussing the decisions that keep us operating at a higher risk than necessary.

Summary

The safety culture of our aviation organization continues to improve. SMS provides a solid structure to present guidance, identify and mitigate risks, verify that controls are working, and promote success in operations. For the Southwestern Region in 2011, SMS showed itself to be highly effective in a precedent-setting situation. Although we experienced a higher-than-normal amount of airspace close-calls, we did not experience a near-midair collision. Through the tools of SMS, we kept the discussion focused on mitigating risks and, in the end, everyone came home safe. ■

A Historical Prescribed Fire Smoke Database for North Carolina

Beth L. Hall and Robert P. Davis

The State of North Carolina has engaged in an active prescribed fire and smoke management program since the 1970s in an effort to maintain a healthy ecosystem and minimize uncontrolled fuel overgrowth that contributes to catastrophic wildfires. Each of the State's 13 natural resource fire management districts has archived handwritten records of these prescribed fire events with information such as date of burn request, date of action, and burn location. However, information about surface weather conditions during the burn, upper-air weather stability, and climate (such as drought conditions, global sea surface temperatures, or air pressure, which can suggest climate teleconnections for wildfires in the State) was rarely noted. To extend the usefulness of the historical information, the North Carolina Department of Environmental and Natural Resources (NCDENR), in collaboration with researchers from Towson University, digitized the available prescribed burn records from many of these districts and augmented the database with as much information about the local atmospheric conditions during the burns as possible. Each burn was ultimately associated with 150 data fields on fire, weather, climate, and fire danger (National Fire Danger Rating System [NFDRS]) conditions.

While completing this work, Dr. Beth Hall was an assistant professor in the Department of Geography and Environmental Planning and Robert Davis was a research technician at Towson University in Towson, MD. Dr. Beth Hall is now the director of the Midwestern Regional Climate Center in Champaign, IL.

The objectives behind this effort were to (1) enable users to perform analyses of atmospheric, climatological, and fire danger parameters to better understand smoke management for future burns; (2) improve burn safety; and (3) provide guidance for future prescribed fire and smoke management plans. Analysis of this database would augment the existing experience and knowledge in the regions with quantifiable information on historical burns and environmental conditions.

> The location and date of each burn were important for assigning the proper weather, climate, and NFDRS conditions at the time of the burn.

Data Recording

There were two primary tasks in this project:

- Digitize all historical prescribed burn records from North Carolina through 2009, and
- Augment historical fire data with weather, climate, and NFDRS model information.

In pursuing the first task, we quickly found that each district used its own forms and recorded information in different formats, requiring interpretation of critical fields such as date and location of burn. We digitized data from 16,314 prescribed burns and recorded most of the information from the handwritten forms in the database. The periods of record for each fire district vary greatly within a dataset that spans from 1970 to 2009.

We addressed the second task by assigning data from various meteorological datasets to each burn record. The basic parameters and datasets used are listed in the accompanying table.

Task 1: Recording Location and Date

The location and date of each burn were important for assigning the proper weather, climate, and NFDRS conditions at the time of the burn. But, in some cases, we had to interpret the data, and, in others, we had to record substitute values. When location coordinate information was provided on the handwritten forms, it was not always clear if the values were given in degrees-minutes-seconds (DMS), decimal degrees, or quad-block-section-parcel notation (QBSP). Even when the location field on the original form was labeled "QBSP" and values were entered in that field, all four values were not always provided, and, when they were, they were often not in proper Q-B-S-P order (see figs. 1 and 2).

We often assigned the burn location based upon the only information available. When no quad information was provided in a QBSP field, we assigned the coordinates for the center of the county; if the county information was missing as well, we assigned the coordinates for the center of that fire district. Obviously, error potential increases with each progressive substitution. Ultimately, we converted all location values to decimal degrees to agree with location units for climatic weather data.

Dates of burn were not consistently recorded in the records either. For some records, there was a field specifying "date of burn"; for others, only the "call-in" date was

Summary of data sets used in the historical prescribed fire and smoke database.

Data source	Parameters
Handwritten burn records	Location and date of each burn.
RAWS	1300 LST temperature, relative humidity, wind speed, and wind direction Daily (1400 LST yesterday – 1300 LST today) maximum temperature and relative humidity, minimum temperature and relative humidity, precipitation amount, hours of precipitation, days since last precipitation event, and amount of most recent precipitation event Used as input for NFDRS parameters that included: 1-hr, 10-hr, 100-hr, and 1,000-hr FM; Woody FM; Herbaceous FM, BI, ERC, IC, and SC
ASOS	1300 LST temperature, relative humidity, wind speed, and wind direction Daily (1400 LST yesterday – 1300 LST today) maximum temperature and relative humidity, minimum temperature and relative humidity, precipitation amount, hours of precipitation, days since last precipitation event, and amount of most recent precipitation event Used as input for NFDRS parameters that included: 1-hr, 10-hr, 100-hr, and 1,000-hr FM; Woody FM; Herbaceous FM, BI, ERC, IC, and SC
NARR	~1300 LST temperature, relative humidity, wind speed, wind direction; total cloud cover (%) Daily (~1400 LST yesterday – ~1300 LST today) maximum temperature and relative humidity, minimum temperature and relative humidity, precipitation amount, days since last precipitation event, and amount of most recent precipitation event 500 mb divergence 500 mb TKE
Upper-Air Soundings	850 mb dew-point depression Low elevation lapse (925mb – 850mb) Presence, magnitude, and direction of a low-level jet Brotak's slope based on surface and 10,000-ft (3,000-m) wind speeds (yes/no) Haines' Index for stability Holzworth mixing height Stull mixing height Average transport winds within mixing layer
Climate Division Drought Data	Palmer Drought Severity Index
Climate Teleconnection	Oceanic Niño index (for El Niño/Southern Oscillation index) Arctic Oscillation index North Atlantic Oscillation index Pacific/North American Pattern index

BI = burning index
ERC = energy release component
FM = fuel moisture
IC = ignition component
LST = local standard time
SC = spread component
TKE= turbulent kinetic energy

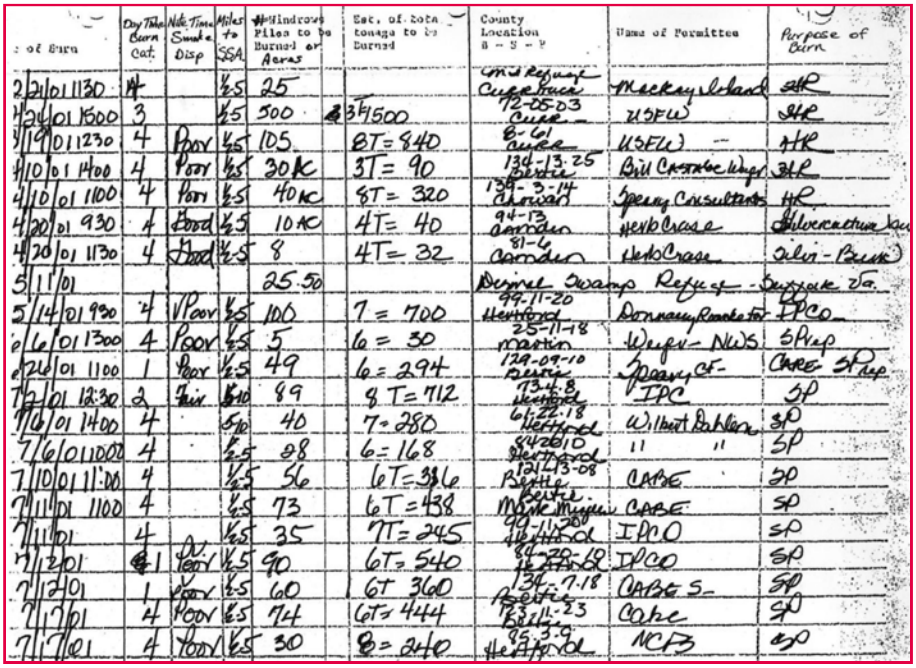
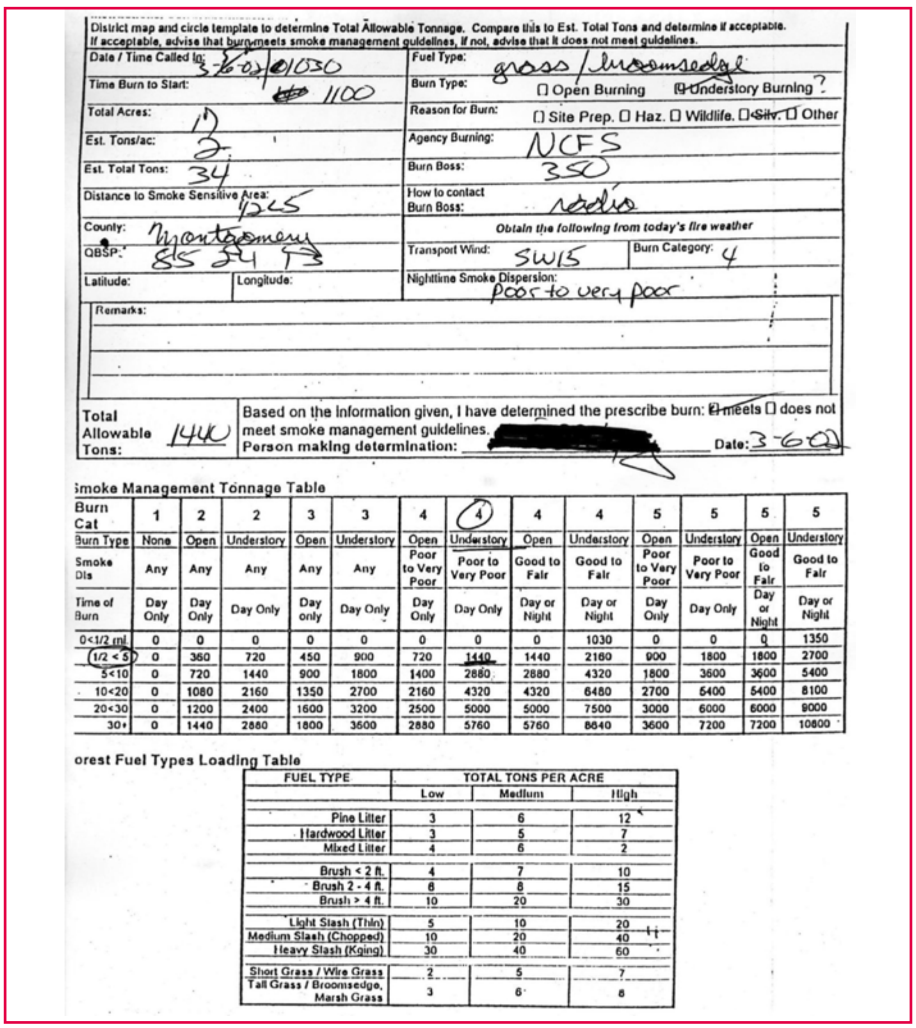


Figure 1—*An example of handwritten burn records. Locations are indicated as B-S-P with no quad information and often only two of the three necessary numbers.*



Burn Cat	1	2	2	3	3	4	4	4	4	5	5	5	5
Burn Type	None	Open	Understory	Open	Understory	Open	Understory	Open	Understory	Open	Understory	Open	Understory
Smoke Dis	Any	Any	Any	Any	Any	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair	Poor to Very Poor	Poor to Very Poor	Good to Fair	Good to Fair
Time of Burn	Day Only	Day Only	Day Only	Day only	Day Only	Day Only	Day Only	Day or Night	Day or Night	Day Only	Day Only	Day or Night	Day or Night
0<1/2 mi	0	0	0	0	0	0	0	0	1030	0	0	0	1350
1/2<5	0	360	720	450	900	720	1440	1440	2160	900	1800	1800	2700
5<10	0	720	1440	900	1800	1400	2880	2880	4320	1800	3600	3600	5400
10<20	0	1080	2160	1350	2700	2160	4320	4320	6480	2700	5400	5400	8100
20<30	0	1200	2400	1600	3200	2500	5000	5000	7500	3000	6000	6000	9000
30+	0	1440	2880	1800	3600	2880	5760	5760	8640	3600	7200	7200	10800

FUEL TYPE	TOTAL TONS PER ACRE Low	Medium	High
Pine Litter	3	6	12
Hardwood Litter	3	5	7
Mixed Litter	4	6	2
Brush < 2 ft.	4	7	10
Brush 2 - 4 ft.	6	8	15
Brush > 4 ft.	10	20	30
Light Slash (Thin)	5	10	20
Medium Slash (Chopped)	10	20	40
Heavy Slash (Kging)	30	40	60
Short Grass / Wire Grass	2	5	7
Tall Grass / Broomsedge, Marsh Grass	3	6	8

Figure 2—*An example of a handwritten burn record. Note that the entire sheet represents a single burn, location was provided in Q-B-S-P, and date indicated is labeled "called-in," not date/time of burn.*

provided, and yet others had both fields filled in. We determined that many burns had to be excluded due to lack of date information, leaving 14,815 burns in the final database.

There was great variability in the number of burns per fire district and in the periods of record. The burn records may not provide a true representation of prescribed burn activity in each district, but rather a representation based on accessible burn records. We do not know whether there simply were no prescribed burns during gaps within a district's period of record or whether there were just no records kept on them during this period. Therefore, one must use caution when drawing conclusions about fire, weather, climate, and NFDRS history from districts that have discontinuous burn records.

Task 2: Weather, Climate, and NFDRS Data

We used data from two surface weather observation networks—Remote Automated Weather Station (RAWS) (Warren and Vance 1981) and Automated Surface Observing Station (ASOS) (National Weather Service 2011)—to assign surface weather data such as temperature, relative humidity, wind speed and direction, and precipitation to each burn. We used data from both networks because both have benefits and drawbacks when assigning weather conditions to archived data.

An additional dataset continuous in both space and time was included: the North American Regional Reanalysis (NARR), a conglomeration of many observational and modeled datasets (Mesinger and others 2006). The dataset begins in 1980 and runs through the period of record for this project. Data are available at a 20-mile (32-km) spatial resolution and at 3-hour intervals. In addition to surface weather conditions, the 500-millibar (mb) divergence and turbulent kinetic energy (TKE) fields were also extracted from the NARR database.

We attained atmospheric conditions throughout the lower atmosphere (e.g., atmospheric stability, midtropospheric transport winds) from upper-air sounding (i.e., weather balloon and radiosonde) data from the National Center for Atmospheric Research. We acquired all available sounding data for North Carolina and adjacent States. Figure 3 shows the location of RAWS, ASOS, and upper-air sounding locations used in the development of the database.

The drought index selected for this project was the Palmer Drought Severity Index (PDSI), which integrates both atmospheric and soil moisture characteristics (Palmer 1965). It has an inherent timelag of 6 to 9 months, meaning that it will take approximately one-half to three-quarters of a year before the cumulative drought impacts start to show up quantitatively in the index value. We acquired the PDSI data from the Western Regional Climate Center (WRCC) spatially by climate division and temporally by month.

Climate teleconnections refer to atmospheric and oceanic anomalies in a particular region that appear to have global impacts over large distances. The most well-known climate teleconnection is the El Niño-Southern Oscillation associated with alternating atmospheric surface pressure locations and significant changes in sea-surface temperatures in the equatorial Pacific Ocean. Other climate teleconnections include the Arctic Oscillation, the North Atlantic Oscillation, and the Pacific-North American Pattern.

Teleconnection indices have been recorded since 1950, and research continues to find climate linkages between these teleconnection phases and climate activity in various regions around the world. Because of their significance, each of the four climate teleconnection indices were collected and assigned to each recorded burn in North Carolina. Data came from the Climate Prediction Center Climate and Weather Linkage Web site (National Oceanic and Atmospheric Administration 2011). Index values, reported monthly, are either negative or positive depending upon the particular phase of that teleconnection; therefore, all burns that occurred in the same month would have the same teleconnection index value for each measure. In recording these, we used the Oceanic Niño Index to represent the El Niño-Southern Oscillation.

Algorithms for the NFDRS output indices came from Deeming and others (1977) and Bradshaw and others (1984). These included the energy release component (available energy per unit area within the flame front at the head of a fire), burning index (scaled predicted flame length), spread component (predicted rate of spread), and ignition component (probability of ignition along with the spread component). We also derived estimated timelag fuel moisture content for

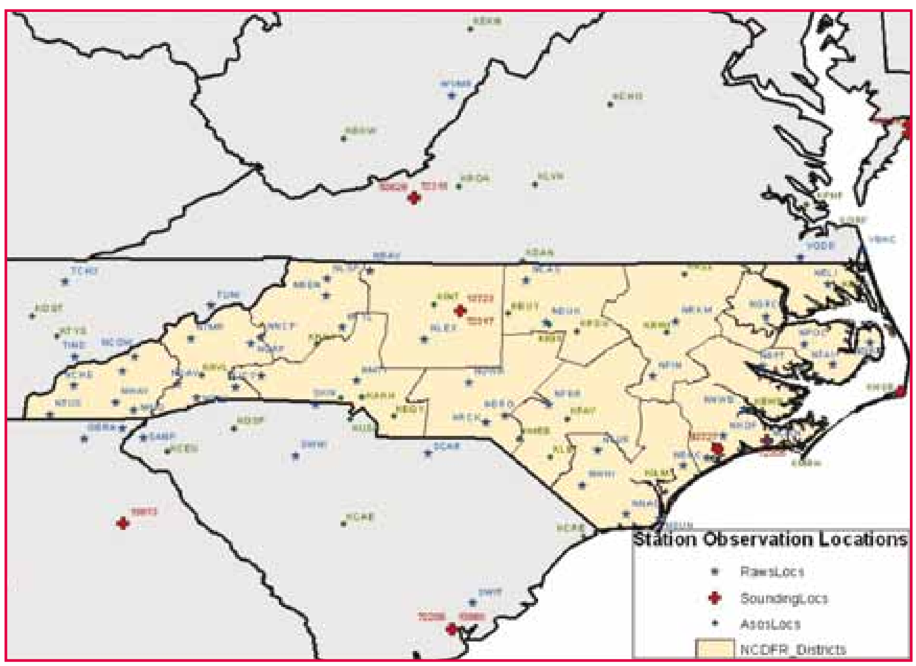


Figure 3—*Locations of ASOS, RAWS, and upper-air sounding locations utilized for the database.*

Data from two surface weather observation networks were used to assign surface weather data such as temperature, relative humidity, wind speed and direction, and precipitation to each burn.

the 1-hour, 10-hour, 100-hour, and 1,000-hour fuels (in which the number of hours is directly correlated to the diameter of the associated fuel stick). Output parameters from the NFDRS model were dependent upon input observations from both the RAWS and ASOS surface weather networks.

Upper-Air Parameters

Although we extracted most surface atmospheric conditions, drought, and climate teleconnection data from the various data sources, upper-air parameters were more often derived values. The following describes the processes involved.

Atmospheric Stability. Atmospheric stability refers to the potential vertical movement of air where unstable, rising air would be associated with windier and perhaps stormier conditions. The Haines Index, sometimes referred to as the Lower Atmospheric Stability Index (Haines 1988), describes the atmosphere's contribution to the growth potential of a wildfire. The Haines Index is derived from the sum of a categorical stability term (change in temperature between the 925-mb and 850-mb pressure levels) and a categorical moisture term (850-mb dew point depression). This sum provides an indication of the potential for the rate of spread of a fire on a given day.

The TKE provides a measure of the intensity of turbulence often generated from thermal energy, which indicates how well air moves vertically and how energy dissipates. TKE can be derived at various atmospheric pressure levels. For this project, as divergence was determined at the 500-mb pressure level, the TKE was taken directly from the NARR database at this same pressure level.

Mixing Heights. The mixing height refers to the height above the ground where air is able to rise and disperse. The greater the mixing height, the less concentrated air pollutants (including smoke) will be. There were two mixing heights derived for each burn where sounding data was available: one value was based upon the Holzworth method (Holzworth 1964, 1967) and the other based upon the Stull method (Stull 1991). These methods use hourly temperature values that account for the greatest ground radiational heating and, therefore, thermal instability. The primary difference between the methods is whether the imaginary parcel being tested for instability stays unsaturated throughout the ascent (the Holzworth-derived method) or if the atmospheric moisture (regardless of saturation) was included in order to account for a change in atmospheric density (the Stull-derived method).

Low Atmospheric Winds. Previous research has found that a key feature in wildfire ignition and spread is the presence of a 500-mb trough associated with low pressure aloft and to the west of the wildfire location (Brotak and Reifsynder 2003; Brotak 1980; Byrum 1954). What makes this trough critical for wildfires is that it provides a potential for converging and rising air, faster than normal winds (i.e., low-level jet), and wind shear all at the location of the fire.

One way to detect the location of a 500-mb trough is to examine the value of divergence at that level. This value indicates whether or not the air aloft is spreading apart horizontally. If it is, then air must be rising from lower levels in reaction to the lower air pressure above it.

To identify faster-than-normal, low-altitude winds, we employed Bonner's (1968) definition of the presence of a low-level jet. Bonner determined that the low-level jet is rarely found higher than 1.9 miles (3 km) from the ground's surface. Within this layer, the wind speed had to be at least 39 ft/s (12 m/s), with a minimum wind speed above this altitude of at least 50 percent of the fastest low-level winds. Strong low-level winds could contribute not only to the flame length of a fire but also the rate of spread.

Wind shear (i.e., a sudden change in wind speed or direction associated with a change in altitude) was quantified by identifying the existence of a "Brotak Slope," the difference between the wind speed at 10,000 feet (3,048 m) above ground level and surface wind speeds (Brotak and Reifsynder 2003). To determine if the slope of the wind speeds was significant enough to suggest strong wind shear, the surface winds had to be at least 10 mph (16 km/h) and the 10,000-ft (3,048 m) wind speeds had to be at least 40 mph (64 km/h).

Average transport winds were defined as the average wind speed and direction within a mixing layer. As two separate definitions of mixing height were derived for the database, there are separate average transport wind values for each method.

Data Use and Recommendations

This historical prescribed fire and smoke database compilation provides a resource of historical information that can be incorporated into a number of scientific analyses. However, any scientific discoveries born from this database are only as good as the data in it. As this is a database with a foundation of historical burn data, the first recommendation is to standardize future burn data in an electronic, perhaps Web-based, data entry system. With quality control checks and conversion factors incorporated into the system, errors such as location and date would be minimized. Mandatory fields could be established with an online, standardized database so that critical information such as acres planned to be burned and acres actually burned, along with the time, date, reason for burn, and location, would be entered for every burn.

We also recommend development of a Web-based climate analysis page that can access all the data, not only within this prescribed burn database, but also within the region, for every day, in order to examine and experiment with proposed "burn windows." The product would consider user-controlled prescription conditions and then report the climatology of those conditions over time throughout a year. It is possible that several "burn windows" of opportunity are being lost simply because historical climatology is not well known.

Our final recommendation is to invite other States to collaborate on these historical database compilations and resulting products. This would allow a more comprehensive, regional perspective of the State-managed prescribed burn and smoke management programs and efforts. With more partners involved in such efforts, the individual expenses would be reduced while geographical application would expand.

For more information on the compilation of this historical prescribed burn dataset for North Carolina, contact Beth Hall, Midwestern Regional Climate Center, bethhall@illinois.edu.

Acknowledgements

This database project was funded through a grant from the North Carolina Department of Environment and Natural Resources (NCDENR Contract #2864; Towson University Grant #5030059) under the supervision of Gary Curcio. Many thanks go out to Curcio and the NCDENR for providing their support and confidence in compiling a database of this magnitude. Additional thanks are offered to Melissa Kirkman, who digitized most of the burn data received in handwritten form.

References

Bonner, W.D. 1968. Climatology of the low level jet. Monthly Weather Review. 96 (12): 833–850.

Bradshaw, L.S.; Deeming, J.E.; Burgan, R.E.; Cohen, J.D. 1983. The 1978 National Fire-Danger Rating System. Gen. Tech. Rep. INT-169. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 44 p.

Brotak, E.A. 1980. A comparison of the meteorological conditions associated with a major wildland fire in the United States and a major brush fire in Australia. Journal of Applied Meteorology. 19: 474–476.

Brotak, E.A.; Reifsnyder, W.E. 2003. Predicting major wildland fire occurrence. Fire Management Today. 38(2): 5–10.

Byrum, G. M. 1954. Atmospheric conditions related to blowup fires. Station Paper #35. Asheville, NC: USDA Forest Service, Southeastern Forest Experiment Station. 34 p.

Deeming, J.E.; Burgan, R.E.; Cohen, J.D. 1977. The National Fire Danger Rating System, 1978. Ogden, UT: USDA Forest Service. 66 p.

Haines, D.A. 1988. A lower atmospheric severity index for wildland fires. National Weather Digest. 13: 23–27.

Holzworth, G.C. 1964. Estimate of mean maximum mixing depths in the contiguous United States. Monthly Weather Review. 92 (5): 235–242.

Holzworth, G.C. 1967. Mixing depths, wind speeds and air pollution potential for selected locations in the United States. Journal of Applied Meteorology. 6: 1039–1044.

Mesinger, F.; DiMego, G.; Kalnay, E.; Mitchell, K.; Shafran, P.; Evisuzaki, W.; Jovic, D.; Woollen, J.; Rogers, E.; Berbery, E.; Ek, M.; Fan, Y.; Grumbine, R.; Higgins, W.; Li, H.; Lin, Y.; Manikin, G.; Parrish, D.; Shi, W. 2006. North American Regional Reanalysis. Bulletin of the American Meteorological Society. 87: 343–360.

National Oceanic and Atmospheric Administration. 2011. Climate and weather linkage: teleconnections. Climate Prediction Center. Available at: <http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/teleconnections.shtml> (accessed March 2011).

National Weather Service. 2011. Automated Surface Observing System. National Oceanic and Atmospheric Administration. Available at: <http://www.weather.gov/ost/asostech.html> (accessed March 2011).

Palmer, W.C. 1965. Meteorological drought. Washington, D.C.: U.S. Weather Bureau. 59 p.

Stull, R.B. 1991. Static stability—an update. Bulletin of the American Meteorological Society. 72(10): 521–1529.

Warren, J.R.; Vance, D.L. 1981. Remote automatic weather station for resource and fire management agencies. Gen. Tech. Rep. INT–116. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 11 p.

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