

WILDFIRE

Still Hot at 50

By Kevin C. Ryan, Susan Gallagher and Colin Hardy with contributions from Diane Smith

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Missoula Fire Lab celebrates golden anniversary by looking toward potential advances in fire science and research.

From the parking lot, the **Missoula Fire Sciences Laboratory** in Missoula, Montana, could pass for a school, except that one end has a 73-foot-high block of reinforced concrete topped by what looks like a giant golf ball. The block is a combustion chamber for experimental burning, and the ball is part of a satellite station that receives data used to map North American wildfires, a function unheard of when the Fire Lab was established in 1960.

The world's largest wildland fire research laboratory turns 50 this month. Half a century of work at the Fire Lab — home of the Fire, Fuel and Smoke Science Program operated by the USDA Forest Service's Rocky Mountain Research Station — has strengthened the safety and effectiveness of fire management worldwide. When the anniversary is celebrated with a public rededication ceremony and related activities in Missoula on Sept. 18, it will be with recognition for accomplishments of the past and a sense of anticipation for still more advances from ongoing work.

AUSPICIOUS BEGINNING

Sept. 12, 1960, brought the original dedication of what was then the Northern Forest Fire Laboratory. When it opened, complete with two wind tunnels and a state-of-the-art combustion chamber, the singular research goal was to stop all wildfires to the extent possible with the equipment of



Research

chemists Shawn Urbanski and Emily Lincoln prepare a fire-atmosphere sampling system to measure gas and particulate emissions from a prescribed fire in a pine forest outside of San Juanita, Chihuahua, Mexico. The instrumentation is deployed within the burn unit to sample smoke emissions during the fire.

the day, availability of personnel and provisions for crew safety. Today, the scope is broader and the focus more complex. Understanding fire behavior and providing for the safety of firefighters and the public still are critical to its mission, but the lab also emphasizes fuels treatments, fire ecology, fire chemistry and fire's dynamic relationship with global change. The sweep of today's lab is further evident in the diversity of the landscapes covered by researchers' work. It influences fire management decisions and ecosystem health in environments as different from each other as wilderness areas and

While the scope has broadened, the dedication of Fire Lab scientists, engineers, mathematicians and others has been constant. Their work, often in collaboration with researchers near and far, is evident globally in myriad ways — benefitting natural resources, fire managers, crews and landowners. Fire retardant, infrared detection systems and the National Fire Danger Rating System are just a few of the tools that trace their origins to Fire Lab research conducted years ago. The Incident Response Pocket Guide that every firefighter is told to carry includes guidelines for creating, recognizing and using safety zones — all based on research carried out at the Missoula facility.

To early generations of scientists, the contemporary lab's computer-intensive research that fire professionals know by monikers such as FSPro, FARSITE and BehavePlus, would have been unfathomable. Improving the safety and effectiveness of fire management remains the core mission at the lab. If its researchers seem proud of what they do, well, they are. "We get excited about our work," says Dr. Mark Finney, research forester. "We think we have an exciting story to tell."

They continue in the great tradition begun almost 90 years ago by Forest Service forester and fire science pioneer Harry Gisborne, says Dr. Scott Stephens, associate professor of fire sciences at the University of California at Berkeley. "The Missoula lab has been a world leader in fire research, including the broad areas of fire behavior and fire effects," says Stephens, one of hundreds of scientists who have been part of its synergy over the years. They include a Fulbright scholar from Russia who says her year at the lab exposed her to "the heart of U.S. fire science" and a Nobel laureate, Dr. Wei Min Hao, who is one of 12 staff scientists at the lab. Hao, who studies fires' atmospheric pollutants and greenhouse gases, shared the 2007 Nobel Peace Prize for contributions to the Intergovernmental Panel on Climate Change.

Scientists from all over the world go to the lab to learn, share their knowledge and explore. "As a relatively young fire ecologist in the 1970s and 1980s, I was inspired by the methods of research at Missoula, the findings of the research or the researchers themselves," says Dr. Malcolm Gill, an Australian scientist and visiting fellow at The Australian National University who has worked for more than 35 years on matters related to bushfires.

A STORIED HISTORY

When President Theodore Roosevelt signed legislation creating the Forest Service in 1905, a primary goal was providing complete fire protection for the nation's forests. Forests protected watersheds, provided grass for grazing and wood for development of the United States. The Forest Service's first chief forester, Gifford Pinchot, wrote that the "best way for the government to promote each of these three great uses is to protect the forest reserves from fire."

Successor Henry S. Graves continued that philosophy and established the Forest Service Branch of Research in 1916, six years after fires burned 3 million acres in Idaho and Montana, killing more than 80 firefighters and commanding a Forest Service outlay of about \$1 million for firefighting, a huge sum in that day. New experiment stations ensued to support fire research, and as early as the 1930s, fire scientist Gisborne was touting the need for an environmentally controlled wind tunnel and combustion chamber. But before the lab could be built, he died of a heart attack while hiking the steep terrain of the Mann Gulch fire that killed 13 firefighters in 1949 as they toiled in the gulch 20 miles north of Helena, Montana. The Mann Gulch tragedy redoubled the Forest Service's emphasis on understanding fire behavior to meet the goal of stopping fires safely.

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Gisborne protege Jack Barrows became the first director of the Missoula lab. Barrows' legacy is large, and even today people at the lab refer to it as "the house that Jack built." When he set about the work of staffing the lab with researchers, he hired not foresters but physicists, chemists and engineers — a departure from Forest Service practice in the area of fire research. Barrows recognized fire as a physical process, and he wanted to put physical scientists and engineers on the staff.



Jack

Among those he hired was Dick Rothermel, an aeronautical engineer who, with physicist Hal Anderson, calibrated the lab's combustion chamber, wind tunnels and other equipment to conduct the first controlled experiments of fire behavior. The scientists learned how fast a fire would spread under different conditions — among them fuel moisture, composition, ambient temperature and wind speed. Rothermel is known for having created formulas and calculations that, for decades, remained an integral part of fire behavior modeling and prediction. He was a technical adviser to Norman Maclean, who wrote about the Mann Gulch catastrophe in his book *Young Men and Fire*.

S. Barrows and a Forest Service aircraft used in early fire retardant research.

Before Rothermel's retirement 15 years ago, he received one of the USDA's highest honors, the Superior Service Award. It recognized his "outstanding creativity in developing fire behavior prediction technology and training programs, enhancing the implementation of the Forest Service's revised fire policy."

Rothermel and his early colleagues were the first of many distinguished researchers drawn to the lab. "If you're a science geek, this is a pretty special place to work," says Dr. Colin Hardy, program manager for the Fire, Fuel and Smoke Science Program.

IMPRESSIVE ARRAY OF PROJECTS

For fire and land managers, tools based on Fire Lab research have become fundamental for informed decision-making. They increase accuracy in the projection of fires' behavior and spread, and the manager furnished with this forward-looking information is strengthened in making decisions for the good of people and natural resources.



Brackett

Creek Fire, Gallatin National Forest. C.E. "Mike" Hardy and another forest officer use the portable weather station to obtain fire weather information.

The Wildland Fire Assessment System (WFAS), BehavePlus, FARSITE fire area simulator, the FSPro fire spread probability model and WindWizard are just a few of the Fire Lab-generated advances that indicate how sophisticated fire sciences have become. Simulators can show the probability that flames will spread to adjacent areas and fuel types under conditions predicted for the next daytime burning period, as well as use Google Earth technology to bring the projected fire growth to life on a computer screen.

BehavePlus is a fire modeling system that expands the BEHAVE fire prediction and fuel modeling system developed in 1986 at the lab. Models combined in BehavePlus describe fire behavior, fire effects and the fire environment. Consider the decision-maker responsible for the lives of several hundred firefighters, the safety of a rural community and the security of a municipal watershed. Assisted by BehavePlus and other advancements developed at the Fire Lab, the manager who is planning deployment of fire crews and equipment can be more confident about the projections than those of even 10 years ago.

Several models of fire behavior in space and time come together in FlamMap to simulate a fire burning across a variable landscape under environmental conditions in flux. FlamMap not only provides spatial analysis of fire behavior and mapping but also produces independent calculations of the different dynamics of fire, among them flame length and intensity at the fire line. While FARSITE helps fire managers determine rate and direction of fire spread, FlamMap allows fire managers to identify hazardous combinations of fuels and topography before a fire occurs. The fire climatology program, FireFamily Plus, further enables the user to calculate fire danger in a given area and analyze historical weather observations in association with a fire's local data. This program is useful in anticipating weather compatible with prescribed burning.

LANDFIRE is an interagency effort to combine information from geo-referenced field plots and remote sensing with scientific knowledge from many disciplines. The goal is to create spatial data layers that are essential for complex fire prediction models and associated tasks, such as helping land managers prioritize treatment for reduction of hazardous fuels and decide when fire can be used safely to help restore ecological balance. LANDFIRE provides spatial fuels data for the entire 50 states, thereby making application of the Fire Lab's fire behavior and effects models available to all stakeholders.

Restoring and sustaining forest landscapes is among the priorities that Agriculture Secretary Tom Vilsack and Forest Service Chief Tom Tidwell have set forth in their vision for America's forests, and it is a priority supported through work at the Fire Lab.

In keeping with the Forest Service's shift to let fire play a more natural role while still protecting the safety of firefighters and the public and important values at risk, scientists are developing a real-time tool that a fire manager could use to quickly evaluate whether a fire is improving the health of an ecosystem and the condition of a landscape. Presently, managers have few tools to help assess whether a fire not threatening humans presents enough benefit that it should be allowed to burn within carefully crafted parameters.

Lab researchers' analyses of the combustion process and the factors that determine fire behavior help fire and land managers anticipate the potential for high-intensity fire, effects of fuel treatments and the potential for loss of life and property damage. Fuel research at the lab helps to improve accuracy in predicting fire behavior and fire effects, and Fire Lab

observations, satellite data and models improve understanding of smoke's composition and movement. This enhances the base of knowledge with which to examine smoke-related health concerns and the movement of greenhouse gases around the globe. Research of fire ecology contributes to stronger conservation, restoration of burned areas and the appropriate use of fire.

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COLLABORATION AND INTERNATIONAL EXCHANGE

Achievements at the lab reflect a lot of collaboration. Principally, it is with researchers' Forest Service Research colleagues in places such as Seattle, Washington; Riverside, California; Athens, Georgia; Delaware, Ohio; and East Lansing, Michigan; however, joint work includes an array of universities and agencies in the United States and other countries. Additionally, the lab's Fire, Fuel and Smoke Science Program is part of the Wildland Fire Science Partnership, which includes the University of Idaho, the University of Montana and the Wildland Fire Management Research, Development and Application Program, a Boise, Idaho-based unit also associated with the Rocky Mountain Research Station.

South Dakota State University's Dr. Mark Cochrane, a senior scientist who studies processes in land-cover change and recently wrote a book about tropical fire ecology, says much of his research would not have been possible without the Fire Lab. It provides "a significant body of knowledge in a coherent form," he says. "The information is there, and it's free."

Brian Stocks, a retired Canadian Forest Service fire scientist, enthusiastically recalls his involvement with the Missoula lab over the span of his 35-year CFS career, which concluded in 2002. Now a fire consultant in Sault Ste. Marie, Ontario, he remembers when "both the U.S. and Canadian fire research groups were working on the development of national fire danger rating systems, and we had many meetings in Missoula to share data and ideas. Although our fundamental approaches were different, there was a strong sense of collaboration and camaraderie, and we developed close relationships — something fundamental to conducting solid science, both then and now."

Working with fire specialists from other countries can benefit all concerned. For example, fire ecology and forest fuel management in Russia may seem remote to interests in the United States, until one considers that Russia is home to roughly 70% of the world's coniferous forests. Dr. Tatiana Sofronova, the Fulbright scholar who remarked about connecting with "the heart" of fire science in the United States, came from the Sukavhev Institute of Forest in Krasnoyarsk, Russia. During her year at the lab, which ended last fall, she studied fire behavior and forest management applications. Sofronova says she hopes the knowledge she gained will be used to create vegetation databases for all of Russia, similar to ones created through the LANDFIRE project. Her outreach beyond the lab included speaking at the University of Montana.

French engineer Jean-Charles Valette was at the Fire Lab in 1988 on behalf of the National Institute for Agronomic Research and its Mediterranean Forest Ecology Unit in Avignon, France. Valette went home with information used to design facilities for European fire research. Another representative of the Avignon unit, Eric Rigolot, says his two months at the lab in 1992 were "crucial for launching French studies on fire effects on pines and opening many years of collaboration on fire ecology."

Other examples of the Fire Lab's reach beyond U.S. borders include Chinese translation of the BEHAVE modeling system's user guide, and a visit last winter by four scientists from

by the Minister of Environment for Lebanon, Mohamad Rahal.

Among members of the lab staff, destinations have included Canada's Northwest Territories (to participate in the International Crown Fire Modeling Experiment conducted between 1995 and 2001) and South Africa (to help implement a fire danger rating system).

REMARKABLE FACILITIES

The Fire Lab's signature facilities are the wind tunnels and combustion chamber for burn experiments conducted in a controlled environment under varying conditions of temperature, humidity and wind. But there is much more.

Advanced computing facilities are used to model fire spread, fire danger and air quality; also, scientists use a gas chromatography lab to analyze smoke samples collected

during experiments. Researchers can obtain smoke samples from a wild or prescribed fire and store those samples in canisters for later analysis. An electronics shop and buildings for metal and wood fabrication are part of the campus, and a library provides a valuable reference collection for lab staff and others studying fire and its effects.

The Fire Lab's accomplishments over the past five decades and its current work may be unknown to many people, even those in Missoula and the surrounding region. But the lab is of great value as a source of cutting-edge research and scientific understanding in human efforts to live with fire and address its impacts on climate and the earth's natural resources. Fiftieth anniversaries are golden, and for the Missoula Fire Sciences Laboratory, the milestone shines exceptionally.

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Colin Hardy is Program Manager of the Fire, Fuel, and Smoke Science Program at the Missoula Fire Sciences Lab.



Lab scientists Mark Finney and Bret Butler conduct an experimental burn in the Fire Sciences Laboratory large combustion chamber.

Fire