Joint Fire Science Program

Fire Science Brief

RESEARCH SUPPORTING SOUND DECISIONS

Prescribed fire in the Baker City, Oregon, watershed. Photo by Roger D. Ottmar.

A Toolkit for Assessing Fire Hazards

From the redwood forest to the Gulf Stream waters, the Joint Fire Science Program has helped provide funding to support a suite of tools for assessing fuel loads, fire hazards, and emissions characteristics.

Summary

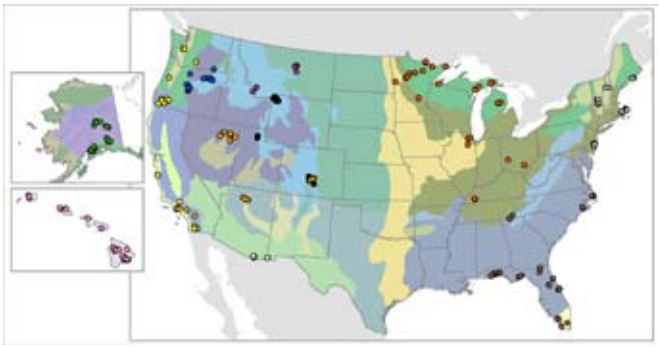
Whether the goal is to improve wildlife habitat, gauge the effects of prescribed burns or wildfire, or assess the unaccustomed conditions and hidden dangers of fallen trees in the aftermath of hurricanes, a suite of tools developed by the Fire and Environmental Research Applications (FERA) Team at the Pacific Northwest Research Station, Pacific Wildland Fire Sciences Laboratory, allows resource managers to estimate fuel loads, fire hazards, and smoke emissions characteristics in a wide range of forest and grassland ecosystems. The Natural Fuels Photo Series, developed by FERA's Roger Ottmar, is a field guide for resource managers who need a quick way to gauge fuel load. Complementary computer programs allow managers to predict the behavior of wildfire or prescribed fire and estimate smoke emissions. These assessments of fuel load, fire behavior, and fire effects will help managers fulfill increasingly strict air quality regulatory requirements for prescribed fire and assess the hazard to the public from wildfire.

Key Findings

- The Natural Fuels Photo Series provides a snapshot of different ecosystems for rapid assessment of fuel loads in the field.
- As scientists predict increased frequency and intensity of hurricanes, the new hurricane photo series for the southeastern United States will provide a tool for early, quick assessment and long-range management planning.
- The software programs CONSUME and the Fuel Characteristic Classification System (FCCS) work together with the Natural Fuels Photo Series to provide modeling of predicted fire behaviors and air pollutant emissions.
- Together, the suite of tools offers an integrated, sophisticated approach to assessment of fuel load, fire risk, and smoke hazard for managers on a wide range of ecosystems on federal, state, and private lands.

A Suite of Tools

Whether the management goal of prescribed fire is to improve wildlife habitat for threatened species, mitigate the effects of prescribed burns or wildfire, or get rid of invasive plant species, a suite of tools developed by the Fire and Environmental Research Applications (FERA) Team at the Pacific Northwest Research Station, Pacific Wildland Fire Sciences Laboratory, allows fire and natural resource managers to assess fuel loads, fire hazards, and smoke emissions characteristics in a wide range of forest and grassland ecosystems. The tools include the Natural Fuels Photo Series, the software program CONSUME, and the Fuel Characteristic Classification System (FCCS).



Map of geographic distribution of the Natural Fuels Photo Series site locations.

Natural Fuels Photo Series

Originally developed as a field guide for managers, the Natural Fuels Photo Series emerged in the late 1980s. Timberland managers had earlier developed a photographic assessment to use after logging, where activity fuels such as mechanical debris and slash pose wildfire risks, and where prescribed fire may be used to reduce the hazard and prepare for replanting. "We decided to take that one step further and start assessing fuels that are more natural," says Roger Ottmar, a research forester with FERA.

The 11 volumes published in the series so far cover more than 30 fuelbed types, from the mixed conifer and sagebrush of the Pacific Northwest to the longleaf pine, marsh grass, sand hill, and mixed pine and hardwood of the Southeast. "One of the critical pieces of the puzzle is to determine first how much fuel is out there," Ottmar says. "Second, you need to know how much is consumed. Once you have those two pieces, you can determine the burn prescription and when you want to burn to meet your objectives."

Fixed, stereo, and wide-angle photos, focused on an area about one seventh of an acre in size, provide more detail than a single shot photo can render. The high resolution photographs are printed using a top-of- the line process and placed in a portable ring-bound binder. Site specific information includes georeferenced location, forest type, species inventory, understory characteristics, and also estimates of the size of saplings and trees, the amount of debris on the forest floor, and the loading of woody material measured in tons per acre. "This assessment allows you to estimate fairly accurately what the fuel loading and characteristics are in the area without a lot of field work," Ottmar says.

A digital version of the Natural Fuels Photo Series based on the published volumes has also been developed. This tool allows fire and resource managers to quickly access the information via the Internet and download high-resolution images that can, for example, be printed as posters for group presentations. The digital photo series is available at ***http://depts.washington.edu/nwfire/dps/***.

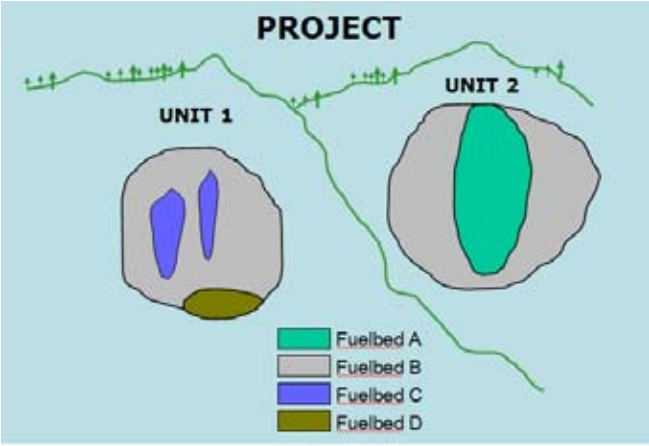
The stereo camera setup used to photograph sites. Stereoscopic photography gives the three-dimensional view used in the field guide.

New Hurricane Photo Series

The newest entry in the Natural Fuels Photo Series will focus on five states in the southeastern region of the country that were affected by severe blowdown from the intense hurricane seasons of 2004 and 2005. They are Florida, Georgia, Alabama, Mississippi, and Louisiana. Ottmar foresees three main scenarios. If the area is a national park or wilderness, most of the fuel load will probably be left in place. "If hurricane damage occurs in an area that was planted and the timber was mature enough, they can salvage it or pile and burn the slash material," he says. In other areas, managers may use either prescribed fire or a mechanical treatment. If ocean surface temperatures continue to rise, and the incidence and severity of hurricanes increases, the new series will be useful in immediate, post-incident assessments for years to come. *(See Fire and Rain sidebar.)*

CONSUME

The computer program CONSUME helps determine how much consumption takes place during prescribed fire or wildfire. Users feed CONSUME a number of crucial variables and the software calculates fuel consumption and emissions. To generate the data behind Consume, the team set up research plots on prescribed fires or in certain cases actually went ahead of wildfires on public lands, measured the fuel load before the fire approached, recorded fuel and meteorological conditions, and then measured what fuels were left after the fire. "If you multiply the fuel consumed by the emission factor, you can tell how much smoke is generated, which is critical for a prescribed burn or to estimate impacts of wildfire on a community," Ottmar says.



Consume is organized hierarchically into projects containing one or more burn units to reflect actual management strategies. Burn units are further divided into multiple fuelbeds. The majority of fuel and environmental information is managed at the fuelbed level.

The Fuel Characteristic Classification System

The Fuel Characteristic Classification System (FCCS) is a sophisticated and comprehensive software system designed to predict potential fire behavior and to assess fuelbeds from the ground fuel stratum to the canopy. This program lets the user create a fuelbed based on the published literature or knowledge gained from working in an area for many years and apply these characteristics to a specific landscape. "With FCCS you can actually be back in the office in the dead of winter, build a fuelbed, and plan for a prescribed burn in the spring or summer," Ottmar says. Fuelbed data and prescription parameters can then be fed into the CONSUME software to predict fuel consumption and gauge potential pollutant emissions.

FERA has developed a fuel map for the continental USA that can be updated as ecosystems change over time. The FCCS quantifies live and dead fuel loadings for 16 categories of fuels across 6 strata, from canopy to duff.

In the FCCS, fuelbeds represent realistic fuel conditions and can accommodate a wide range of fuel characteristics in six horizontal fuel layers.

Fire and Rain: Hurricanes Spark New Idea for Photo Series

Severe damage to forests from back-to-back, record-breaking hurricane seasons in 2004 and 2005 poses unprecedented challenges for regional resource and fire managers in a wide swath of the coastal southeastern United States. “What was vertical is now horizontal and a lot more sunlight is reaching the forest floor now than did before the hurricanes.” says Dave Brownlie, regional fire ecologist with the U.S. Department of the Interior Fish and Wildlife Service (USFWS), Southeast Region, Tall Timbers Research Station in Tallahassee, Florida.

In November 2005, as the hurricane season was winding down, a small group of fire managers convened for a “train the trainers” workshop at the Joseph W. Jones Ecological Research Center in Ichauway, Georgia. The goal of the workshop, sponsored by the Joint Fire Science Program (JFSP), was to design hands-on training for fire and resource managers using a suite of tools that includes CONSUME, the Fuel Characteristic Classification System (FCCS), and the Natural Fuels Photo Series. It was there, at an informal and impromptu session, that the idea for a hurricane photo series was hatched, Brownlie says. “We realized as we struggled to complete the damage assessments that we needed the hurricane photo series to aid in future post-storm assessments.” Those present were already familiar with the Natural Fuels Photo Series. “Incident management teams do fire predictions routinely on wildfire,” Brownlie says. “The fire behavior analysts more and more are carrying volumes from the photo series to large incidents to use in their forecasts and models.”

The arrangement and loading of fuels change dramatically in a few hours during these hurricane seasons. Long-term concerns include increased fire danger over time. Drastic alterations to ecosystems, some of which harbor federally threatened or endangered species such as the red-cockaded woodpecker and the non-migratory Mississippi Sandhill crane, also pose specific management challenges.

Three USFWS National Wildlife Refuges that are part of the Southeast Louisiana Refuge Complex were especially affected by Hurricane Katrina. These refuge ecosystems require managers to maintain habitat relatively free of woody species encroachment, often using prescribed fire to accomplish this. The refuges are near major transportation routes and large population centers like New Orleans, where smoke management is critical. “With the new fuel loading and arrangement, prescribed fires will likely burn hot and create a lot of smoke for a really long time,” Brownlie says.

The inevitable future, post-hurricane emergency damage assessments will be greatly facilitated once the new hurricane photo series is available.

U.S. Fish and Wildlife Service heavy equipment operators clear a passage to the southeast Louisiana Refuges Complex Headquarters following Hurricane Katrina. Photo by Tom MacKenzie/USFWS.

Hidden Dangers

The new hurricane photo series will also help managers become more attuned to some of the unaccustomed conditions and hidden dangers that follow in the aftermath of hurricanes, even when there is not a lot of blowdown. “An unappreciated fact is that when hurricanes come through, they add lots of pine needles to the fuels on the ground,” says J. Kevin Hiers, an applied fire ecologist at the Jones Center. Those needles are the primary carrier of fire and the main constituent of biomass in the fuel. “It’s the subtle effects and changes in fuel loading that represent the most dangerous conditions,” he says.

Hiers, who has previous experience in ecological monitoring and resource management with The Nature Conservancy and at Eglin Air Force Base, sees the Natural Fuels Photo Series, CONSUME, and FCCS as essential tools for managers in the southeast in a wide variety of circumstances. “These tools are critical in estimating emissions, especially in terms of fuels outside the normal experience of managers,” he says. “After a hurricane, suddenly, you find a familiar ecosystem that isn’t quite so familiar.”

Increasingly, fuel load assessment will be part of prescribed fire regulatory planning. Florida, for example, has a sophisticated system to model smoke emissions using weather forecasts. The model is part of the permitting process and requires an estimate of tons of fuel load per acre. Fuels inventory is essential to compliance with state air quality regulations and ensuring public health. Of course, each state’s permitting process for prescribed burns is slightly different. “It’s a nice flexible tool that can work within a variety of regulatory processes,” Hiers says.

Further Information: Publications and Web Resources

The following journal articles are in press and can be accessed on the FERA website at ***http://www.fs.fed.us/pnw/fera/fccs/draft_papers.shtml*** (18 October 2007). The articles will be printed in late 2007 in a special section of the Canadian Journal of Forest Research, which is online at ***http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?cjfr***.

McKenzie, D., C.L. Raymond, L.-K. Kellogg, R. Norheim, A. Andreu, A. Bayard, K. Kopper, and E. Elman. [In press]. Mapping fuels at multiple scales: landscape application of the Fuel Characteristic Classification System. Canadian Journal of Forest Research.

Ottmar, R.D., D.V. Sandberg, C.L. Riccardi, and S.J. Prichard. [In press]. An overview of the Fuel Characteristic Classification System – quantifying, classifying, and creating fuelbeds for resource planners. Canadian Journal of Forest Research.

Riccardi, C.L., R.D. Ottmar, D.V. Sandberg, A.G. Andreu, E. Elman, K. Kopper, and J. Long. [In press]. The fuelbed: a key element of the Fuel Characteristic Classification System. Canadian Journal of Forest Research.

Riccardi, C.L., S.J. Prichard, D.V. Sandberg, and R.D. Ottmar. [In press]. Quantifying physical characteristics of wildland fuels in the Fuel Characteristic Classification System. Canadian Journal of Forest Research.

Sandberg, D.V., C.L. Riccardi, and M.D. Schaaf. [In press]. Fire potential rating for wildland fuelbeds using the Fuel Characteristic Classification System. Canadian Journal of Forest Research.

Sandberg, D.V., C.L. Riccardi, and M.D. Schaaf. [In press]. Reformulation of Rothermel's wildland fire behaviour model for heterogeneous fuelbeds. Canadian Journal of Forest Research.

Schaaf, M.D., D.V. Sandberg, C.L. Riccardi, and M.D. Schreuder. [In press]. A conceptual model of crown fire potential using the reformulated wildland fire behaviour model. Canadian Journal of Forest Research.

Management Implications

- The Natural Fuels Photo Series provides a quick, efficient first assessment of live and dead biomass across a range of landscapes. The photo series can be used to evaluate fuelbed characteristics and fuel load, and may also be adapted for goals as diverse as assessing animal and insect habitat to estimating carbon sequestration.
- Information from the new hurricane photo series will help characterize the fuels in high-priority areas for cleanup, especially those that present a clear danger to human safety and structures in the urban/wildland interface.
- The CONSUME software program allows managers to assess fuel consumption and air pollutant emissions, predict the consequences of prescribed fire and wildfire, develop a smoke management plan, and gauge some of the potential effects of wildfire on a community.
- The Fuel Characteristic Classification System (FCCS) lets managers create and catalogue fuelbeds. The system also allows the user to classify those fuelbeds for their capacity to support surface fire, crown fire, and consume fuels using a 0-9 rating scale.
- Together, this suite of tools can be used to achieve specific management objectives, from risk assessment to habitat improvement.

Fire and Environmental Research Applications (FERA) Resources

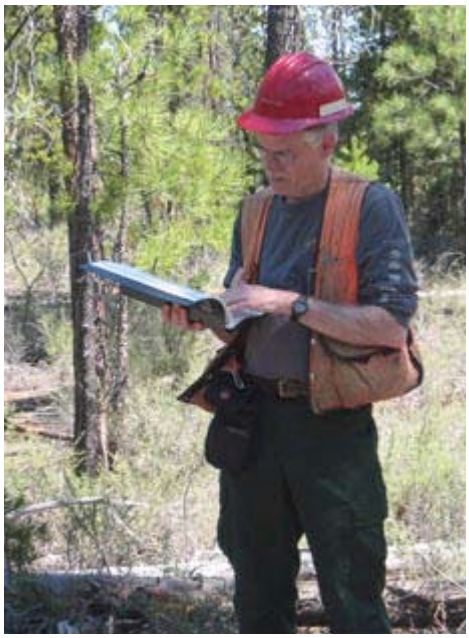
CONSUME Tutorials and Teaching Materials: ***http://www.fs.fed.us/pnw/fera/research/tutorials/consume.shtml*** (11 October 2007)

The Fuel Characteristic Classification System (FCCS) Tutorials and Teaching Materials: ***http://www.fs.fed.us/pnw/fera/research/tutorials/fccs.shtml*** (11 October 2007)

Natural Fuels Photo Series Tutorial and Teaching Materials: ***http://www.fs.fed.us/pnw/fera/research/tutorials/photoseries.shtml*** (11 October 2007)

All photos and graphs are from Roger D. Ottmar and the FERA website at ***http://www.fs.fed.us/pnw/fera*** unless otherwise noted.

Scientist Profile



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