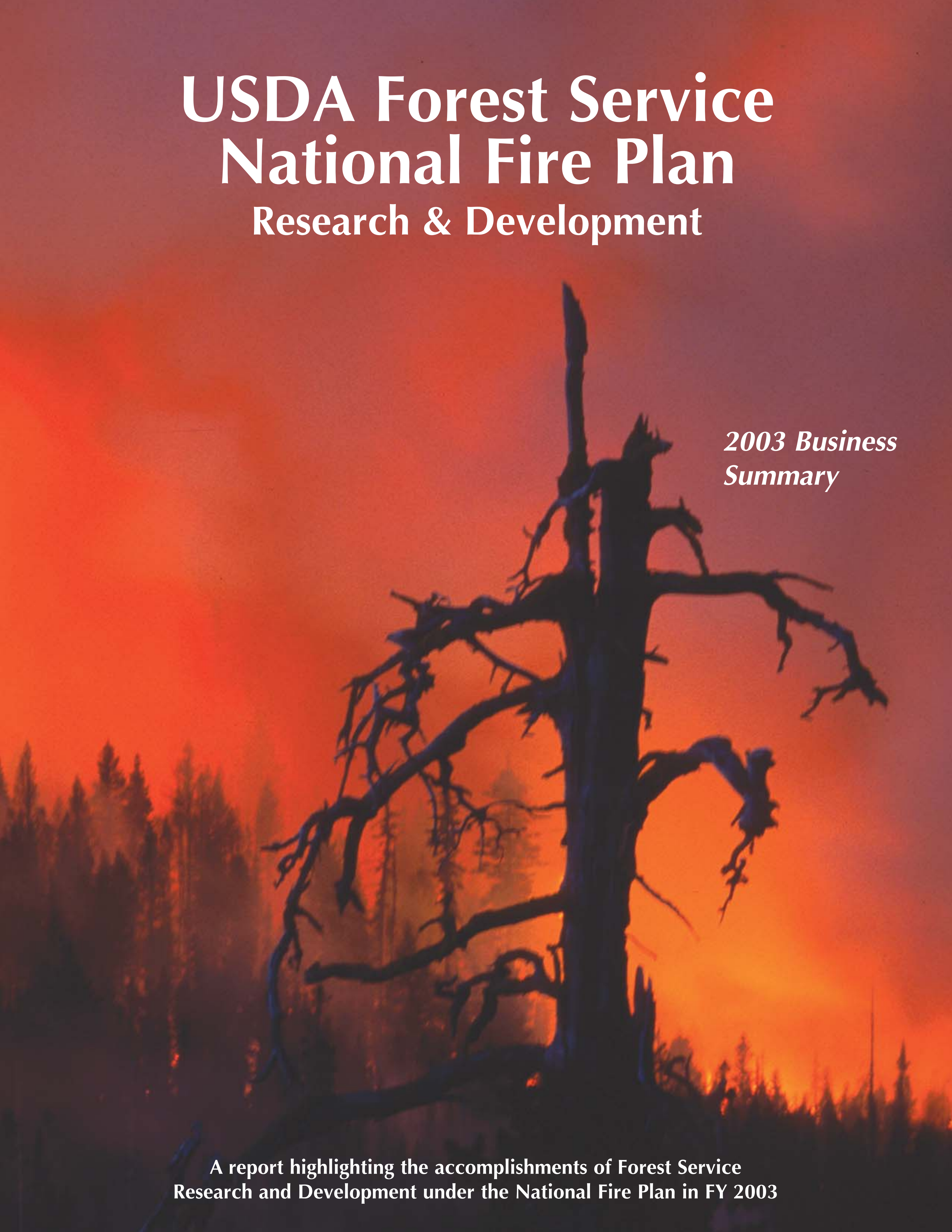
USDA Forest Service National Fire Plan

Research & Development



2003 Business Summary

A report highlighting the accomplishments of Forest Service Research and Development under the National Fire Plan in FY 2003

The National Fire Plan
USDA Forest Service

Managing the Impacts of Wildfires on Communities and the Environment

Acknowledgments

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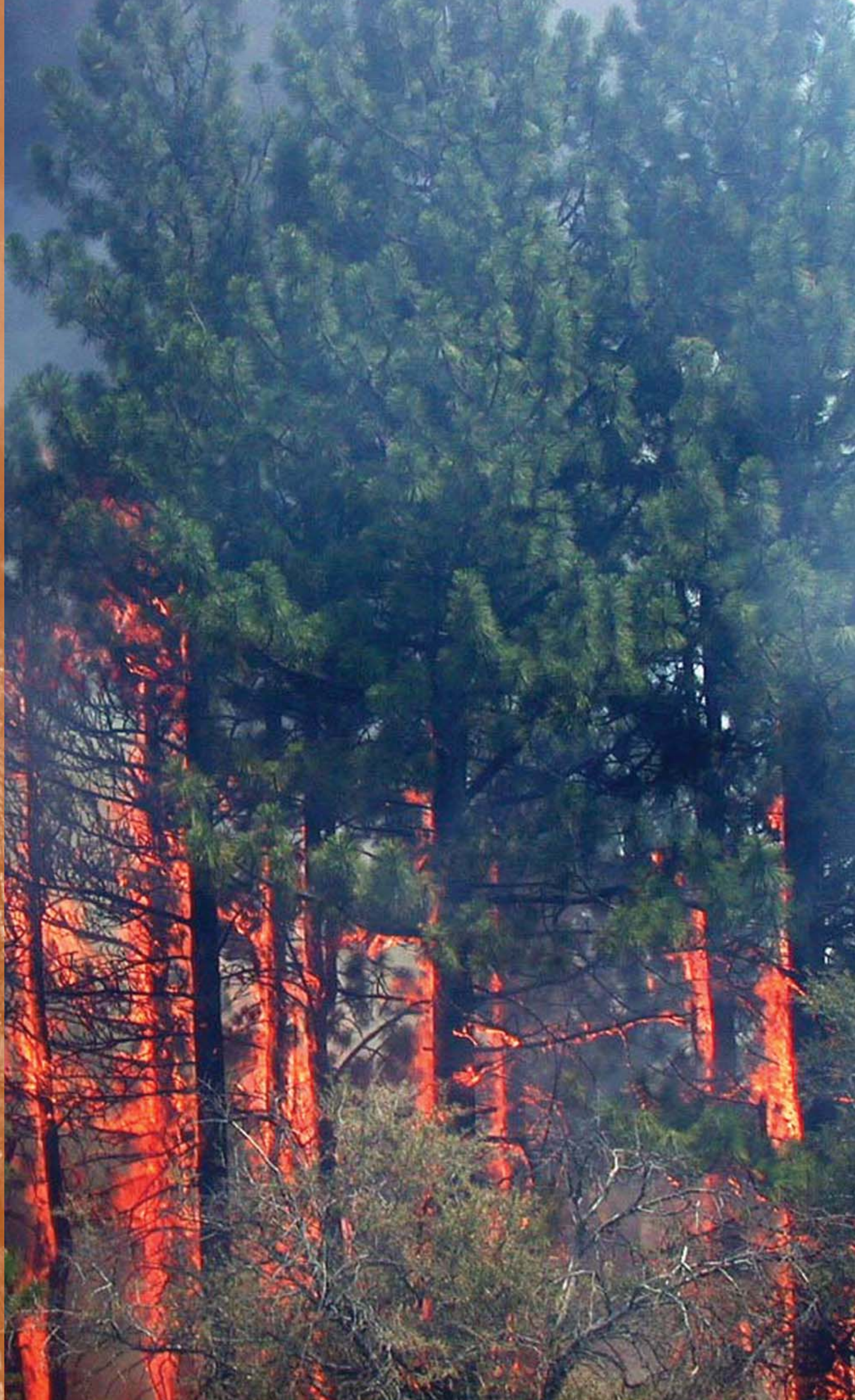
Photos provided by Forest Service Research and Development; Joint Fire Science Program; The National Interagency Fire Center Image Portal; Bureau of Land Management; and Tom Iraci.

Executive Summary



Executive Summary

As the United States continues to have unusually severe fire seasons, science-based knowledge and tools developed by National Fire Plan (NFP) research are rapidly being used by managers. These tools are helping managers better predict potential fire hazard, fire growth, and smoke impacts; evaluate fire behavior and fire severity more accurately and rapidly; improve their planning for postfire rehabilitation; better understand the effects of fuel treatments on fire behavior; and evaluate the economic costs and benefits of fuel treatments and alternative forest products. New information and tools are helping communities and homeowners to better understand what they can do to reduce wildland fire risk to their communities, and are helping managers to understand how to best work with communities in collaborative planning efforts. New information is helping wilderness managers to better predict where fires can be allowed to burn naturally without causing severe ecosystem damage or hazard to communities. Syntheses of existing knowledge are building our understanding of the impacts of fire and fuel treatments on aquatic systems and fish populations.

In 2003, in the third year of the NFP, Forest Service Research and Development (R&D) received $27 million in appropriated and carryover funding from the NFP. The R&D projects are being carried out in all 50 States. Seventy-eight research teams continued to establish new agreements with universities and other research partners; produce publications and decision-analysis tools; provide training; and transfer new information and technologies to managers, policymakers, and the public through Web sites, field tours, presentations, and other means. Scientists funded by NFP built on newly developed tools and databases to provide critical assistance to Federal, State, and local governments as they responded to the numerous fires in the interior West in summer 2003.

Guided by the strategic goals outlined in the NFP and the 10-year Comprehensive Strategy and Implementation Plan (which expanded the NFP focus into a broad, collaborative effort among multiple Federal agencies and their partners), fire research continued to actively address crucial needs in four areas:

- **Firefighting capacity—**Provide better models of weather, fire behavior, and smoke and other tools for improving firefighter decisions.
- **Rehabilitation and restoration—**Provide rapid-response information and models to help restore landscapes and protect communities from the aftereffects of fire.
- **Hazardous-fuels reduction—**Develop improved analysis tools for determining the effects and economic tradeoffs of treatments intended to reduce fire risk by removing hazardous fuels (combustible forest materials).
- **Community assistance—**Work with communities to understand their needs and priorities, develop new approaches and materials for education, and recommend acceptable approaches to ensure adequate community protection from wildfire.

Contents

Introduction

Introduction

The National Fire Plan (NFP), initiated in 2001 in response to the devastating fire season of 2000 (table 1), helps to support the enhancement of much-needed fire management and fire research activities. The severe fire seasons of 2002 and 2003 (when over 3,000 structures were burned in southern California alone) reinforce the need for an aggressive and coordinated management response, and for the science needed to support it, including knowledge about fuel conditions that predispose landscapes to large uncharacteristically destructive wildfires. Over the past 3 years, the Forest Service and the Department of the Interior have made considerable progress in reducing hazardous fuels and assisting communities in preparing for fire. The Forest Service has accelerated efforts to improve the science base, analysis, and decision-support tools for fire and fuel management in its basic Research and Development (R&D) work as well as NFP research. National Fire Plan research and Forest Service R&D complement the research supported by the interagency Joint Fire Science Program and individual agencies—such as the U.S. Geological Survey, the National Aeronautics and Space Administration, the National Science Foundation, the National Oceanic and Atmospheric Administration—and other partners. A strong science foundation is key to predicting and managing hazards from wildland fire, improving the health of fire-adapted ecosystems, and supporting management decisions in the most cost-effective and environmentally sensitive way. Supported by scientific knowledge, decisionmakers are better equipped to forecast or prevent damaging fires and to understand the consequences of their decisions for society and for forest and rangeland health.

Table 1—Number of fires and burned areas as reported by the National Interagency Fire Center, 2000–2003[a]

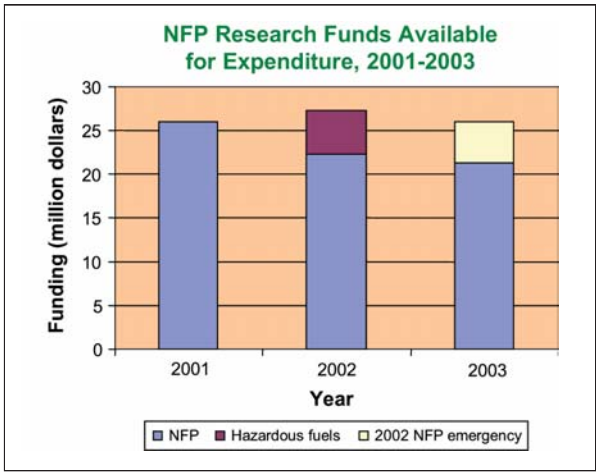
Date	Number of fires	Acres burned
2003 (Jan. 1 – Nov. 10)	57,637	3,815,952
2002 (Jan. 1 – Nov. 10)	70,140	6,734,211
2001 (Jan. 1 – Nov. 10)	76,055	3,396,363
2000 (Jan. 1 – Nov. 10)	90,420	7,250,708
10-year average 1993-2003	81,805	4,944,647

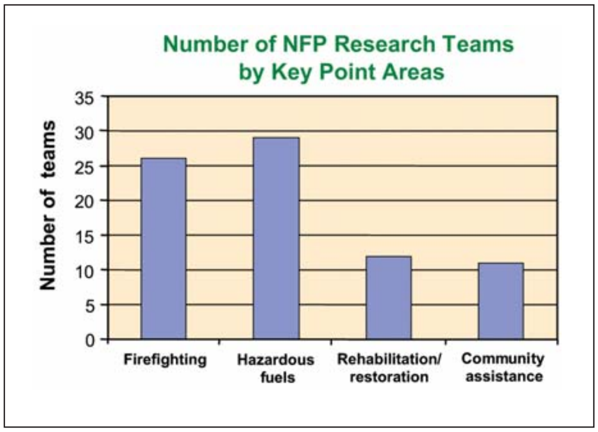
[a] This information is available online at http://www.nifc.gov.

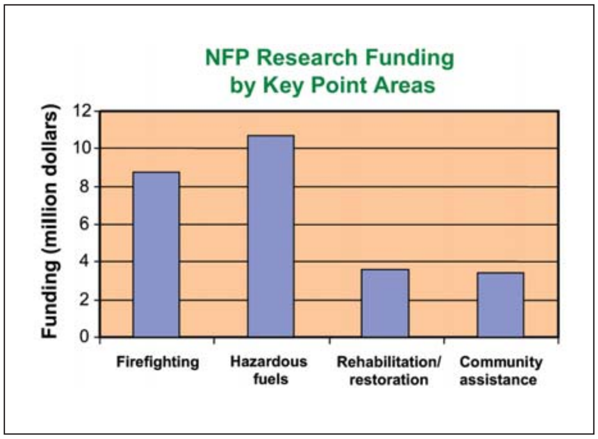
The benefits of NFP research are multifaceted. In addition to making research available through the standard research outputs of publications in journals, proceedings, and agency research papers, NFP teams focus strongly on outputs designed to meet the needs of those who make management and policy decisions. Over the past 3 years, NFP research funds have provided:

- Development of science synthesis documents and products.
- Development of useful models and tools for analyzing management alternatives.
- Critical advice to managers on fuel treatments, restoration and rehabilitation, and invasive species management.
- Evaluation of the effects of postfire treatments and fuel treatments.
- New tools and data to managers on active fire incidents.
- Development of new training materials and Web sites for disseminating information.
- Education for managers, policymakers, and citizens on related issues.
- Collaboration with universities and other key science partners.

Recent progress under NFP research is providing new information and tools to improve **firefighting** effectiveness, enhance **recovery** of burned ecosystems,improve programs for **hazardous-fuels reduction**, and enhance **community preparedness**.





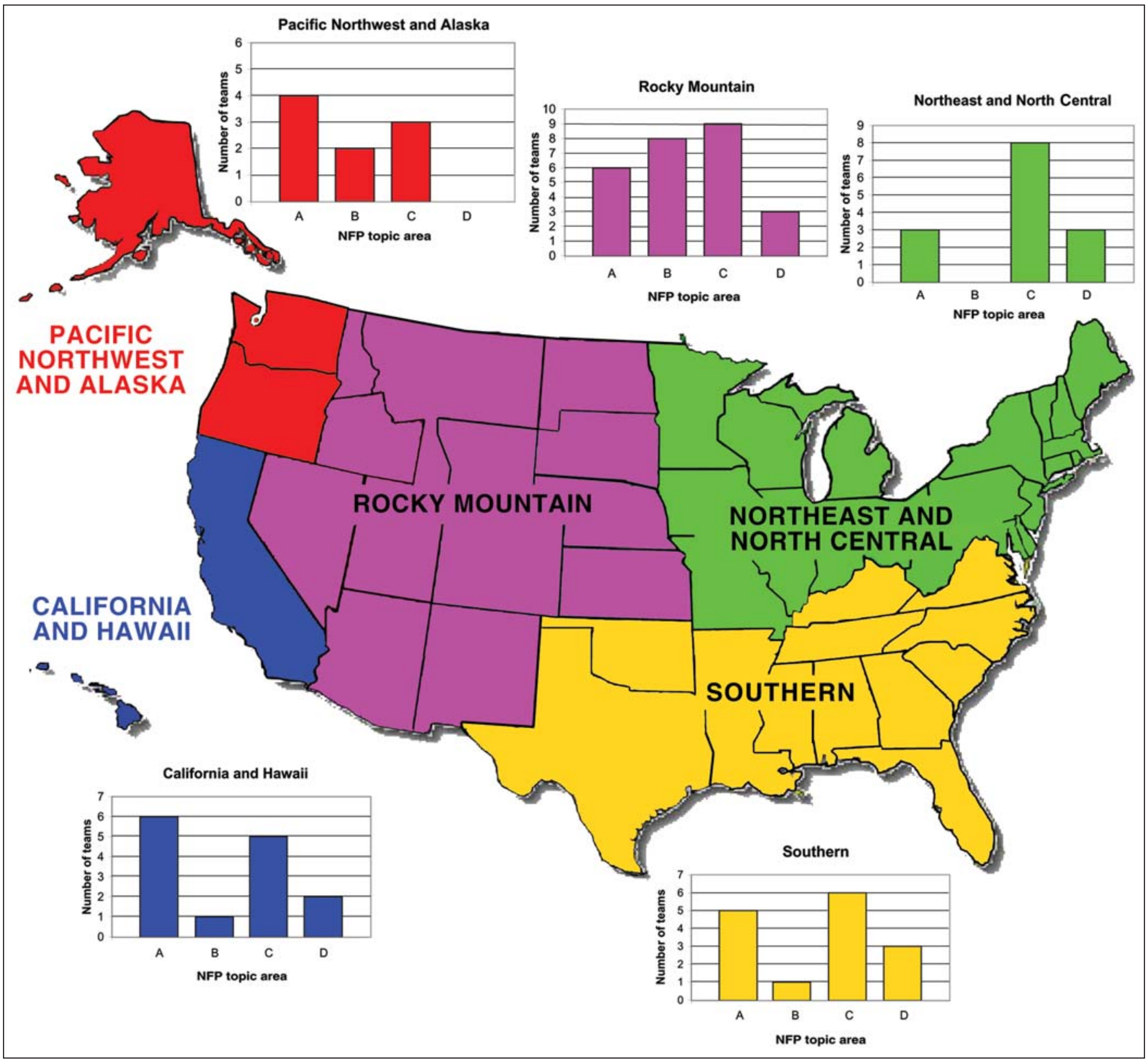


National Fire Plan Research Funding

Available funding for NFP research has remained relatively constant since 2001. However, the sources of this funding have varied from year to year. In fiscal year 2003, Forest Service R&D received a $21 million appropriation for the Forest Service NFP research program. In addition, $5 million in emergency funds, originally allocated for NFP research in fiscal year 2002, was released for spending in early 2003 and became available to support NFP research projects. Based on appropriation language for 2003, $1 million of program funds was allocated to the University of Montana Landscape Fire Center, $200,000 went to the University of Idaho to support the Fire Research and Management Exchange System project, and $390,000 was designated for national program support and special projects. The remaining $20 million (plus $5 million emergency funds) was distributed to research stations to support the 78 Forest Service NFP research teams. The number of research teams and funding amounts for the four key NFP areas are summarized in the graphs at the right.

Where Is National Fire Plan Research Taking Place?

The NFP research program is a national program that supports research in all 50 States, as well as Puerto Rico. The program attempts to balance priorities and funding to meet needs across the country in terms of science support for the key points of the NFP. The research involves Forest Service research teams and many cooperators from universities, the private sector, and non-Federal agencies (see “appendix,” table 4). The distribution of NFP activities across the country on a state-by-state basis is illustrated below. It is important to note that research funding allocated to a team at a given location may support studies in other States or regions of the country. Many Forest Service research teams have broad national or regional missions and expertise, and research conducted at one location is often applicable across broad geographic areas.



Number of research teams in different regions of the country within each National Fire Plan (NFP) topic area.

Accomplishments

Accomplishments

This report summarizes the progress and accomplishments of the Forest Service National Fire Plan (NFP) Research and Development (R&D) in fiscal year 2003, the third year of NFP funding. It describes research findings, tool developments, technology transfer, and research highlights in four key areas:

- Firefighting
- Rehabilitation and restoration
- Hazardous-fuels reduction
- Community assistance

Improving our understanding of the ecological and social factors influencing fire regimes can provide insights into the vulnerability of different communities to wildfires.

Firefighting

National Fire Plan (NFP) research is working to improve firefighting preparedness through tools and models developed to predict activities such as wildfire behavior, aggression, intensity, and effects; smoke transport; and fire-weather forecasting. Results of this research are helping managers and national forest personnel to fight fires cost effectively, increase firefighter safety, plan and conduct prescribed burns, and reduce wildfire damage to natural resources and society.

The following are NFP Firefighting Accomplishments for 2003:

- Scientists are working together in a regional consortium to develop improved means of predicting fire weather and smoke transport to enhance firefighting capability and fire preparedness. In cooperation with fire managers and fire-weather forecasters, many new and modified fire-weather predictive indices are under development and are being tested for potential implementation in operational weather-forecast models. These new indices will provide new tools for fire-weather forecasters to predict when atmospheric conditions will be conducive to extreme fire behavior (*Heilman et al., 01. NCS.A.1, North Central Research Station*).

- Improving understanding of the ecological and social factors influencing fire regimes can provide insights into the vulnerability of different communities to wildfires. Researchers completed and delivered a first-approximation fire regime map, ancillary data, and spatially explicit estimates of historical and current fire rotations to National Forest System fire managers in northern lower Michigan and Wisconsin. This information is assisting managers in allocating resources for firefighting and for identifying landscape ecosystem restoration opportunities (*Haight and Cleland, 01.NCS.A.2, North Central Research Station*).

- A stochastic fire generator was designed that incorporates potential natural vegetation, current and historical fire regimes, daily to multiannual climatology, and management scenarios (application of thinning or prescribed fire). It allows for exploration of multiple scenarios for management, particularly prescribed/wildland fire tradeoffs, and climatic change for long-term projections of patterns of variability in regional haze—air pollution in the form of haze that travels long distances and reduces visibility and the quality of the viewing experience in scenic areas (*Sandberg, 01.PNW.A.2, Pacific Northwest Research Station*).

- Researchers are producing maps linking weather conditions and fire occurrence since 1895 and using this information to develop 3- to 12-month forecasts of burned areas. They developed a data set of observed fire area for the period 1986-1996 in the conterminous United States. This information will be used to verify trends in predicted fire area simulated by the continental-scale fire and ecosystem models (*Neilson, 01.PNW.A.3, Pacific Northwest Research Station*).

- Fuels such as shrubs, old stumps, duff, and moss layers are not well represented in models currently used by fire managers to predict fire behavior and fire effects. Scientists measured consumption and fuel conditions on four wildland fires and two prescribed fires in Alaska to improve model predictions of fire severity. The findings will enable managers to make better predictions of fire danger and fire severity involving residual combustion, fire effects, and the opportunities for fire use (*Sandberg, 01.PNW.A.4, Pacific Northwest Research Station*).

- Researchers are developing a model to simulate alternative scenarios for initial response of suppression resources to wildfires (“initial attack”). This model takes advantage of new computing technology to make realistic estimates of the time required for firefighters to reach a fire from various locations where resources may be available. The new model will assist fire managers in quickly exploring options and identifying with greater certainty the best levels of investment in fuel treatments, prevention, and initial-attack programs (*Wiitala, 01.PSW.A.2, Pacific Southwest Research Station*).

- To better understand and model combustion processes in live vegetation, researchers successfully characterized the behavior of live chaparral fuels (chamise, manzanita, scrub oak, and ceanothus) by examining flame height, temperature field, and mass loss rate when fuels were burned in a cylindrical container. With this information, managers will be better able to anticipate fire risks (*Weise, 01. PSW.A.3, Pacific Southwest Research Station*).

- Forest Service research is using a recently developed thermal imaging radiometer (FireMapper) to accurately monitor active wildfire progression and intensity from aircraft, and rapidly transmit fire information to incident management groups via a combination of satellite phone and the Internet. The system, which also includes on-board computers, geopositioning, and auxiliary digital cameras, provided near-real-time data in 2003 on fires in Montana and southern California. The FireMapper system also was used to map the

A recently developed thermal imaging system provides information to evaluate and improve fire behavior models, improve firefighting safety, make firefighting more effective, and reduce wildfire damage to natural resources and society.

distribution and progress of tree mortality in control areas near homes and communities in California's San Bernardino Mountains. Maps are readily accessible over the Internet. This new system is providing information to evaluate and improve fire behavior models, improve firefighting safety, make firefighting more effective, and reduce wildfire damage to natural resources and society (*Riggan, 01.PSW.A.4, Pacific Southwest Research Station*).

Researchers established the capability to routinely retrieve, process, and store real-time satellite data to provide daily maps of active fire locations and growth of fires at 1-km resolution...

- Daily information on fire locations and burned areas is compiled from ground surveys and is not reported until the following day. Researchers established the infrastructure and capability to routinely retrieve, process, and store real-time satellite data. This automated system provides daily maps of active fire locations and growth of fires at 1-km resolution in most of the continental United States and is being used to predict fire behavior and the potential threats of fires on communities and electrical power lines (*Hao, 01.RMS.A.2, Rocky Mountain Research Station*).

- Assessing the severity of the upcoming fire season is key to efficiently allocating fire-suppression resources. A cooperative agreement was initiated with the School of Computational Sciences and Information Technology at Florida State University to evaluate the performance of physics-based fire-dynamics models to assess their applicability to southern fuel/weather conditions. These sensitivity studies will help guide long-range forecasting toward those parameters most critical to fire behavior in the South (*Goodrick, 01.SRS.A.4, Southern Research Station*).

- Nitric acid (HNO_3) is a pollutant resulting from forest burning that may be toxic to humans and plants. Because of its rapid deposition, HNO_3 contributes large amounts of nitrogen to forest ecosystems, in extreme cases causing saturation of forests with nitrogen and contamination of groundwater and streams. Scientists developed a passive sampler for HNO_3 vapor to monitor HNO_3 vapor and improve modeling of smoke contributions to regional haze in the remote locations in the Western United States (*Bytnerowicz, 02.PSW.A.1, Pacific Southwest Research Station*).

- To comply with the Clean Air Act and Regional Haze Rule requirements, it is necessary to forecast the transport of smoke over large regions. Researchers developed and validated an algorithm for mapping burned areas of large fires in real-time by using Terra and Aqua satellite data. This major breakthrough allows fire scientists to quantify daily emissions of atmospheric pollutants from fires and will help land managers plan for and conduct prescribed burns while complying with air quality standards. Regional Haze Rule is a new U.S. Environmental Protection Agency rule promulgated under court order requiring that visibility be protected in Clean Air Act Class I Areas (i.e., Forest Service wilderness, national parks, etc.) and returned to natural conditions by the year 2064 requirements and that the effects of fires on air quality be evaluated (*Hao, 02.RMS.A.2, Rocky Mountain Research Station*).

- Researchers are developing mobile instruments that can do real-time measurements of particulate concentrations emitted by fires over a large area. Three prescribed burning experiments were conducted by using light detection and ranging (LIDAR) to study plume height and smoke dispersion. This proof-of-concept study demonstrated the utility of LIDAR for investigating smoke plume properties in harsh conditions (*Hao, 01.RMS.A.3, Rocky Mountain Research Station*).

- Costs of suppressing wildfires are increasing over time, along with total suppression costs on Federal lands. Collaborative research with North Carolina State University seeks to quantify the effectiveness of suppression resources on fires nationwide. Preliminary results show how firefighters and equipment (air and ground) affect the amount of damage observed. The goal of this research is to better understand how to minimize the costs of suppression and fire-related resources and economic losses from large wildfires (*Prestemon, 01.SRS.A.2, Southern Research Station*).

Costs of suppressing wildfires are increasing over time, along with total suppression costs on Federal lands...[Research is helping to] better understand how to minimize the costs of suppression and...economic losses from large wildfires.

- A study was begun on the effect of differences in canopy cover at the home-range scale on reproductive success of California spotted owls. This analysis used previously published data from southern Sierra Nevada to examine how different amounts of low-, moderate-, and high-density canopies affected the annual recruitment of owls, after adjusting for population-level trends. The study illustrated the use of influence diagrams (graphical models that show the relationships among decisions elements such as decision alternatives, chance events and outcomes, and consequences) for comparative risk assessment and indicated that fuel treatments in some areas might be expected to have no measurable effect on owl reproduction (*Lee, 01.PSW.A.1, Pacific Southwest Research Station*).

- Wildfire resource deployments and prescribed burn go/no-go decisions depend on past, present, and predicted weather at the event location. Although programs for past and present "spot" forecasts provided by the National Weather Service are site specific, they do not provide the level of detail that state-of-the-art systems can produce. The Rocky Mountain Center provides user-friendly, up-to-the-hour analysis and forecasting of fire weather, using the Local Analysis and Prediction System. This tool supports all weather-related fire management needs (*Zeller, 02.RMS.A.1, Rocky Mountain Research Station*).

Firefighting Highlight

Reducing Risks and Protecting the Public

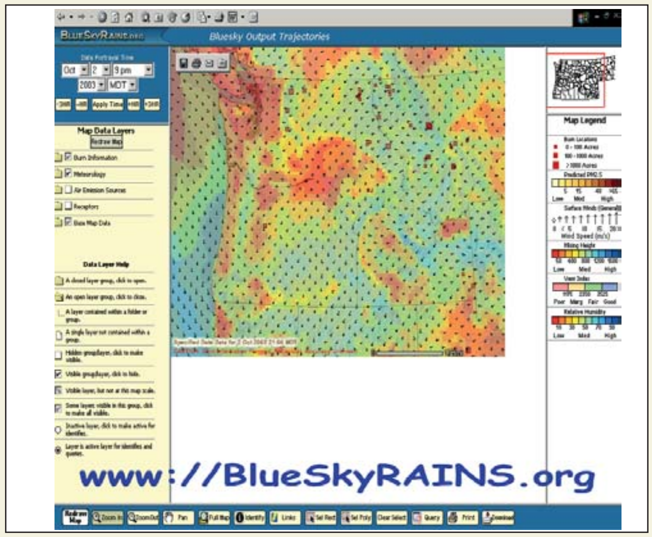
Fire Consortia for Advanced Modeling of Meteorology and Smoke

Background: We can improve firefighter safety and fire management by better understanding fire weather and smoke. Scientists in five Forest Service research stations are working cooperatively to develop a nationally consistent program of consortia, Fire Consortia for Advanced Monitoring of Meteorology and Smoke (FCAMMS), for simulating fire weather and predicting its short-term development. Each of five regional consortia is a multiagency coalition of researchers; fire managers; air-quality managers; and natural resource managers at the Federal, State, and local levels.

The mission of FCAMMS is to:

- Increase understanding of fire weather; fire danger; fire behavior; and the transport, diffusion, and impact of smoke from fire.
- Develop and implement new technologies related to regional fire weather and air quality (e.g., satellite-based, real-time smoke emissions).
- Enhance ability to use fire for land management purposes.
- Improve tools for firefighters to better predict and respond to the dangers of wildfire.

Approach: Key to the success of FCAMMS is collaboration between science and management. The members of the ideal FCAMMS include government and university research scientists; analysts; operational forecasters; information officers; and representatives from private, State, and Federal agencies concerned with fire weather and smoke. An overarching organizational structure allows administrators, field personnel, and scientists to work together to meet user needs and requirements. At the core of the products provided by the FCAMMS is output from high-resolution meteorological simulation models such as the Pennsylvania State University/National Center for Atmospheric Research mesoscale model (MM5) and similar models. Research scientists use these models, along with ancillary behavior and smoke dispersion models and remote sensing data, to provide forecasts of probable fire-weather or smoke conditions to meet operational data needs. They also use the models to study and better understand how the atmosphere and fires or smoke interact, thereby improving the value of the model results and fire-weather or smoke-dispersion tools for their users. This type of science-management collaboration allows a small number of researchers to provide data and develop products that are potentially useful to a large number of users. Different regions of the country have different smoke- and fire-related weather products needs. This regional approach combined with their user-scientist collaborative approach enables FCAMMS to better meet fire and smoke management needs of each region of the country.



The Northwest Modeling Consortium, a cooperative effort between the U.S. Environmental Protection Agency, the University of Washington, and the Pacific Wildland Fire Sciences Laboratory, is producing real-time forecasts of smoke from prescribed fire and wildfires. BlueSkyRAINS is a research product linking wind and smoke emissions being adapted for use by the Fire Consortia for Advanced Modeling of Meteorology and Smoke nationally.

Products: Products developed include:

- **High-resolution weather information**. While the National Weather Service continually upgrades observations and model data for its forecasters, access to locally focused model results (at 4-km or smaller resolution) provides firefighters with more accurate detailed winds around topographic features.
- **Fire indices.** Researchers have developed a set of indices useful for forecasting fire weather, fire danger, extreme fire behavior potential, and seasonal fire risk.
- **Smoke predictions.** The BlueSky smoke framework links weather model outputs with fire emissions to project where smoke will go and how it may impact the public. Information from the National Aeronautics and Space Administration's Moderate Resolution Imaging Spectroradiometer (MODIS) instruments is being used for fire location and near real-time fire emission inventories and is being linked with weather simulations.
- **Fire-behavior models.** Terrain-gridded weather simulations are now being used as a primary input for spatial fire behavior models, which are used for predictions of fire spread and intensity to protect people, structures, and resources.

Application: FCAMMS are helping firefighters do their jobs more safely and effectively by providing timely, high-resolution, meteorological data good for up to 72 hours into the future to:

- Burn more safely by planning prescribed fire with relevant weather information.
- Burn more effectively by identifying additional burning or treatment windows.

Firefighting Highlight

- Burn cleaner and reduce air-quality problems by developing and applying better smoke management tools.

FCAMMS are helping air-quality officials understand and properly attribute the contribution of forest fire smoke to ambient air quality by using "best smoke management practices" tools. This year, through the efforts of FCAMMS, the BlueSky smoke modeling system became operational in the Northwestern United States, southwestern Canada, California, and central and southern Rocky Mountain regions. The system consists of a flexible framework for obtaining information on the impacts of smoke by integrating fire location, forest fuels, geographic information, outputs from meteorological simulations, and air-quality dispersion models to illustrate where smoke will go and how much of it will get there. The BlueSky model predicted smoke impacts from hundreds of wildfires and prescribed fires in eight States and two provinces. Incident command teams and air managers used the predictions to anticipate impacts, warn surrounding communities of impending hazards, and help plan aerial attacks for wildfires. Air regulators used BlueSky to coordinate burn activities across land ownerships for prescribed fires. The BlueSky prototype is being evaluated by all the FCAMMS for implementation nationwide. Additionally, FCAMMS will allow access to state-of-the-science models such as the U.S. Environmental Protection Agency Community Multiscale Air Quality Model for regional haze and air-quality standard assessments.

FCAMMS is advancing fire science through basic and applied research on new fire-weather and fire-climate indices, predicting seasonal fire severity, small-scale fire-atmosphere interaction dynamics, remote sensing to detect smoke, smoke transport and diffusion, and coupled fire-atmosphere modeling. Each regional consortium produces daily predictive simulations of fire-weather and transport/diffusion variables by using a common set of modeling tools, available in almost realtime via the World Wide Web (http://www.fs.fed.us/fcamms). Users can tailor map products and analyses depicting current and future atmospheric conditions relevant for fire weather, fire behavior, and smoke. These products are already being used by fire managers and fire-weather meteorologists in many regions to aid them in making decisions about daily firefighting activities, as well as for planning prescribed burns. FCAMMS is committed to learning how well these products work by validation through feedback from user communities and field tests.

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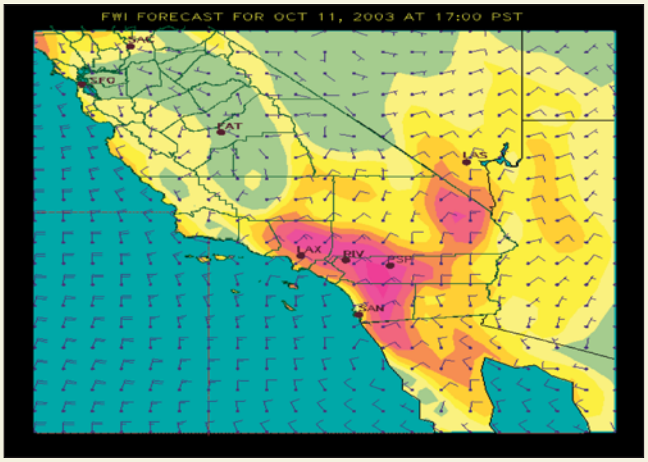
U.S. Department of the Interior



The southern FCAMMS-SHRMC, a cooperation between the University of Georgia and the Forest Service Southern Research Station, produced this 12-km resolution MM5 simulation of surface relative humidity, winds, and surface pressure at 12Z, August 28 for 24 hours ahead.

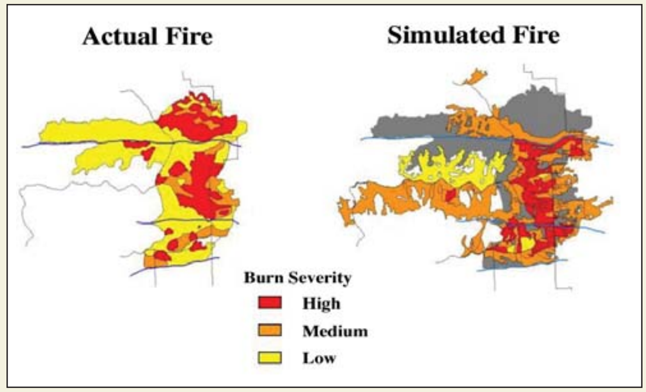
Firefighting Highlight

Improving Decisions for Fuel Treatment Options

Background: Two decision-support tools, SIMulating Patterns and Processes at Landscape ScaLEs (SIMPPLLE) and Multiresource Analysis and Geographic Information System (MAGIS), are being developed to (1) analyze the extent and likely location of fire, insects, and diseases both in the presence and absence of treatments; (2) develop treatment alternatives for addressing fuels treatment along with other resource objectives; and (3) evaluate those alternatives in a way that captures the combined effects of treatments and disturbance processes.

Approach and Products: Maps and charts are developed to illustrate the modeled distribution of fire (across the modeled landscape treatments) and other selected disturbance processes. Economics of treatments are evaluated by comparing fire-suppression costs with and without treatments with treatment costs and revenues (if any). This year the ArcGIS software extension for SIMPPLLE was completed allowing the user to easily map SIMPPLLE simulation results with the latest geographic information system (GIS) software. New fuel treatment logic in SIMPPLLE was tested for use in management plan revision. Two fine-scale fire growth simulation models, FARSITE and Forest Vegetation Simulator (FVS), with the fire and fuels extension, are being used to improve the representation of fire processes within SIMPPLLE. Design for both MAGIS Professional and eXpress was completed in cooperation with the Forest Service Inventory and Monitoring Institute and the University of Montana. The final design includes user interfaces for data checking and input, model and scenario specifications, output display, and an interactive tool for scheduling fuel treatments and other activities. MAGIS eXpress version 1.1 and MAGIS Professional versions also include a number of features requested by field personnel and geospatial integrity checks, in addition to the new GIS interfaces. New and updated screens for managing program variables (attributes) also have been added, making the modeling process easier to understand. In cooperation with the University of Montana, work has begun on a heuristic solver for MAGIS eXpress that will be much easier for field personnel to use than the current mathematical programming solver.

Four new agreements were entered with cooperators, 1 new contract was completed, 4 publications were completed, 4 presentations were made at scientific conferences, 14 demonstrations were done, and 7 significant consultations occurred.



Blodgett trailhead fire compared to the fire simulated with SIMPPLLE.

Application: Work is underway with a number of cooperators to test and evaluate these models on nine planning areas representing a variety of fuel types found on public lands across the United States. These models also are being used by the Bitterroot Ecosystem Management Research Project in cooperation with the Bitterroot National Forest to plan fuel treatments. In addition, SIMPPLLE was used to evaluate fuel treatment scenarios on a 400,000-acre area in the Swan Valley in cooperation with the Forest Service Northern Region (R-1) regional silviculturist and the assistant fuels director. The SIMPPLLE tool is being used by R-1 for project planning and forest plan revision, by the Montana field offices of the Bureau of Land Management, and by an environmental consulting firm for broad regional assessment.

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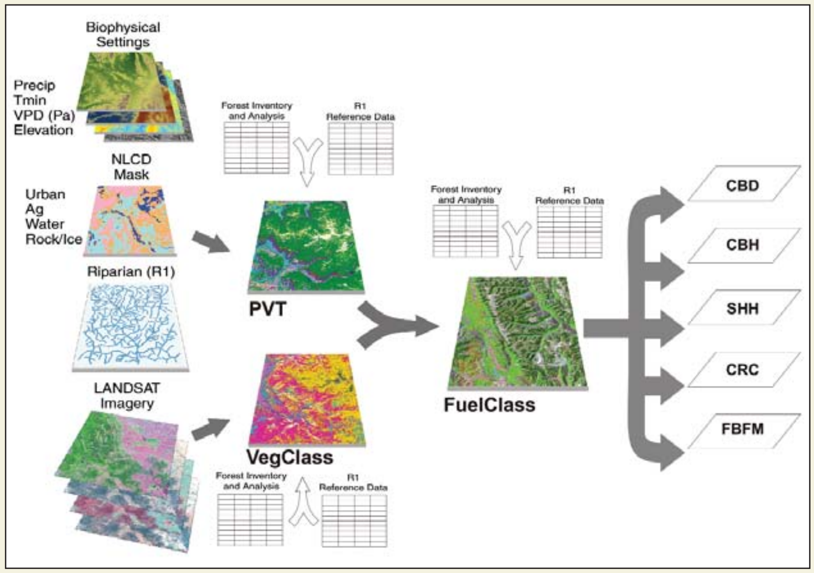
Key Partners:

Rocky Mountain Research Station units: RWU-4802, RWU-4151, RWU-4654 (Bitterroot Ecosystem Management Research Project), RWU-4653, RWU-4401, and RWU-4403
Pacific Southwest Station units: RWU-4402, RWU-4403
University of Montana
Forest Service Inventory Monitoring Institute
Forest Service Northern Region
Carroll Nelson and Associates
Geo Data
Systems for Environmental Management
Jack Losensky
Swan Ecosystem Center
Bureau of Land Management, Montana State Office

Firefighting Highlight

Remote Sensing, Geographic Information System, and Landscape Assessment Tools for Fire Management



A modified LANDFIRE approach used for creating FARSITE layers for the Northern Rockies Coordination Group, August 2003.

Background: In August 2003, scientists at the Missoula Fire Sciences Laboratory were asked to support the Northern Rockies Multiple Agency Coordination (MAC) Group in evaluating potential fire activity for 33 large fires, managed by 4 area command teams. The MAC group needed a quick way to create the fuels and vegetation structure data required to implement FARSITE, a fire area simulator, for predicting the spread and behavior of fires as a planning tool. Data and methods from the ongoing Northern Rockies LANDFIRE prototype were applied in managing these rapidly spreading, severe fires.

Approach: An adapted set of LANDFIRE protocols was used to develop the geospatial inputs for FARSITE. The LANDFIRE fuels mapping protocols integrate extensive field reference data, remotely sensed imagery, ecosystem simulation, and biophysical gradient modeling to create maps of vegetation condition and fuel characteristics. Overlap between the Northern Rockies LANDFIRE prototype area and MAC area of operations created a unique opportunity to use the LANDFIRE reference database and biophysical modeling approaches to provide an immediate product for fire management and planning.

Products: Creation of 30-meter resolution FARSITE fuel maps incorporated three main LANDFIRE databases:
Reference data–Data extracted from the LANDFIRE reference database. Consisted primarily of Northern Region ECODATA and forest inventory and analysis plot data. Information on fuels and vegetation condition was derived for each plot by using the FIREMON analysis package, a fire effects monitoring and inventory protocol.
Potential vegetation types–Created by classifying mapped topography, climate, and ecophysiological information by using classification and regression trees.
Existing vegetation–A maximum likelihood fuzzy approach was used to classify Landsat 5 and Landsat 7 satellite imagery from summers 2002 and 2003 for the MAC group's area of operations.

Potential vegetation and existing vegetation were combined, and different combinations were assigned fuel models and structural characteristics required by FARSITE. This is the main departure from the LANDFIRE method where structure is mapped separately and incorporated explicitly during the fuel mapping process. For example, researchers created separate fuel models for mesic montane shrub and herbaceous vegetation and upper subalpine shrub and herbaceous vegetation, each based on the Anderson fuel model 5 (a fire model used to predict fire behavior in a montane shrub type).

Application: The resulting fuels data were applied in several FARSITE simulations at both regional and local scales under an array of fire-weather conditions. The results of these simulations aided the MAC group in strategically planning for rapidly developing incidents across the area of operations. In some cases, the simulation results were used to pre-position resources and pretreat areas where specific values were at risk. Simulation results showed that fuels mapped with the modified LANDFIRE approach more accurately portrayed the behavior of real fires than the existing fuels data based on national forest stand maps.

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Key Partners:
U.S. Geological Survey
Forest Service Pacific Northwest Research Station
University of Montana
Systems for Environmental Management
Forest Service Forest Inventory and Analysis
National Aeronautics and Space Administration

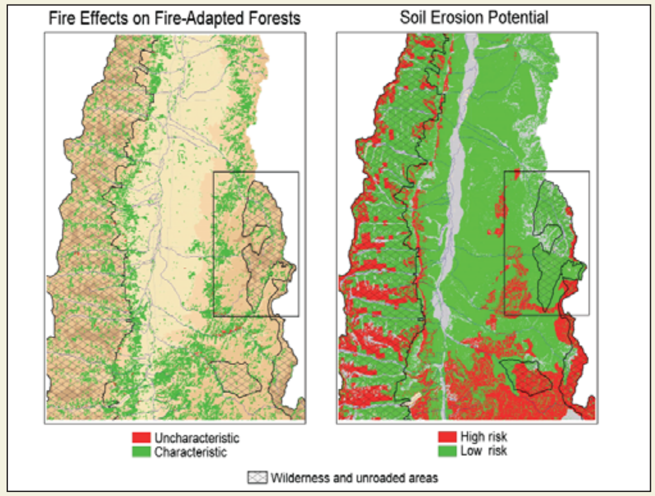
Firefighting Highlight

Identifying the Benefits and Risks of Fire Improves Planning

Background: Wilderness and other unroaded areas serve an important and unique role in the management of fire within larger landscapes. These areas provide the greatest opportunity for learning how to use lightning-ignited fires as a cost-effective strategy for thinning forests, reducing accumulated fuels, and restoring the natural role of fire to ecosystems. Currently, most lightning ignitions in large unroaded areas are suppressed because of the risks fires might pose to a variety of social and ecological values. Suppressing fire reinforces a feedback cycle where fuels continue to accumulate, risk escalates, and the tendency to suppress fires continues. Existing decision-support tools focus only on the negative consequences of fire. To make effective decisions regarding fuels and fire, managers need to assess the benefits of fire use along with its risks, as well as the consequences of continued fire suppression. Without information on the benefits of fire, the justification for using wildland fire as a management strategy is severely limited.

Approach: Our geographic information system (GIS)-based protocol uses available data and computer tools. A weather analysis tool (FireFamilyPlus) is used to summarize local fire weather data in terms of threshold conditions (i.e., 87th, 90th, and 97th percentile fire danger ratings). Spatial data on fuels and the summarized weather data are then put into a spatially explicit fire behavior model (FlamMap), which is used to generate a library of GIS maps that identify fire behavior parameters (such as crown fire activity) under different fire weather threshold conditions. This generates information about the current landscape. To consider future conditions, landscape dynamic simulation models may be used to generate potential future landscapes and fuels profiles. Map libraries of first- and second-order fire effects are then generated from these fire behavior parameters by using existing tools such as First Order Fire Effects Model (FOFEM) or the Water Erosion Prediction Project model (WEPP), or from locally developed, rule-based algorithms such as species-habitat relationships.

Products and Tools: Rocky Mountain Research Station scientists at the Aldo Leopold Wilderness Research Institute in Missoula, Montana, are trying to break the feedback cycle between fire and fire suppression. During fiscal year 2003, they developed a protocol for managers to use to identify key areas of fire risk and systematically determine where and under what conditions fire will benefit ecological conditions while reducing fuels. Information about fire weather, vegetation, and fire behavior is used to build a library of maps that display the expected fire behavior under critical fire-weather conditions and resulting effects on different social and ecological values. These maps can be used to identify areas where opportunities exist for achieving resource benefits on a wildfire incident, as well as to monitor and report progress toward land management goals. An important feature of this protocol is that fire effects are expressed in terms meaningful to both fire managers and land managers, thereby bridging a common communication gap that exists between those two groups.



Two maps from the library generated for the Bitterroot National Forest of expected effects on soil erosion and fire-adapted forests from a burning under moderate weather conditions. Together with other maps in the library, these maps identify areas where managers can safely allow fires to burn. For example, within the highlighted area, fires are likely to have substantial ecological benefits with few adverse impacts.

Application: The library of maps generated by this protocol is being used by managers at the Bitterroot National Forest in western Montana to update and develop new guidelines for their fire management plan. In addition to providing them with planning and tactical assistance, local fire management officers will use the map library as a valuable public communication tool. The national forests in the Northern Region's Western Montana Planning Zone also are planning to use the protocol. For instance, the Beaverhead-Deerlodge National Forest will use the protocol during their upcoming forest plan revision to project how the addition of wildland fire use zones could affect critical forest resources in the future. This research is providing a way for managers to classify potential fire effects into beneficial vs. detrimental categories, and is helping them decide where and under what conditions fires can be allowed to burn. With better informed decisions, managers can focus suppression resources where fires pose clear risks and avoid costly expenditures where fires confer resource benefits.

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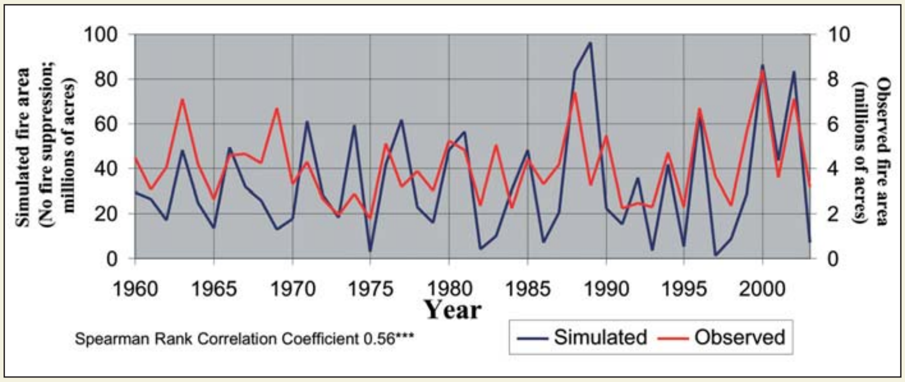
Key Partners:

Bitterroot National Forest, Beaverhead-Deerlodge National Forest Northern Region Western Montana Planning Zone

Firefighting Highlight

Forecasts and Applications in the 2003 Fire Season



MC1 demonstrated a highly significant correlation between observed vs. simulated trends in total annual area burned in the United States from 1960 to 2002. The observed area burned is an order of magnitude less than the simulated area owing to fire suppression and other land use effects not yet accounted for in the model. An ocean atmosphere climate regime shift occurred in 1988-89 and demonstrates that the recent increase in fire area is clearly related to climate.

Background: Recent fire seasons have been unusually severe and expensive in terms of firefighting costs, as well as loss of life and property. Forewarned is forearmed in terms of how much to allocate for firefighting, where to locate the firefighting resources, and where fuel reduction activities might be most effective. Ideally, forecasts of fire risks would project out 2 or 3 years, but even a few months warning is helpful. Increased fuel loads, owing to a century of fire exclusion, have traditionally been thought to be the cause of recent large fires. However, climate variability is now increasingly considered to have had a large role in the recent fire patterns. Thus, fire forecasts must be balanced by historical analyses of fire-climate interactions to understand the present fire situation and how to prepare for both the near- and the long-term future. Fire area in the West has been strongly related to the Palmer Drought Severity Index (PDSI), following two interdecadal wet-dry cycles since the mid-1970s. The recent climate variations are related to El-Niño/La-Niña cycles and various oceanic interdecadal oscillations, with climate regime shifts in the mid-1940s, 1970s, and from 1988 through 1989. The West is in one of the worst droughts of the century, following fuel buildup during strong wet cycles, a pattern that appears to have fostered much of the recent severe fire situation.

Approach: Retrospective analyses are made possible through gridded weather observations dating from 1895 to the most recent month. Simulations of the past century also are required for the model to estimate current fuel loading and fuel condition, albeit without fire suppression included in the model. The model shows good accuracy in simulating the spatial and temporal distributions of observed fire activity in the United States over the last four decades, even without accounting for fire suppression. Both observed and simulated fire areas over the United States declined slightly from 1960 to 1988, but have increased dramatically since then. Forecasts for the 2003 fire season were updated monthly, based on three 6-month coupled ocean-atmosphere climate model forecasts. Observed fire activity in the 2003 fire season was remarkably coincident with the simulated distribution of fire risk and was relatively low compared to recent years.

Products and Tools: The Mapped Atmosphere-Plant-Soil System (MAPSS) Team has developed one of two models in the world that can simulate most terrestrial ecosystem dynamics, including the location, timing, and impacts of wildfire. Although originally developed for simulating potential climate change impacts, the model, MC1, is ideally suited for seasonal fire danger forecasting and for analyzing historical climate-fire interactions. The team is publishing on the World Wide Web experimental 6-month fire-risk forecasts to better anticipate firefighting and management needs (http://www.fs.fed.us/pnw/corvallis/mdr/mapss/fireforecasts.htm).

Application: The forecasts and historical analyses are being used in briefings to the USDA Undersecretary for Natural Resources and Congress and for the Quadrennial Fire Review for understanding the recent historical and possible future fire patterns. Because the seasonal forecasts are relatively new and experimental, their use on the ground is only now being explored.

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Key Partners:

Oregon State University, Spatial Climate Analysis Service

The Program for Climate, Ecosystem and Fire Applications: a collaboration between the Desert Research Institute and the Bureau of Land Management National Office of Fire and Aviation

International Research Institute for Climate Prediction (Columbia University)

SCRIPPS Institution of Oceanography

Rehabilitation and Restoration

After wildfires, Federal, State, and local agencies are concerned with maintaining the quality of water; minimizing the negative impacts of accelerated runoff, erosion, and sedimentation; and ensuring optimal recovery of vegetation and ecosystems. Results of this research are helping managers to apply appropriate and cost-effective restoration and postfire rehabilitation treatments and to develop improved procedures for monitoring treatment effects.

The proliferation of fire-adapted species, such as cheatgrass in the Great Basin, is negatively impacting ecosystems by increasing fire frequency, intensity, and size.

The following are NFP rehabilitation and restoration accomplishments for fiscal year 2003:

- Researchers are monitoring the effects of fuel reduction and restoration treatments on the spread of weeds to provide managers with information on the relative risks of choosing alternative vegetation treatments. They adapted and developed landscape invasive plant sampling methods for use in the upper Grande Ronde River basin study area. Researchers also discovered a major, previously undetected landscape-scale invasive plant infestation, *Ventenata dubia* (Leers) Gross. & Dur., or north Africa grass. A new study of *V. dubia* was initiated in cooperation with the Wallowa-Whitman National Forest (*DePuit, 01.PNW.B.1, Pacific Northwest Research Station*).

- Management objectives increasingly require burned areas to be restored by using native plant species, but the availability of these species is low, and little information is available on which native species would work best. Researchers found that post-wildfire rehabilitation on pinyon-juniper woodlands and big sagebrush shrub steppe by aerially seeding grasses was much more effective when the seeding is followed by chaining than when no postfire treatment was administered (*McArthur, 01.RMS.B.2, Rocky Mountain Research Station*).

- Extensive fires in recent years have left entire landscapes vulnerable to weed invasions that in turn dramatically alter fire regimes and negatively impact native plants and animals. A greenhouse pilot study was conducted that assessed alterations in plant primary metabolic processes as indicators of plant biotic stress owing to herbivory by biological control agents. This information will help managers to anticipate and mitigate weedy species invasion (*Markin, 01.RMS.B.3, Rocky Mountain Research Station*).

- The proliferation of fire-adapted species, such as cheatgrass in the Great Basin is negatively impacting ecosystems by increasing fire frequency, intensity, and size. Factors that make ecosystems particularly susceptible to these “invasions” were examined. Researchers developed improved equations for determining fuel loads for Great Basin woodland trees and determined fuel loads for trees in Joint Fire Science Demonstration Area plots. They also developed techniques for safely conducting small-plot burns in Great Basin shrub and woodlands. This information will facilitate development of management techniques that prevent initial invasions and curb expansions (*Chambers, 01.RMS.B.5, Rocky Mountain Research Station*).

- High-elevation white pines (bristlecone, whitebark, and limber pines) are important species that regenerate after fire, help reduce soil erosion, and set the stage for the development of commercially valuable forest types. Researchers demonstrated that limber and bristlecone pines are effective at naturally colonizing and stabilizing the interior of large burned areas where other species cannot. This information will assist managers by identifying and selecting sources of white pine seeds that display hardiness and resistance to the pathogen to ensure economical and ecological restoration of these sites (*Schoettle, 01.RMS.B.6, Rocky Mountain Research Station*).

- Researchers are looking at the effectiveness of tools, such as prescribed fire, in restoring and sustaining native grasslands and reducing the incursion of woody plants. A study was completed by using calorimetry to document population differences in important shrub species and biological soil crusts. It documented the physiological differences in optimal growth temperatures of southern and northern collections, information important for restoration work (*Finch, 01.RMS.B.7, Rocky Mountain Research Station*).

- As nonnative plants become more dominant on both disturbed and undisturbed sites in the interior Pacific Northwest, native plant communities may experience loss of biodiversity, alteration of ecosystem function, and shifts in plant succession patterns. A study was conducted on seeds collected from 10 species of native grasses and 13 species of native forbs (flowering plants). They were sown following a prescribed burn. New germinants indicate the sowing was successful. Methods for postfire rehabilitation and restoration that favor native over nonnative plant viability will be developed and shared with land managers (*Parks, 02.PNW.B.1, Pacific Northwest Research Station*).

- Several watershed models have been developed to predict runoff and sediment yield, but little effort has been directed specifically toward modeling the effects of wildfire and prescribed fire on forest hydrology. A new study site (mountains of northwest Georgia) was established and instrumented (i.e., with streamflow samplers, overland flow samplers, and soil solution lysimeters) to model the effects of wildfire and prescribed fire on forest hydrology and soil erosion. Pretreatment baseline data on a new study area were obtained, and an additional study site was established to measure and model postburn water-quality responses (*Vose, 02.SRS.B.1, Southern Research Station*).

- Information on the waterflow patterns and geology of sites is critical for assessing risks of postfire erosion and flooding, and selecting postfire treatments that will mitigate these effects. Researchers are working to incorporate these factors into predictive models that

Post-wildfire peak flood flows are the major threat to watershed resources, cultural resources, and human health and safety after fires are extinguished.

will provide managers with better support for burned area emergency rehabilitation decisions. Two watersheds with prior data on streamflow at Stermer Ridge (Apache-Sitgreaves National Forest) were reinstrumented to measure post wildfire peak flow floods. Researchers found that peak flow floods on both watersheds were higher than previously measured (1972-1976). Post wildfire peak flood flows are the major threat to watershed resources, cultural resources, and human health and safety after fires are extinguished (*Neary, 01.RMS.B.1, Rocky Mountain Research Station*).

- Stands previously thinned and burned via stand treatments to improve forest health (STIFH) provided the opportunity to investigate postburning forest pathogen conditions in ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) to determine forest pathogen population dynamics and pathogen survivability in stands treated with different fuel reduction treatments. It was found that southwestern dwarf mistletoe (*Arceuthobium vaginatum* ssp. *cryptopodum*) is the most common pathogen in northern Arizona thin and burn STIFH stands. This information will be useful in developing guidelines for postfire vegetation management (*Clancy, 01.RMS.B.4, Rocky Mountain Research Station*).

Early-spring fire in a pine-hardwood forest ecosystem on the Uhwarrie National Forest, North Carolina.

Rehabilitation and Restoration Highlight

Effectiveness of Postfire Rehabilitation Treatments

Background: Each year land management agencies spend millions of dollars on emergency stabilization and rehabilitation treatments to protect downstream resources from increased erosion and flooding after wildfire. However, the effectiveness of many rehabilitation methods has never been tested quantitatively, making it difficult for burned area emergency rehabilitation (BAER) teams to assess realistically the short- and long-term benefits of prescribed treatments relative to their economic and ecological costs.

Approach: In fiscal year 2003, researchers established and measured two study sites that test the effectiveness of contour-felled logs, a popular but expensive treatment for reducing postfire runoff and sedimentation, on the Hayman (Pike-San Isabel National Forest, Colorado) and Cannon (Humboldt-Toiyabe National Forest, California) Fires of 2002. They now have six installations measuring the effectiveness of this treatment. The Hayman Fire site also tests two alternative rehabilitation treatments: hydromulch and helimulch (helicopter-applied dry mulch). Analysis to date shows that contour-felled logs may reduce sediment output from watersheds after small or average storms, but they have little effect on erosion or runoff from short-duration, high-intensity rain events. The researchers presented these results at BAER training sessions and professional society meetings attended by land managers and rehabilitation specialists. Preliminary results indicate that the helimulch treatment produced less sediment than the other treatments and the control.

Measurements continued in fiscal year 2003 at the site on the Indian Fire (Prescott National Forest, Arizona), set up in cooperation with the San Dimas Technology and Development Center, where researchers evaluated erosion reduction effectiveness of innovative mulch treatments, relative to hand-spread straw and an untreated control. Felling and chipping all fire-killed trees and spreading compressed straw pellets impregnated with an adhesive substance that ties mulch and soil together, both reduced initial sediment production by 40 to 100 percent relative to untreated plots during the first year, depending on storm intensity. The team established another experimental site in fiscal year 2003 testing alternative rehabilitation treatments following the Williams Fire (Angeles National Forest, California) in several 3- to 5-acre catchments. An aerially applied soil flocculant (polyacrylamide or PAM) had no effect on surface texture, erosion rates, or sediment yield from the winter rains of 2003. Prefabricated wooden check structures (Flow Check™) functioned as designed, trapping sediment in the channels and reducing initial yield from the watersheds. Flocculant-releasing blocks (Floc Logs™) had no apparent effect on movement of sediment once it reached the stream channels.

Installation of silt fences at the mouth of a treated catchment on the Indian Fire mulch treatment study on the Prescott National Forest.

Products: A color brochure summarizing the first-year results was prepared for managers at the Prescott National Forest and others who have expressed interest. Subsequent data indicate continued effectiveness of these treatments.

Application: Over 200 users have been trained in the use of erosion prediction and mitigation effectiveness prediction tools. In 2003, over 18,000 runs were carried out on Forest Service servers predicting soil erosion risks following wildfire and supporting fuel management, with users from over a dozen universities, eight Federal agencies, and every National Forest System region.

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Although the research described here was originally funded as a hazardous-fuels project, the team also is addressing components of postfire rehabilitation as part of its research program.

Key Partners:
National Forest System Northern, Rocky Mountain, Intermountain, Pacific Southwest, and Pacific Northwest Regions

Rehabilitation and Restoration Highlight

Decision-Support Tools for Fire-Related Erosion

Background: Sediment from rapid soil erosion on areas severely burned can damage public drinking water supplies, fish habitats, and downstream structures. Land managers need a way to select and implement effective postfire emergency erosion treatments. Computer modeling tools developed by the Rocky Mountain Research Station can help managers make better decisions about treatments.

Approach: Forest Service scientists have made adaptations to the Water Erosion Prediction Project (WEPP) model, originally developed by the Agricultural Research Service National Soil Erosion Laboratory, to make it applicable to forest conditions after fire. These adaptations of the WEPP model use climate, soil, topographic, and vegetation information appropriate to forests to estimate runoff, erosion, and sediment yield from a site. These tools are being made available to managers and field personnel on the World Wide Web. A separate model, the Fire Enhanced Gully Initiation Model (FERGI), addresses effects of specific slope treatments on surface waterflows and streamflow. Fieldwork is continuing to gather data following wildfires and fuel management on sites in California, Colorado, Idaho, Montana, Utah, and Washington to aid in further refinement and validation of all our models.

Products and Tools: Tools developed include:

- FSWEPP (http://forest.moscowfsl.wsu.edu/fswepp/) is an Internet-based modeling system used to estimate erosion rates from soils disturbed by fire and to identify what areas have high erosion risk after fire.
- The Erosion Risk Management Tool (ERMiT) model predicts the probability of a given erosion event and annual erosion amount for 5 years following a fire, considering variability in climate, soil, and space. The ERMiT model is particularly useful in predicting the benefits of seeding or mulching on erosion reduction.
- A geographic information system (GIS) interface for the WEPP model (GeoWEPP) aids in postfire predictions of erosion over large, complex landscapes for uses such as protecting sensitive watersheds.
- The FERGI model (http://www.fs.fed.us/rm/boise/) was developed for evaluating the impacts of contour-felled logs, a commonly applied mitigation after wildfire, on surface waterflows and stream channel hydrology. It estimates the probability of runoff events and the probability of gully initiation on hillslopes by using simple information that can be gathered from onsite measurements. Although increased sediment loads reduce fish habitat quality, severe gully-forming events following fire that scour streams and kill and remove fish are of greater concern ecologically. Estimating the degree of risk reduction for such events is important to decisionmaking.

Application: The NFP funded 10 workshops in fiscal year 2003 to train natural resource specialists to use the WEPP-based tools. Over 200 practitioners were trained in the past year alone, and more workshops are planned in 2004. Tools developed are being used extensively by all Forest Service regions, many State agencies, consultants, numerous universities, and over a dozen foreign countries. Since May 2003, when it was put on-line, there have been 480 computer runs using ERMiT, mainly for designing erosion control measures after fires in Montana, Idaho, and Arizona. Burned Area Emergency Rehabilitation specialists applied GeoWEPP for the first time in 2003 to a postfire evaluation on a municipal water supply watershed in Idaho. This new tool will be Web-enabled in the future. The FERGI model was first used in 2003 for analysis of three wildfires in Idaho. Information from the model was the deciding factor for not using contour-felled logging over a large area because the marginal decrease in risk of a severe event was too small to warrant the cost. By using additional information about fish ecology provided by NFP-funded research, it was decided that removal of fish passage barriers would be substantially more cost effective for protection of endangered species. The decision resulted in a savings of several million dollars and protected conditions for several populations of a threatened species.

Researchers from Rocky Mountain Research Station, Boise Aquatic Sciences Laboratory, working on the influence of wildfire on stream fish communities within the perimeter of the 2003 Hot Creek Fire on the Boise National Forest in October 2003.

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Although one of the teams whose research is described here was funded primarily as a hazardous-fuels project, the team is addressing components of postfire rehabilitation as part of its research program.

Key Partners:
Forest Service San Dimas Technology and Development Center (San Dimas, California)
Agricultural Research Service National Soil Erosion Research Laboratory (West Lafayette, Indiana)
Bureau of Land Management National Science and Technology Center (Denver, Colorado)
National Forest System Northern and Intermountain Regions

Rehabilitation and Restoration Highlight

Fire and Aquatic Ecosystems Synthesis: A Proceedings

Background: The Fire and Aquatic Ecosystems Workshop was held April 22-24, 2002, in Boise, Idaho. The purpose of the workshop was to synthesize new information and current knowledge on the role of fire in, and effects of fire on, aquatic and riparian ecosystems, and to explore potential research areas that will improve understanding of these areas. The goal was to provide a foundation for biologists and managers trying to protect and restore the ecosystems and important processes influenced by fire.

Approach: The workshop was arranged around four major themes: fire history, vegetation and postfire management, the effects of fire on physical and watershed-level processes, and the effects of fire on biological processes. Presenters were invited based on their expertise in these areas and the relevance of their work to issues in the management of aquatic ecosystems or the integrated management of terrestrial and aquatic ecosystems.

Products and Tools: Fourteen papers including a keynote address by Michael Rains, the primary architect of the NFP, were presented in the workshop. Over 30 leading scientists and managers authored 13 peer-reviewed publications and a formal synthesis of fire management implications from the workshop. These papers appeared in a special issue of *Forest Ecology and Management,* published in June 2003. Information on the workshop with links to related information and publications are available on the Internet: http://www.fs.fed.us/rm/boise/teams/fisheries/fire/firehome.htm.

Application: Biologists and managers have used the workshop proceedings extensively. Tracking of Web site activity has documented over 5,000 downloads and requests for workshop papers since January 2003. Some specific comments from a range of users follow:

- "I have used every paper presented in the workshop…I have used the products for BAER training, planning, and implementation, assessing fire effects on threatened and endangered species, emergency consultations, comments on Fire Management Plans, prefire planning, and scientific presentations."
  - Chad Mellison, U.S. Fish and Wildlife Service, Reno, Nevada.
- "I have extensively used the papers from the proceedings. I also forwarded information regarding the workshop proceedings to the National Oceanic and Atmospheric Administration (NOAA) fisheries biologists throughout our northwest and southwest regions, and have had positive feedback about its content and use for Endangered Species Act consultations."
  - Charley Rains, NFP Coordination Team representative for NOAA Fisheries
- "The Boise National Forest has used the newest research from the journal *Forest Ecology and Management* to assess the effects of the Hot Creek Burned Area on the fisheries resource, specifically bull trout. We feel that the research has been key in rationalizing the importance of providing full access to habitat within ecosystems."
  - Thomas J. ("T.J.") Clifford, Boise National Forest Supervisor's Office
- "I thought the special issue of *Forest Ecology and Management* was fabulous… I've already made use of it in classes and at a symposium."
  - Dan Binkley, Director of the Graduate Degree Program in Ecology, and Professor, Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University

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Key Partners:
University of Idaho Ecohydraulics Research Group
Boise National Forest
Pacific Northwest Research Station Aquatic and Land Interactions Program
National Forest System Forest Service Northern and Intermountain Regions

Hazardous-Fuels Reduction

Prescribed fire increased soil bulk density and coarse texture as well as increased and redistributed coarse surface sediment.

Managing forest and rangeland vegetation and fuels in ways that reduce fire risk to communities and fire damage to ecosystems is a major focus of the National Fire Plan (NFP). Research on hazardous-fuels reduction is helping managers set priorities, determine appropriate treatment regimes, and balance the often complex tradeoffs between the benefits of managing fuels to reduce fire intensity and severity and the possible social, environmental, and ecological impacts of mechanical and prescribed fire treatments.

The following are NFP hazardous-fuels reduction accomplishments for fiscal year 2003:

- Knowledge about the condition of vegetation (fuels) is critical in assessing fire hazards and fire effects; however, managers need tools to help them assess the amount, distribution, and arrangement of fuels in the field. Two photo series volumes (hardwoods with spruce in Alaska and jack pine (*Pinus banksiana*) in the Lake States) were completed that will aid fire and fuels managers in estimating fuel loading and other characteristics for fire planning and fire risk assessment (*Sandberg, 01.PNW.C.1*).

- The objective of the Kings River Experimental Watershed (KREW) study is to quantify the effects of fuel reduction techniques (mechanical thinning and prescribed fire) on small streams. Renovation of the Teakettle Weir will maintain continuity of a valuable streamflow record for small streams that dates from the 1940s. This is a critical control watershed for the KREW study because it is representative of historical conditions for mixed conifer in the southern Sierra Nevada and has never been harvested or significantly influenced by roads. KREW has results that will help to guide managers in selecting fuel reduction treatments best suited for these sensitive zones (*Hunsaker, 01.PSW.C.1, Pacific Southwest Research Station*).

- Researchers are examining various fuel treatments as alternatives to fire in reducing fuel buildups, enhancing soil properties, and improving carbon storage. Through a cooperative agreement with the University of California, Challenge Experimental Forest and Whitmore Forest were instrumented to continuously record soil moisture and temperature fluxes at 20 and 50 centimeters soil depth. Findings will help guide managerial decisions about treating fuels in high-risk zones (*Powers, 01.PSW.C.2, Pacific Southwest Research Station*).

- The effect of fire and fuel reduction treatments on wildlife species is not well understood. A draft study plan was completed for the Plumas-Lassen Administrative Study to assess multiscale effects (stand-landscape) of fuels treatments and wildfire on California spotted owls (*Strix occidentalis occidentalis*) and their habitat within the Herger-Feinstein Quincy Library project area, and to evaluate alternative land management regimes on owls, fuel conditions, wildfire, vegetation, and other response variables. Results will help managers make decisions about fuel reduction alternatives to achieve ecosystem goals while minimizing impacts on key species (*Keane, 01.PSW.C.4, Pacific Southwest Research Station*).

- A book entitled *Restoring Western Ranges and Wildlands* was completed. It will aid specialists in managing existing vegetation and restoring native ecosystems, managing fuels, and reducing the spread of invasive species, and also will provide managers with new tools and plant resources for reestablishing and protecting biological diversity (*Shaw, 01.RMS.C.1, Rocky Mountain Research Station*).

- Scientists investigated the effects of treatments such as thinning, salvage logging, and prescribed fire on soil characteristics and found that hillside erosion from cable logging is so low that silt fences are inappropriate tools to measure erosion rates. This result means that future research using silt fences will be limited to sites that have been disturbed by fire, where erosion rates are higher. Information on the treatment effects will be incorporated into computer models that can be used by managers to assist in fuel management decisions (*Elliot and Page-Dumroese, 01.RMS.C.3, Rocky Mountain Research Station*).

- Researchers are gathering information on the types and methods of fuel reduction alternatives that would be best suited to treating high fuel levels to restore a more natural mix of ecological conditions and reintroduce fire as a management tool. Types of fuels management in western ecosystems are described in the *Proceedings of the Fire, Fuels Treatment and Ecological Restoration* workshop, funded by both the Joint Fire Science Program and the NFP. Nearly 300 managers, scientists, and policymakers attended the 2002 workshop in Fort Collins, Colorado, and attested to the value this report will have for fuels management and ecological restoration in the Western United States (*Joyce, 01.RMS.C.4, Rocky Mountain Research Station*).

- Prescribed burning is cost-effective but frequently off limits because of safety or liability issues and smoke regulations. New fuel management strategies require methods to characterize the extent and spatial distribution of the wildland-urban interface. An investigation is being done to define the characteristics of the wildland-urban interface in the South and develop integrated systems to manage fuel loads. An outcome from this research will be a decision-support system to help users make cost-effective decisions on fuel treatments with knowledge of the nonmonetary environmental effects of the treatment (*Stanturf, 01.SRS.C.4, Southern Research Station*).

- Researchers investigated the effectiveness of a treatment that combines prescribed fire with herbicide treatments to reduce fuel buildup. The first study that used this treatment was successfully completed by Florida Department of Forestry and the St. Johns River Water Management District personnel. Results from this study will help landowners to accurately weigh the costs and benefits of prescribed fire as a forest management tool, balancing wildfire prevention, reduced treatment costs, and potential impacts on timber production (*O'Brien, 01.SRS.C.5, Southern Research Station*).

- Researchers examined multiple components of fuels as they relate to fire hazard for landowners in the wildland-urban interface. Specific projects address interface landscape characteristics and fire risk, flammability ratings of southern fuels, landowner risk assessment procedures, and fuel management options for landowners. An extension fact sheet was released entitled "Fire in the Wildland-Urban Interface: Understanding Fire Behavior" (*Roussopoulos, 01.SRS.A.3, Southern Research Station*).

- The cost of removing small-diameter trees can be more than the value of the wood, but if cost-effective methods for removal and markets for use could be found, forest management costs could be offset. For the strategic assessment of forest biomass and fuel reduction treatments in the West, potential revenue from products was compared to costs. In virtually all areas, sale of some larger diameter trees (greater than 7 inches diameter at breast height [d.b.h.]) for higher value products was needed to cover costs of harvesting. Sale for fuel wood was not sufficient to cover costs. Evaluations indicate the need to either subsidize the cost for thinnings or find higher value uses for timber greater than 7 inches d.b.h. (*Skog, 02.FPL.C.1, Forest Products Laboratory*).

- Little is known about animal and plant responses to wildfire, fire exclusion, or fuels management treatments designed to mimic presettlement conditions. We developed and applied methods to monitor wildlife populations and habitats following wildfire and fuels reduction treatments. This information will help land managers assess cumulative effects and evaluate ecological tradeoffs when considering options for treating and managing fuels (*Block, 02.RMS.C.2, Rocky Mountain Research Station*).

- Researchers worked to develop marketable products from forest undergrowth and underutilized timber to encourage its harvest and use. Laminated structural I-Beams were made from small-diameter curved and unmerchantable trees at a Wyoming sawmill. Structural evaluations show that a value-added product could be made from suppressed-growth unmerchantable trees. The resulting laminated beams had good strength properties, similar to those from larger diameter trees. This information will provide a sawmill or stud mill with engineering data to verify the potential for using low-value, small-diameter trees to produce a value-added structural product (*Hunt, 01.FPL.C.2, Forest Products Laboratory*).

- Previously oak-dominated forests are shifting to maple dominance owing to fire exclusion over many years. Prescribed fire and thinning treatments may restore oak dominance, but there is little information on fuels, fire behavior, and fire weather in the region to guide these efforts. An interdisciplinary team of scientists conducted experimental burns and theoretical work to study how trees (oak and hickory forests) are killed in forest fires.

Managers can use software based on a physically based tree mortality model produced from this study to evaluate restoration options for these fire-dependent ecosystems (*Dickinson, 01.NES.C.1, Northeastern Research Station*).

- Researchers gathered information to help managers identify areas of high fire risk, and to develop management options to reduce future fuel loads. Scientists developed county-level estimates of fine, medium, and large down deadwood biomass and live tree biomass for the Eastern United States. They also developed a prototype map at 30-meters resolution depicting wildfire risk in the wildland-urban interface based on land use change and forest patch characteristic data sets (*McNulty, 01.SRS.C.1, Southern Research Station*).

- To understand the physical effects of prescribed burning on soil processes affecting runoff and erosion in semiarid environments, researchers completed soil data collection for a prescribed burn conducted on the San Dimas Experimental Forest. The researchers determined that prescribed fire increased soil bulk density and coarse texture as well as increased and redistributed coarse surface sediment. Prescribed fire can be useful to managers to economically manage sediment in chaparral systems (*Hubbert and O'Dea, 01.PSW.C.3, Pacific Southwest Research Station*).

- Lodgepole pine (*Pinus contorta* Dougl. ex Loud.) is the fourth most extensive timber type west of the Mississippi River and the third most extensive in the Rocky Mountains. Currently, many lodgepole pine stands are in late-successional stages containing high fuel loading; these stands are at high risk of catastrophic fires, such as occurred in 2000 and 2003. Scientists from several disciplines working on the Tenderfoot Creek Experimental Forest are exploring the ecological and biological effects of thinning and prescribed fire in lodgepole pine stands through silvicultural prescriptions that reduce forest fuels, restore healthy stand structure, and maintain species composition. This research will result in recommendations on silvicultural options including fuel treatments for reducing fuel loading, improving stand health, and maintaining regeneration potential; options for hydrologic and wildlife considerations; and prescriptions for improving residual tree growth (*McCaughey, 01.RMS.C.6, Rocky Mountain Research Station*).

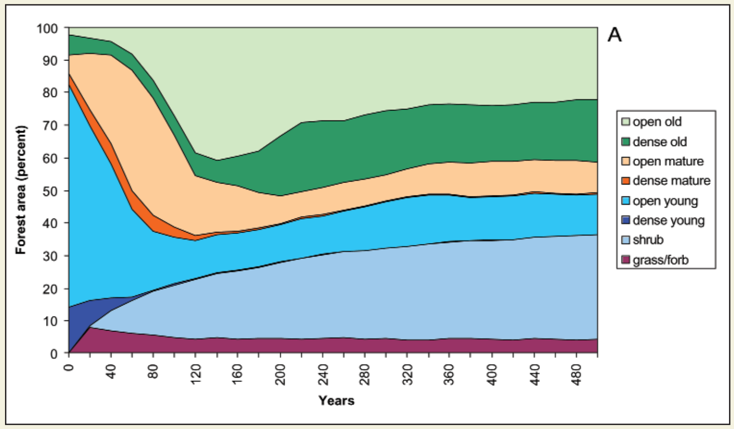
- Reducing fuel buildups, with or without prescribed fire, may adversely impact the environment through increased erosion and runoff, reduction in stored carbon and forest health, or damage to remaining vegetation. There is little integrated information on the impacts of biomass reduction operations on soil, water, and forest health. Scientists at the Rocky Mountain Research Station found that engineered wood straw is as effective as wheat straw at reducing soil erosion. In areas where production of this material is economical, it may replace wheat straw on postfire and other disturbed sites for erosion mitigation. This information will help managers in assessing the impacts and selecting among the array of fuel-reduction alternatives available to them (*Elliot, 02.RMS.C.1, Rocky Mountain Research Station*).

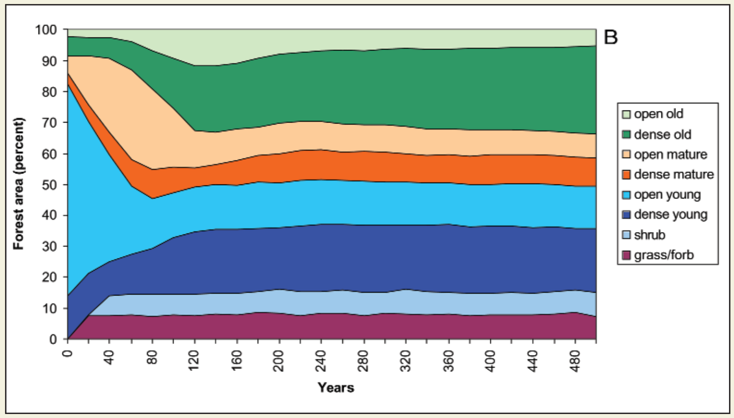
Hazardous-Fuels Highlight

Financial Analysis and Processing Options for Hazardous Fuels

Background: The Blue Mountains in northeastern Oregon have presented many challenges to forest managers during the past two decades. In the 1980s and 1990s, a severe outbreak of spruce budworms (*Choristoneura fumiferana* [Lepidoptera: Tortricidae]) caused extensive mortality, opening up stands and greatly increasing fuel loadings. Lower stand densities resulted in extensive conifer regeneration, which was encouraged in part by grazing by cattle, deer, and elk. The high fuel loadings and increasing stand densities of young conifers heightened concerns about fire hazard over extensive areas of the Blue Mountains. Partially in response to these conditions, the Forest Service established the Blue Mountains Demonstration Project to "accelerate ecosystem restoration in a manner that benefits local communities and unites land managers and scientists in cooperative efforts."

Approach: Researchers worked through the Blue Mountains Demonstration Project and other National Forest System staff to develop techniques that would help them to view management actions from the standpoint of the larger landscape and to understand the effectiveness of Federal land management decisions in mixed land management practices. In part, this involves stepping down analyses from broad regional reviews to the subbasin scale to specific projects.





Upper Grande Ronde study area, potentially forested land, (A) low grazing, and (B) high-moderate grazing background fire, 500 years.

Application: Over the past 2 years, project scientists and professionals have participated in the Blue Mountains Vegetation Assessment (an effort by the Blue Mountains Demonstration Project and the Oregon Department of Forestry to determine whether timber production could support fire-hazard reduction in northeastern Oregon) and the Mount Emily Project (an NFP-supported fuels reduction project by the La Grande Ranger District in the wildland-urban interface near La Grande, Oregon) to provide examples of how managers can use the most up-to-date science and modeling tools in analyses to support decisions about reducing fire hazard at both a landscape scale and in site-specific instances. Outcomes of these analyses are helping decisionmakers and managers, from the three forest supervisors to district-level specialists, to understand the possibilities and challenges associated with implementing current natural resource management policy. For example, the mapping exercise conducted by the three national forests for the Blue Mountains Vegetation Assessment helped decisionmakers realize the importance of various land allocations in restricting their ability to array landscape-level fuel treatments in an efficient and effective manner. Our financial and wood utilization analyses helped them to understand the challenges associated with finding areas where treatments could "pay for themselves" and at the same time reduce fire threat.

At the subbasin (500,000- to 1-million-acre) scale, the analyses are helping managers to recognize some of the difficulties associated with accomplishing reductions in fire threat over the long term. For example, deer and elk are a part of the ecosystem in northeastern Oregon, and cattle are a political fact of life. The analyses suggest that ungulate herbivory has an important effect on both the structural characteristics and species composition of stands in the Blue Mountains. This information suggests that policies directed toward timing of management activities and controlling numbers and distribution of ungulate herbivores could influence stand structure and composition over large parts of the Blue Mountains. From an economic standpoint, this points to the need for a continuing program to control regeneration across the landscape, which probably means

Hazardous-Fuels Highlight

a sustained program of maintenance burning and mechanical fuels treatments, such as mastication, that have negative net financial revenues.

The analyses at the project level support some of these same findings. Projections of stand structure and fire behavior made for the Mount Emily fuels reduction project indicate a need to control conifer regeneration after treatments designed to reduce crown bulk density (an indicator of crown fire potential). This analysis also shows that in a wildland-urban interface with mixed ownerships, it is not enough to only treat the lands administrated by the Forest Service; involvement of all landowners in efforts to reduce fire hazard will be much more effective. This finding does not address the social aspects of "getting people involved," rather it is a technical finding that relates to the distribution and timing of treatments across the landscape and the need to alter structural conditions where it will do the most good to change fire behavior.

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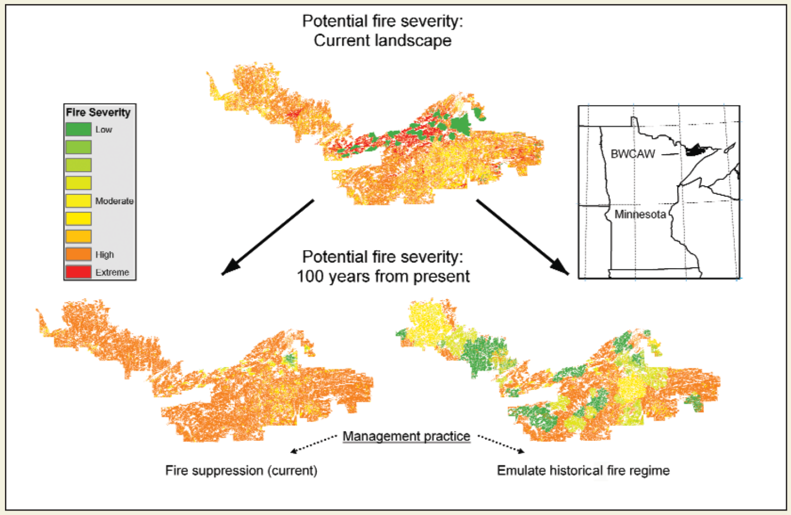
Key Partners:
The Blue Mountains Demo
The Umatilla National Forest
The Wallowa-Whitman National Forest
The Malheur National Forest
Pacific Northwest Region Planning
Boise Corporation
Southwestern Region Natural Resources and State and Private Forestry

Hazardous-Fuels Highlight

Predicting Landscape-Scale Fire Risk



Projecting the effect of fire and fuels management on potential fire severity in the Boundary Waters Canoe Area Wilderness, Minnesota.

Background: The spatial distributions of fuels and forest types affect the spread of fires and the severity with which they burn. As a result, fire risk in a given location (for example, a community or a home) depends not only on the condition of the adjacent forest but on the condition of the forests in a much larger landscape. The development of effective and efficient fire-risk reduction strategies requires tools that will predict the response of forests, fuels, and fire risk to landscape-level processes, including forest management and natural disturbances.

Approach: Working with resource managers, Forest Service and university researchers are using LANDIS (a landscape simulation model) to simulate the effects of current and proposed forest management strategies on fire risk and fuel loadings. Model results for the Superior National Forest, for instance, show that continued fire suppression in the Boundary Waters Canoe Area Wilderness will result in increased fire risk and substantial changes in forest composition, while the introduction of prescribed fire will reduce fuel loads and maintain native fire-adapted species. Similar results were seen in the fire-adapted oak forests on the Mark Twain National Forest, where model results show that the rate of prescribed fire use significantly affects the forest's susceptibility to wildfire—as prescribed fire use increases, the predicted average size, intensity, and frequency of wildfire decreases. On the Chequamegon-Nicolet National Forest, however, none of the eight alternative forest management strategies proposed for a forest plan revision have unintended consequences for landscape-level fire risk, although activities that increase the abundance of conifers (timber harvest and blowdowns) also can increase fire risk in some local areas.

Products and Tools: Scientists at the North Central Research Station have been working with partners at the Universities of Wisconsin-Madison and Missouri-Columbia to develop a sophisticated forest landscape model that simulates forest responses to these interacting drivers of forest change. LANDIS simulates forest dynamics across hundreds of thousands of acres, over timespans ranging from decades to centuries.

Application: As part of the collaborations developed through these NFP projects, the results from this work have been applied in the forest plan revision process and form the basis for a large effort in which representatives from State, Federal, and nonprofit landowners are evaluating the cumulative effects of forest management on forest composition and fuel loading in a large, mixed-ownership landscape. In addition, NFP is funding ongoing efforts to improve the capabilities of the LANDIS model. In January 2004, a new version of LANDIS will allow the important relationships between forest disease and insect outbreaks, fuel loadings, and fire risk to be simulated, and new, more powerful fire ignition and spread algorithms will improve the modeling of these complex phenomena. These capabilities will be applied to help managers develop fire management plans on the Chequamegon-Nicolet, Superior, and Huron-Manistee National Forests. The LANDIS model has great potential to be applied in many different ecosystems throughout the country where vegetation management and natural disturbances interact to affect the risk of wildfire.

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Key Partners:
University of Wisconsin, Madison
University of Missouri, Columbia

Hazardous-Fuels Highlight

The Relationship Between Forest Structure and Fire Severity

Background: Large wildfires can be very destructive but are also large-scale experiments that provide scientists opportunities to do research at a scale they could neither afford to nor would they be allowed to conduct. There is limited information available to determine forest structure (vertical and horizontal density) on fire severity during wildfires. Fire severity can provide an indication of forest structure, which in turn can influence fire behavior. Fire severity also can be used to predict the recovery of a particular forest stand after it is burned by a wildfire.

Approach: Researchers hypothesize that (1) wildfire severity is altered by forest structure and (2) vegetation recovery differs with fire severity. To address hypothesis 1, scientists are conducting a retrospective study to evaluate the relation between forest structure and fire severity. A total of 559 stands have been randomly selected and sampled in 21 large wildfires that occurred during 2000-2002 in Montana, Colorado, and eastern Oregon. To address hypothesis 2, a subset of these plots in Montana and Oregon is being used to quantify vegetation recovery at 1, 3, 5, 10, and 15 years after wildfire.

Preliminary results show that fire severity is best described in terms of litter cover, mineral soil exposure, and tree crown and bole scorch. In addition, forest structure affects fire severity. Important stand structure predictors of fire severity are tree density, average stand height, crown base height, and tree diameter. For example, (1) stands less than 26 feet tall have a 62-percent probability of a low-severity fire, (2) stands with crown base heights higher than 20 feet tended to have lower fire severity than stands with crowns less than 20 feet above the ground, and (3) stands with lower densities or smaller average tree size had lower fire severities than denser stands or larger trees.

Products and Tools: The retrospective fire-severity study will provide information on the relationships between forest structure and wildfire severity by displaying empirical probability distributions associated with fire severity and forest structure, key structural characteristics related to fire severity, and thresholds in structural characteristics. From the vegetation recovery study, scientists will construct predictive models of vegetation development based on prefire stand structure, postfire stand structure, and fire severity. Both the fire severity and vegetation recovery results will be incorporated into the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS). The FFE-FVS predicts fire behavior, fire effects, snag dynamics, and woody fuel decomposition over time, with and without management. In turn, FFE-FVS will be linked to models that predict postfire soil erosion. Results also will be published in various outlets, and other technology transfer will take place through presentations and consultations.

This hillside shows part of the 2002 Flagtale Fire in eastern Oregon. As shown in this photograph the fire burned from the left to the right. A high-density stand on the left was killed by a crown fire (black crowns). In the middle, the fire entered a thinned area and changed to an intense surface (brown crowns). The right portion of the photograph shows where the fire intensity decreased, and only a few trees were killed (green crowns) from a low-intensity surface fire.

Application: Land managers can use this information to design treatments that will reduce wildfire severity at the stand and landscape levels of planning. The information on vegetation recovery can be used to prioritize erosion control, predict stream hydrology, and forecast browse production.

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Key Partners:
National Forest System
Forest Inventory and Analysis

Hazardous-Fuels Highlight

Hazardous-Fuels Reduction Through Harvesting Underutilized Trees and Forest Undergrowth and Producing Three-Dimensional Structural Products

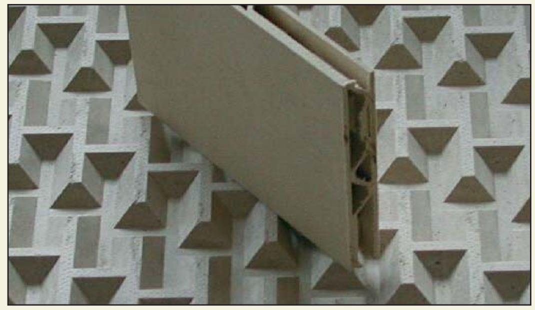
Background: Many forests in the Western United States have residual material from logging or thinning operations that has little or no value because of the high costs associated with removing and processing these materials. To provide incentive to market a product and provide the needed revenue to cover the associated costs, economical processes and value-added products that would provide sufficient performance/cost advantages over existing products need to be developed.

Approach: At the Forest Products Laboratory in Madison, Wisconsin, research scientists are (1) developing an economical process to reduce this low-grade material into a homogeneous bondable fiber mixture, and (2) developing a process to engineer value-added three-dimensional structural fiberboard with performance properties. Such a product could be used in the production of many products such as pallets, bulk bins, heavy duty boxes, shipping containers, packaging supports, wall panels, roof panels, cement forms, partitions, displays, reels, desks, caskets, shelves, tables, and doors.

The material-processing research uses existing industrial wet-processing equipment to reduce the material into a homogeneous fibrous slurry. The fiberizing process is similar to that used in pulping for paper, but the requirements for pulp quality are significantly reduced. The fiberization process includes bark in the mixture, whereas pulp for paper requires debarked clean material. The process also uses very few, if any, chemicals in the pulping process and requires less refining to produce a useable fibrous pulp. The research is developing a technology to form a three-dimensional fiberboard with predictable fiber distribution, shape, and properties.

The formed fiber mat is pressed by using heat and pressure to bond the fibers together with or without resin. Once dry, the final properties of the bonded fibrous material are equal or superior to commercial hardboard, and scientists are able to design for a range of specific performance requirements for packaging to structural uses. To date, scientists have used lodgepole pine treetop material including the bark, fiberized it, designed specific three-dimensional molds, and are making three-dimensional structural panels for testing. The scientists are finalizing the engineering equations and computer modeling techniques that will be used to verify the predicted properties with those from the tested structural panels.

Products and Tools: The outcome of this research will be fiber-processing information and three-dimensional engineering and modeling techniques that a small- to medium-size company could use to determine potential economic costs and returns on their investment for a given product need.



Engineered cores can have complicated geometries to produce a laminated structural panel product for specific performance requirements. The panel shown is about three-fourths of an inch thick.

Engineered structural panels can be made by using simple uniaxial core structures to provide efficient structural panels. The panel shown is approximately 1-½ inches thick.

Application: This product also will provide improved forest management opportunities to fully utilize the fiber resource off the forests. The process can be tailored to use most any logging residues or thinning material. The proposed technology, if it were adopted, would clear land for much needed rural development and would significantly reduce the cost to the Federal Government for fire mitigation. The economic feasibility of constructing panels by using this process from these materials will be developed.

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Key Partners:

Bighorn National Forest—Tree Tops for Fiber
Wyoming State Forest—Tree Tops for Fiber
Genesis Laboratory, Batavia, Illinois
Crescent Technology, LLC, Madison, Wisconsin

Hazardous-Fuels Highlight

Fuel Reduction and Forest Restoration Strategies That Sustain Key Habitats, Species, and Ecological Processes in Fire-Prone Ecosystems in the Interior Northwest

Background: It is relatively well known that past forest management practices have altered fire regimes, but the effects of management treatments to alleviate this problem on key habitats and species are not well understood. Concerns about key species in mature and old forests, such as the northern spotted owls (*Strix occidentalis caurina*), have led to controversy over large-scale fuel management plans. Although the concerns are valid, management also might consider how to increase long-term persistence of old forest while restoring open ponderosa pine (*Pinus ponderosa*) habitat for other sensitive or keystone species. Another consideration is how to design stand- and landscape-level fuel and fire management strategies to maintain or restore both sets of key habitats and species.

Needs: Information is needed to determine the effects of treatment alternatives, including no treatment, on key ecological processes and elements of biodiversity, particularly late-successional forests, keystone species such as woodpeckers (*Dendrocopus*), and threatened and endangered species. Management needs to restore some habitats and maintain others, but the uncertain impacts of altered fire, insect, and pathogen disturbance regimes make that task risky.

Approach: There are two components of this program: (1) research to design appropriate treatments at stand and landscape scales; and (2) the development and testing of those treatments with managers in an operational, but experimental, adaptive management approach.

Products: A key product is the organizational change in thinking among scientists and managers when they cooperate in gaining reliable knowledge through our adaptive management projects. A 5-year cooperative agreement with University of Washington scientists is focused on understory plant species responses to fire and thinning. Information from two adaptive management experiments and a number of other research projects on key species and processes (e.g., snag, bird, and mammal ecology and northern spotted owl habitat selection) and their management will be demonstrated through a series of publications over the next several years. Several local workshops have been held. Prototype decision-support systems are being designed.

Tools and Applications: Research has provided reliable information to design projects and do credible National Environmental Policy Act analysis, and for scientists to better understand the impacts of management on ecosystems. The Okanogan, Wenatchee, and Colville National Forests are the first forests in the Pacific Northwest Region of the Forest Service to revise their forest plan; work on these forests will contribute to their groundbreaking process. Decision-support

Prescribed fire used for fuel reduction is a critical process that may create or destroy snags and defective trees and that changes the pattern of the remaining forest around snags in ways that can influence the nonexcavating species that depend on them to create nesting cavities.

systems will help managers to understand complex research for planning. Generally, the work will contribute substantially to the knowledge base for scientific management of fire-prone ponderosa pine and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) forests throughout the West.

Implementation Example: On the Okanogan National Forest, the results of the work are being used to help design sound fuel and fire management on 350,000+ acres of dry forest. Research is a partner with the forests in three "adaptive management" projects on 5,000+ acres, including two that are part of regional or national "metaexperiment" research networks (28 sites total), that examine in part or in whole the effects of prescribed fire or fire surrogate (thinning) treatments on ecosystem pattern (e.g., plants, animals, fuels, and soils) and processes (fire, insects, and disease). Treatments in both studies are scheduled for spring 2004.

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Key Partners:

Colvillle, Okanogan, and Wenatchee National Forests
Rocky Mountain Research Station
University of Washington
Washington Department of Fish and Wildlife
U.S. Fish and Wildlife Service
National Council for Air and Stream Improvement, Inc.
U.S. Geological Survey, Fort Collins Science Center
The Nature Conservancy
Washington Department of Natural Resources
Longview Fiber Company
Plum Creek Timber Company

Hazardous-Fuels Highlight

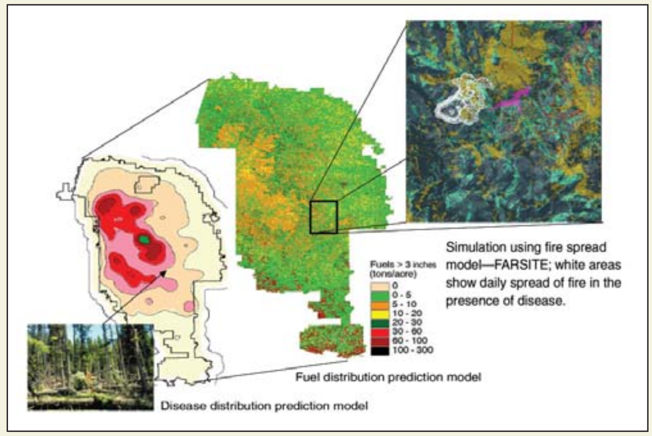
Use of Remote Sensing To Examine Disease Effects of Fuel Patterns

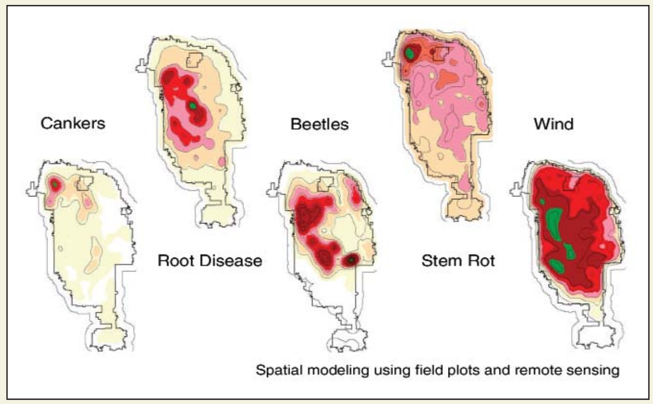
Background: Tree diseases are among the least understood and possibly the most underestimated causes of increased dead fuel loads in forest stands and landscapes. Manipulating forest diseases could be a useful long-term strategy for managing fire risk, but there are few integrated models available to characterize and predict the influence of disease on fire behavior and to guide disease management activities.

Forest pathologists and fire managers need tools that enhance collaboration and communication in decisionmaking. A landscape-scale model for spatial management of diseases is needed that integrates fuel and pathogen probability distributions with predictive fire-spread models. To be a practical tool, this model needs to be based on remote sensing coupled to data from ground plots and spatial analyses. These models would be useful in selecting and prioritizing prescriptive disease management activities aimed at controlling fire risks and in determining where to do them.

Approach: This study involved four phases: (1) Landsat TM imagery combined with field assessments and spatial analyses were used to develop landscape-scale predictive spatial models for several types of fuels and to generate the probable distributions of pathogens and other types of disturbances. (2) These models were then integrated into an existing fire-behavior model to predict the influence of different diseases and their locations on fire spread and impact. (3) Based on simulations from these models, methods of determining the relative importance of different diseases compared to other disturbances across the landscape were developed to help prioritize management options. (4) Various methods of collaborating, communicating, and integrating the technologies developed through this study into the management decisionmaking process are being examined.

Products: (1) Predictive spatial models showing varying conditions of various fuel types, different pathogens, and other kinds of disturbances within stands across the entire forest were generated. (2) These models were integrated into the fire-behavior model, FARSITE, and used to run simulations. (3) A method of estimating the relative importance of diseases compared to other types of disturbances showed that root diseases caused 32 percent of the total fuel load, bark beetles (*Hylesinus oleiperda* Fabricus) 21 percent, lightning damage 11 percent, wind damage 10 percent, canker diseases 10 percent, and others in a ponderosa (*Pinus*) stand under endemic conditions. (4) The integrated models were transferred to managers on a national forest for beta testing, which should improve the chances that the final product will better match users' needs.





Probability distribution models of fuel-generating diseases and other disturbance agents in the Black Hills National Forest.

Application: Tools developed offer a practical way to monitor fuel abundance and distribution from substand to landscape scales and to predict how fuel distribution and fire spread are influenced by changing disease dynamics and the application of different disease management activities. Managers could use these models to develop prescriptions for mediating fire risk by managing spatial patterns of fuel-generating tree diseases and other types of disturbances.

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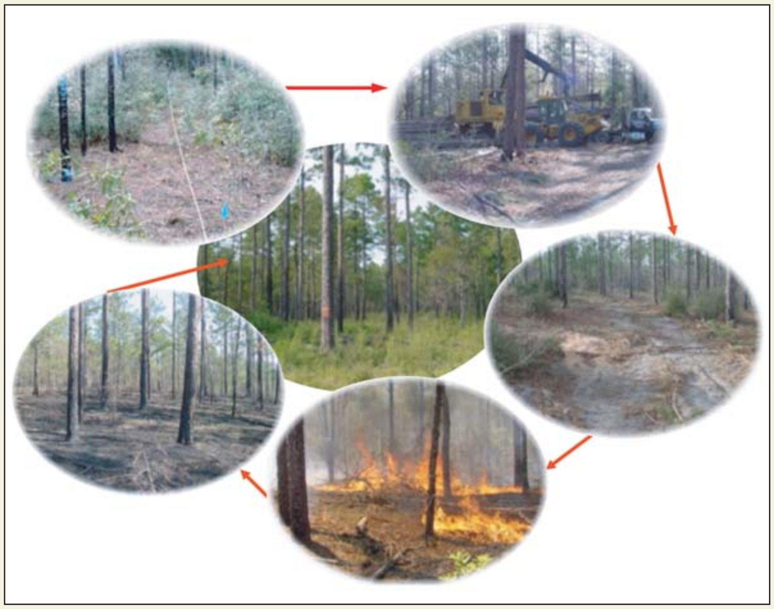
Key Partners:
Colorado State University
Yale University
U.S. Geological Survey
National Forest System
Southern Ute Tribe
Mesa Verde National Park

Hazardous-Fuels Highlight



Progression of thin and burn treatment from initial conditions (upper left) to thinning operation, to postthin conditions, to prescribed burn treatment, to immediate postburn, to one growing season following burn.

Quantifying the Tradeoffs of Fire and Fuels Management Options for Longleaf and Slash Pines in the South

Background: The longleaf pine (*Pinus palustris*) ecosystem of the South, which evolved with and is adapted to frequent low-intensity fires, is at risk of uncharacteristically severe wildfires that threaten people's lives and property and the health of this endangered forest community. Widespread fuel reduction treatments are needed to restore ecological integrity and reduce the risk of destructive wildfires. Of particular concern in the South are the rapidly growing urban-wildland interfaces of the Coastal Plains. Prescribed burning has been used for decades in the Coastal Plain to reduce fuel loads but is now under regulatory pressure. At issue are adverse air-quality and transportation safety impacts of smoke from prescribed burning and the potential for property losses if these burns escape into the wildland-urban interface. Alternative fuel reduction treatments are attractive, but the appropriate balance among cuttings, mechanical fuel treatments, herbicides, and prescribed fire is unclear.

Approach: This research is comparing effects of herbicide, prescribed burn, mechanical and combination treatments on fuels and ecosystem characteristics. Numerous questions are being addressed on operational-sized treatment units across broad disciplinary areas. Areas of study include vegetation, fuels, fire behavior, ecosystem structure, soil compaction, nutrient cycling, forest floor dynamics, mammals, herpetofauna, avifauna, entomology, pathology, treatment costs, and utilization economics. This study is being conducted in south Alabama at the Solon Dixon Forestry and Education Center operated by Auburn University.

Products: All combinations of treatment units of herbicide and prescribed-burn treatment were successfully burned on schedule this past season without incident, demonstrating that it is possible to use prescribed burning in a short time interval after other fuel reduction treatments without undue risk of fire escape or tree mortality. Early results have shown that hazardous fuels can be reduced without significant overstory damage by using a combination of thinning and prescribed burning via commercial timber sales that generate sufficient income to more than cover the cost of burning. These results have application to an estimated 10 million acres in the region, where they will be used to guide investment of scarce treatment funds to give society the greatest reduction in wildfire risk while improving ecosystem health of the imperiled longleaf pine ecosystem and its host of threatened and endangered species.

Products and Tools: The results described above have been presented at workshops and conferences across the South. Information generated by this research will be used to create a decision matrix to provide resource managers with costs and benefits based on ecological, economic, and social consequences of alternative fuel reduction practices.

Application: During this past year, 200 persons viewed the study sites including managers from U.S. Fish and Wildlife Service and private industry, private landowner groups, and students from grade school to the university level. Because of the demonstrated success of the treatment as an effective means of reducing wildfire hazard, improving ecosystem health, and maintaining long-term sustainability, the managers of the Solon Dixon Forestry and Education Center plan to apply fuel reduction treatments to a number of their longleaf stands.

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Key Partner:
Solon Dixon Forestry and Education Center, Auburn University

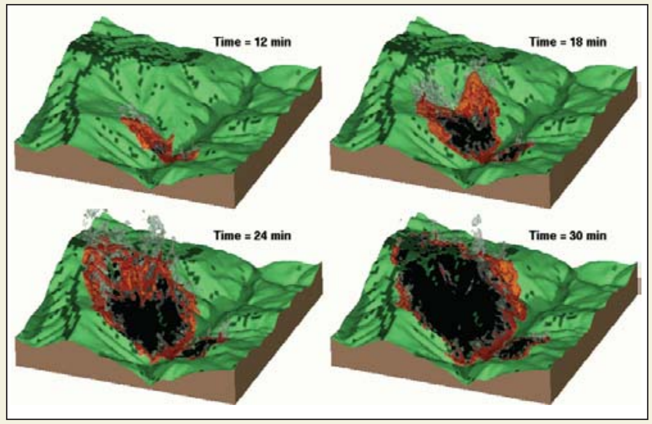
Hazardous-Fuels Highlight

Developing and Validating a Coupled Atmospheric and Physics-Based Wildfire Behavior Model for Use in the Southwest

Background: Improved predictive models of fire behavior are needed to support forest fuels reduction activities, wildfire mitigation efforts, planning for prescribed burns, evaluating potential fire behavior, and assessment of postfire environmental effects. Advancements in wildfire models can dramatically increase the ability to anticipate and respond to fires in situations composed of a variety of live and dead fuels with complex topography and fire-influenced winds. In addition, there is an increasing need to link fire behavior models to postfire effects and mitigation treatments that affect soil erosion, chemistry, productivity, and revegetation. Although existing operational models have been demonstrated to accurately describe some time-integrated results of long-duration fires, these models are not designed for application in the presence of rapidly changing weather (wind) or complex variations in physical environment (such as topography or nonhomogeneous fuels) created by various silvicultural treatments to reduce forest fuels and restore forest health.

Approach: The research approach involves further development, validation, and refinement of a physical-process wildfire model, FIRETEC, originally developed at Los Alamos National Laboratory to include representations of combustion, wind interactions with fuels, heat transfer mechanisms, and fire-influenced atmospheric flows. Collaborators are working to provide real-time data from prescribed burns on operational fuels management research areas that are part of a national study of the consequences of fire and fire surrogate treatments supported in part by the Joint Fire Science Program. This effort is a collaboration of the Rocky Mountain Research Station; U.S. Department of Energy, Los Alamos National Laboratory; Pacific Southwest Research Station, Riverside Forest Fire Laboratory; Rocky Mountain Research Station, Missoula Fire Sciences Laboratory; New Mexico State University Department of Mechanical Engineering; and Northern Arizona University School of Forestry.

Products and Tools: The FIRETEC model is the first physics-based, three-dimensional model designed to simulate the constantly changing, interactive relationship between fire and its environment. The model includes representation of the coupled interactions between fire, fuels, atmosphere, and topography on varying scales ranging from within forest stands to a landscape scale. The FIRETEC model combines physics models that represent combustion, heat transfer, aerodynamic drag, and turbulence with a computational fluid-dynamics model that represents airflow and adjustments to terrain, different types of vegetation fuels, and the fire itself. Unlike empirically based models in current operational use, FIRETEC simulates the dynamic processes that occur within a fire and the way those processes relate to and alter each other. The level of resolution embodied in the model allows research and development in wildfire mitigation strategies to be conducted at a level of detail in time and space not available in existing operational models.



Simulation of the Corral Canyon portion of the Calabasas Fire in 1996 near Malibu, California. Images are 12, 18, 24, and 30 minutes after spot ignition at the bottom of the canyon. Firefighters that had been dispatched to the top of the ridge, shown in the upper left of the image, were overcome by the fire and were injured.

Application: Physical-process models that intimately couple topography-influenced atmospheric flows with physics-based fire models have demonstrated sensitivity to these more complex conditions and provide more accurate results over short periods. Owing to computational complexity and fine-scale resolution, these process models are not currently capable of being implemented in real-time situations. However, with further validation and development from ongoing field experiments, these models can be used as training, planning, and risk assessment tools. More importantly, these models provide a critically needed tool for further development of simpler, computationally efficient wildfire behavior models for operational purposes. This effort also facilitates regional and national collaboration with scientists and managers in other disciplines interested in using fire-behavior models to assess expected effects on vegetation, habitat, soils, and watershed condition. The collaborative development of the FIRETEC wildfire behavior model recently received an “R&D 100 Award” for innovation and potential service to society in a national competition sponsored by R&D Magazine.

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Coronado National Forest
Lincoln National Forest
Coconino National Forest

Community Assistance

Fuel treatments cannot protect communities from wildfire unless the communities themselves are fire safe. To protect communities from wildland fire, community leaders and residents must understand and act on the need for structures and their immediate surroundings to be modified in a way that reduces fire risk. Fire research (National Fire Plan [NFP]) is improving our understanding of community attitudes and beliefs and developing new approaches to working in partnership with communities to enhance preparedness and decrease the negative social and economic impacts from wildland fires.

Where prescribed burning is common, respondents were more likely to approve of prescribed fire, trust a government agency to engage in prescribed burns, and think prescribed fire restores natural conditions and improves wildlife habitat.

The following are NFP community assistance accomplishments for fiscal year 2003:

- Researchers examined the aesthetic and social acceptability of various forest management treatments. Where prescribed burning is common, respondents were more likely to approve of prescribed fire, trust a government agency to engage in prescribed burns, and think prescribed fire restores natural conditions and improves wildlife habitat. This information can help managers in creating effective strategies for working with the public and developing fuel reduction and restoration activities that are locally acceptable (*Dwyer, 01.NCS.D.1, North Central Research Station*).

- Researchers gathered information from communities that have been successful in disaster preparedness to identify what factors are critical to success and develop models of community cooperation and partnerships. Fifteen studies were completed that focused on community decisions and actions related to wildfire preparedness. Several elements were identified as being critical to developing community preparedness for wildfire: a stable local fire department, leaders and community members who can think "outside the box," community members who have knowledge or skills that transfer to wildfire preparedness, a local champion or leader for wildfire preparedness, networks for collaboration, and governmental involvement (*Jakes, 01.NCS.D.2, North Central Research Station*).

- Researchers developed a set of alternative landscape designs that will enable homeowners to meet their personal landscape needs while at the same time increasing fire safety. FIREWISE Version 1, a Web-based program, allows homeowners and agency staff to visualize how planting, pruning, and removal of vegetation influence fire hazard to structures. In so doing, it can help residents take responsibility for protecting their homes from fire (*McPherson, 01.PSW.D.2, Pacific Southwest Research Station*).

- Scientists are studying the effects of information on people's perceptions and choices related to fire management techniques with the goal of improving two-way communication between the public and fire management agencies in reducing fire hazard. Two workshops were conducted with members of the Ridgewood Homeowners Association (near the Manitou Experimental Forest, Colorado Springs, Colorado) to discuss risk perception and fire and fuels management preferences after the Hayman Fire. An annotated bibliography has been prepared on the risk perception and risk communication literature. This literature will assist land managers with designing recommendations for communicating fire and fuels management strategies and implementing successful, socially acceptable, fire and fuels management policies and programs (*Kent, 01.RMS.D.1, Rocky Mountain Research Station*).

Managers may need to provide clear messages to visitors about fire management with explanations of why no fires are allowed, why there is decreased air quality, and why there may be traffic delays.

- Catastrophic wildfires take a large economic toll on communities, including property losses, decreased tourism, and even changes in the long-term structure of the local economy. A decision-process framework was developed that illustrates the importance of social measures in developing effective responses to wildfire threats. Findings indicate that an effective community response to wildfire means that a community works through all stages of the decision process with appropriate social and structural responses to its specific threat (*Prestemon, 01.SRS.D.1, Southern Research Station*).

- The wildland-urban interface areas are where firefighting is most challenging; damage to communities, homes, and property is at the greatest risk; and where danger to human life is greatest. However, specific locations, classifications (i.e., city, suburban), and the extent of the wildland-urban interface in terms of distance from the urban boundary into the wildland area, are not well-defined. Scientists are developing valid methods for estimating housing density at a fine scale over a long period (1940-2030) across the United States. Two thousand wildland-urban interface maps for the United States, States, and regions were completed. The identification of wildland-urban interface communities at risk from fire as required under the NFP will be facilitated by these maps. Work was completed on decadal housing density backcast, decadal housing density projection, decadal wildland-urban interface change backcast, wildland-urban interface change predictions, and tabular statistics (wildland-urban interface area and number of housing units, interface versus intermix). Initial projections of wildland-urban interface change over time, and analysis of historical changes in the wildland-urban interface were completed. Through this effort, it will be possible to clearly delineate wildland-urban interface areas and track their growth and change over time (*Dwyer, 02.NCS.D.1, North Central Research Station*).

- A growing body of information exists on the long-term effects of fire on processes that determine sustainability (ecological, economic, and social) and how to restore fire-dominated ecosystems. However, a huge gap exists between what scientists know and what the management community is able to access and apply on the land. A content management system was completed that will allow authors, editors, and reviewers to access encyclopedia material on southern fire science directly through the Internet. The encyclopedia also will help community leaders, land managers, and landowners make more informed decisions by deepening their understanding of the social, economic, and political implications of fire, fuels, and recovery strategies (*Kennard, 02.SRS.D.1, Southern Research Station*).

- Although fire is increasingly recommended as a vegetation management tool on both public and private lands, controversy often inhibits its use. A lack of communication and understanding between land managers and the public contributes to these difficulties. This project is designed to offer a remedy by gathering historical and contemporary information on public knowledge, beliefs, attitudes, and practices related to fire use and fuels management in the Southwest (New Mexico and Arizona) and by providing these data to land managers in a user-friendly format. Researchers are also examining the factors contributing to successful public involvement approaches for fire and fuels management planning. Results will assist land managers in designing and implementing successful, socially acceptable fire and fuels management policies and programs (*Raish, 02.RMS.D.1, Rocky Mountain Research Station*).

- Researchers examined the attitudes, beliefs, and behaviors of local residents and area visitors affected by fire events. Results of two studies indicate that recreation visitors are not overly concerned with fire management, although there is some concern with constraints on their behavior such as not being able to have fires in pits or grills, decreased air quality, and traffic delays owing to fire suppression. Managers may need to provide clear messages to visitors about fire management with explanations of why no fires are allowed, why there is decreased air quality, and why there may be traffic delays (*Chavez, 01.PSW.D.1, Pacific Southwest Station*).

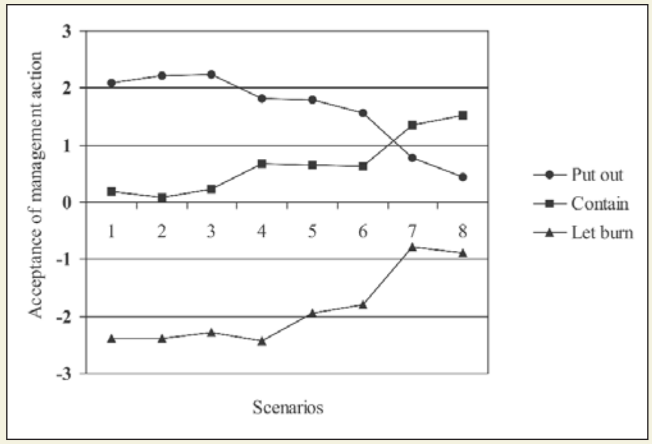
Community Assistance Highlight

Recreation and Fire in the Wildland-Urban Interface

Background: There is a strong need to understand the human dimensions of wildfire management. Large or small, fires impact property, communities, local institutions, and individuals. More specifically, wildfires may impact a range of locally important quality-of-life or economic outcomes, such as recreation experiences and ecotourism. Also, wildland fire communications and policies should be tailored to local conditions. This suggests that we need a better understanding of human dimensions across geography and subpopulations and how this variation in the social landscape is linked to agency programs and processes. Simply put, we need to link human cognition with wildland fire policies or desired behaviors such as Firewise actions, i.e., acquainting people who live or vacation in fire-prone areas of North America with the challenges of living around interface/intermix wildfire.

Approach: A comprehensive model was proposed that includes human values, beliefs, knowledge, attitudes, intentions, and behaviors across different settings and subpopulations. Initial work has focused on the fundamental values and beliefs that individuals hold and relates them to support for fire management issues such as prescribed fire, fuel treatments, fire suppression, and postfire forest health issues. Results suggest that an individual's fundamental values are oriented to specific wildfire management issues by basic beliefs. These value-laden perceptions of wildfire management directly influence individuals' attitudes and norms about wildfire. In turn, these have a direct impact on behaviors related to wildfire management (e.g., creating "defensible space" around a residence or support for agency management actions, such as prescribed burns and mechanical thinning).

Products: To date, fire-specific measures of visitors' values and norms toward wildland fire have been developed. Over 3,000 visitors to three geographically dispersed western urban-interface national forests were sampled. Six separate scales were developed for wildland fire beliefs (responsibility, biocentrism, anthropocentrism, freedom, trust, and the benefit and harm of wildfire). Social norms data (acceptability of management practices in different situations) were measured by using combinations of various types of situational factors (i.e., fire origin, recovery time, effects on air quality, and recreation access on private property) across three fire management choices (let burn, contain fire, or put out immediately). Results demonstrate the reliability and validity of the measurement model and provide much needed insight regarding differences in public support for common fire management activities. Another outcome is that the structure of the basic beliefs was relatively consistent across the different strata (national forests). Although this suggests similarity across a diversity of populations, there are differences in support for wildfire actions that can be linked to geography and situational influences. For urban proximate forests, the effect of human origin, quick recovery, and loss of property are notable influences on support for management actions.



Different combinations of a fire's impacts or origin (scenarios 1-8) can affect the public's acceptance of a particular management action.

Application: Publications and presentations at conferences and individual meetings are transmitting these results to the field and keeping them abreast of the latest developments in the quickly emerging field of human dimensions of wildfire. Specific analyses are being used to better inform policy and public information programs. Managers are aided by knowing that there are some generalized cultural beliefs about wildfire, but also how beliefs differ across settings. The model also provides situation-specific ways to assess public acceptance of fire management choices, such as prescribed fires or fire use (let-burn) decisions.

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Key Partners:
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Michigan State University
Colorado State University
California Polytechnic University, San Luis Obispo
University of Florida
U.S. Geological Survey
Bureau of Land Management

Community Assistance Highlight

Preventing Residential Fire Disasters in the Wildland-Urban Interface

Background: The Forest Service along with the National Fire Protection Association generated the National Wildland-Urban Interface (WUI) Initiative in response to the fire destruction in residential areas during the wildfires of 1985. Since 1990, political attention to homes destroyed and communities evacuated during extreme wildfires has increased. With this increased attention, the WUI Initiative has become the National Wildland-Urban Interface Program (that includes firewise) with a National Wildfire Coordinating Group working team managing the program. Recent policy documents also reflect the importance of destruction of residential areas during wildfires. Documents such as the Cohesive Strategy, the revised Federal Wildland Fire Management Policy, the 10-Year Comprehensive Strategy, the NFP, the Healthy Forests Initiative, and the recently passed Healthy Forests legislation all, in varying degrees, recognize the need for preventing WUI fire disasters.

Although home destruction and the threat of destruction during wildfires have become an important issue, an appropriate, scientifically based definition of the wildland-urban interface fire problem has not been widely incorporated as a basis for management. Proposed management actions are not necessarily based on explicit physical descriptions of how homes ignite related to the characteristics of wildland fires. This suggests that scientists may be missing significant opportunities for effectively and efficiently preventing residential fire disasters during extreme wildfires.

Approach: A three-method approach was applied to the problem of homes igniting during wildfires: mathematics was used to model the physics of the problem, experiments verified and augmented the modeling, and investigations of the actual wildland interface fires were used to capture a broader range of conditions. These three methods have converged on how homes ignite during wildfires.

Products and Tools: This research indicates that a home's exterior materials and design related to a home's immediate surroundings within 100 feet principally determine the home's ignition potential during extreme wildfire conditions. This area is called the **home ignition zone**. The home ignition zone provides the scientific basis for explicitly defining the problem of residential fire disasters during extreme wildfires. This research indicates that the necessary and sufficient reductions in a home's ignition potential during extreme wildfires can occur within the home ignition zone. Thus, a home's location does not necessarily determine its vulnerability to wildland fire; the condition of the home ignition zone determines its vulnerability. Because the home ignition zone largely falls on private property (perhaps more than one owner), the authority for conducting mitigating actions belongs to the homeowners. Therefore, given that wildland fires are inevitable and that wildfires during extreme conditions are inevitable, the principal actions for preventing residential fire disasters during wildfires must occur on private property. Public land management agencies can facilitate homeowner mitigations, and these agencies may be able to reduce fire intensities and the extent of burning around communities; however, these agencies cannot accomplish the necessary and sufficient actions for preventing residential fire disasters by actions taken beyond the home ignition zone.

A highly ignitable home zone can result in home destruction without a high-intensity crown fire burning within the home ignition zone. Note that the home is burning without fire in the surrounding vegetation.

Application: This research also provides the basis for the Wildland-Urban Interface Program's mission and vision statements. Specifically, it is nationally applied through the projects sponsored by the National Interagency Wildland-Urban Interface Program. For example, the nationally implemented Firewise Communities U.S.A. Program, inaugurated with the 2002 signing of a memorandum of understanding by the Forest Service, the National Association of State Foresters, and the National Fire Protection Association, uses this home ignition research as its basis for approach. Recognizing that the home ignition zone principally determines home ignition potential, the Firewise Communities U.S.A. process specifically focuses on homeowners and facilitates their principal role in preventing wildland-urban interface fire disasters. As part of the Firewise Communities U.S.A. Program, five national wildland-urban interface coordinators training courses have presented the fundamentals of how homes ignite during wildfires and applications to the assessment of and mitigation of home ignition potential. In addition, this research forms the basis for nationally distributed homeowner and fire service videos. The National Wildland-Urban Interface Program video *Wildfire: Preventing Home Ignitions* shows homeowners and firefighters how homes ignite and how that provides opportunities for mitigating the problem. More than 8,000 videos have been requested and distributed since January 2002. The first video in the National Wildland-Urban Interface Program's *Firefighter Safety in the Wildland-Urban Interface* video series is based on the home ignition research. *The Fire Behavior in the Wildland-Urban Interface* video takes a firefighter through the basics of home ignition and how that provides opportunities for effective fire protection. About 7,500 video sets have been distributed to fire departments nationally.

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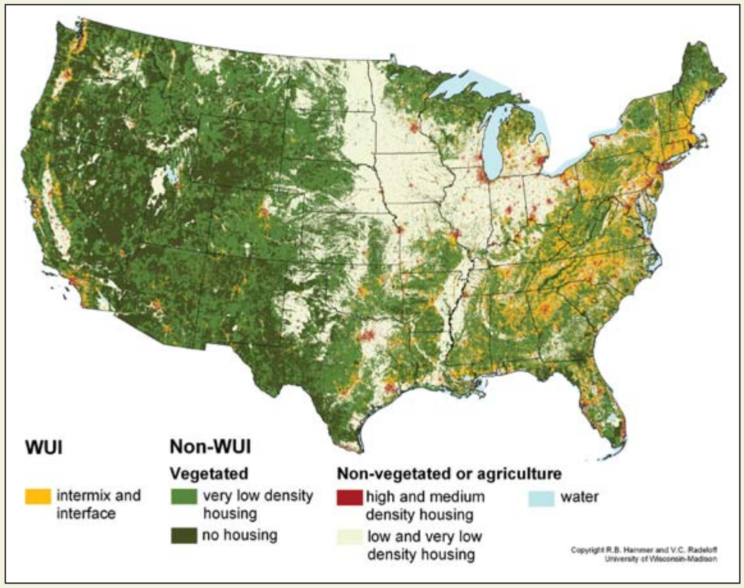
Key Partner:

National Interagency Wildland Urban Interface Program/National Wildfire Coordinating Group Working Team

Community Assistance Highlight

Mapping the Wildland-Urban Interface and Projecting Its Growth to 2030



The 2000 wildland-urban interface.

Background: The wildland-urban interface is a national phenomenon, one that has become widespread across the United States. Defined as "the area where structures and other human developments meet or intermingle with undeveloped wildland," it is where houses and fairly dense vegetation are both present. Issues pertaining to management have increased recently because the wildland-urban interface itself has grown: housing growth occurs in sprawling, wooded suburbs and in rural areas rich in amenities like lakes and forests. Future housing growth promises to further expand the wildland-urban interface.

Fire in the wildland-urban interface poses a risk to life, property, and resources, and challenges firefighters because neither municipal nor wildland firefighters are fully equipped to protect a mixture of houses and vegetation. Although the risk of fire is currently the most high-profile, wildland-urban interface issue, there are others. These include forest fragmentation, increasing pressure from recreation activities, wildlife habitat loss and encroachment, human-wildlife conflicts, exotic and invasive pests, and changes in forest productivity when housing growth affects harvesting decisions. The scope and seriousness of the wildland-urban interface issue is still unclear. This research created the first-ever, fine-scale national map of the wildland-urban interface, and will determine its extent, distribution, and change over time.

Approach: Researchers created a working definition of the wildland-urban interface, based on the *Federal Register* definition, and combined U.S. Census data and the National Land Cover Dataset (NLCD) to map the wildland-urban interface at high spatial resolution (census blocks, median size 3 acres and 30 meter NLCD land cover pixels) across the lower 48 States. Two wildland-urban interface types were identified, and in both, housing density must be more than one housing unit per 40 acres. Interface wildland-urban interface, where housing is near wildland vegetation, is less than 50 percent vegetated, but within 1.5 miles of an area over 75 percent vegetated. In intermix wildland-urban interface areas, housing and vegetation intermingle; and the area is over 50 percent vegetated. Interface and intermix make up the wildland-urban interface. Some wildland-urban interface areas are at risk of fire, some are not; data are geographic information system-based so that fire risk maps may be overlaid to identify wildland-urban interface areas at risk from fire.

Products and Application: The analysis of the extent and distribution of wildland-urban interface in 2000 is complete. Results indicate that 37 percent of all U.S. homes lie within the wildland-urban interface, covering 9 percent of the land area. In 20 of the 48 States mapped, over half the homes are within the wildland-urban interface. Policymakers are already using our results. Congress and the Forest Service Research and Development and State and Private Deputy Areas and the Strategic Planning and Resource Assessment staff in Washington have been briefed. The General Accounting Office has requested maps and data for their recent analysis of the scope of wildland fire management. State foresters and other local-, regional-, and national-level land managers are receiving map images, GIS data, and tabular statistics as they are completed for use in fire hazard mitigation and planning. The utility of the maps for exploring alternative wildland-urban interface definitions and policy scenarios makes it an invaluable tool for strategic wildland fire policymaking at all levels.

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Key Partner:

University of Wisconsin, Madison

Community Assistance Highlight

The National Database of Wildfire Hazard Mitigation Programs Information

Background: The rapid expansion of wildland interface communities has created a complex challenge to wildfire protection managers trying to mitigate wildfire risk to protect lives, property, and natural resources. A major issue is the reduction of hazardous fuels on wildlands adjacent to communities and the creation of defensible space around homes. Public outreach and educational programs, coupled with assistance programs and regulatory policies tailored to the communities' needs, are often used. As officials develop wildfire mitigation strategies, a knowledge base of existing programs and what has been successful in similar communities can greatly enhance planning efforts, while reducing time and cost in implementing new programs.

Approach: The program categories include the following approaches to creating fire-safe communities and reducing vegetative fuels:

- Assessments of wildfire risk and designation of high-risk areas assessments are based on the interaction of factors, such as fuel loading, topography, fire history, climate, housing density, and infrastructure for firefighting.
- Public outreach and educational programs include a variety of methods to educate residents about the importance of creating defensible space and to motivate homeowners to take responsibility for their own safety. Educational efforts include demonstration homes, pamphlets, landscaping guides, public displays, radio and television spots, print media, videos, interactive games, classroom programs/teacher education, neighborhood meetings, and workshops for developers.
- Homeowner assistance programs focus on the evaluation of individual homeowners' wildfire risk, provide cost-share assistance for reducing fuels, creating defensible space, chipping of debris, and slash disposal.
- Regulatory programs include State laws and local ordinances and regulations. Regulatory programs most often require developers to design subdivisions in ways that reduce wildfire risk, including reducing fuels before construction, creating fuelbreaks around perimeters, and creating defensible space around homes. Some regulations require existing homes to maintain defensible space standards.

Products and Tools: To facilitate the broader dissemination of ideas, the Southern Research Station, in cooperation with Louisiana State University, has developed a central location describing fire protection programs that communities across the country have adopted—http://www.wildfireprograms.usda.gov. The Web site currently describes over 170 programs in 27 States, and new programs are being added continually. Managers are implementing a wide range of approaches to reduce wildfire risk. Therefore, the above categories have been designated on the Web site to assist officials in identifying programs of interest.

Students from Kittitas County, Washington, schools observe the importance of reducing vegetation and firewise planning around homes as part of the Junior Firewise project.

Application: The Web site files can be searched by State, by program type, or by administrative jurisdiction—State, county, city/town, or fire district. Each file provides a summary of the program components, background for program development, and highlights of the program's most significant activities. Program profiles also include the program manager's contact information and links to pertinent Web sites.

The national wildfire program's database provides a clearinghouse of information where fire protection officials can learn about the strategies communities are using to reduce wildfire risk and how these programs have been funded, administered, and implemented. Web site user requests average 220 per day.

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Key Partner:
Louisiana State University

Appendix

Table 1—Research Projects[1] and Team Lead Scientists

Firefighting

Project ID number	Project title	Team lead scientist(s)	E-mail address
01.NCS.A.1	National and regional fire weather dynamics: improved methods for high-resolution forecasting of fire weather and smoke transport	Warren E. Heilman	wheilman@fs.fed.us
01.NCS.A.2	Assessing vulnerability of populations to wildfire in the North Central Region **(98-1-5-03)**	Robert G. Haight David T. Cleland	rhaight@fs.fed.us dcleland@fs.fed.us
01.NCS.A.3	FIA pilot test of a fuel condition monitoring system	Dennis May	dmay@fs.fed.us
01.PNW.A.1	A modeling framework for real-time predictions of cumulative smoke impacts ("BlueSky") **(98-1-9-05, 98-1-9-06, 01-1-6-07, 01-1-6-08)**	Sue A. Ferguson	sferguson@fs.fed.us
01.PNW.A.2	Estimating haze from prescribed and wildland fires **(98-1-1-05, 98-1-1-06, 98-1-9-05, 01-1-6-01)**	David V. Sandberg	dsandberg@fs.fed.us
01.PNW.A.3	Seasonal prediction of national fire risks and impacts **(98-1-1-06)**	Ronald P. Neilson	rneilson@fs.fed.us
01.PNW.A.4	Fuel moisture mapping and combustion limits **(98-1-9-06)**	David V. Sandberg	dsandberg@fs.fed.us
01.PSW.A.1	Risks to fish and wildlife from wildfire and landscape treatments	Danny C. Lee	dclee@fs.fed.us
01.PSW.A.2	An initial attack model for fire management planning **(01-1-7-06)**	Marc Wiitala	mrwiitala@fs.fed.us
01.PSW.A.3	Fire behavior in live fuels	David R. Weise	dweise@fs.fed.us
01.PSW.A.4	Real-time remote sensing of fire properties	Philip J. Riggan	priggan@fs.fed.us
01.PSW.A.5	Weather models for area coordination centers	Francis Fujioka	ffujioka@fs.fed.us
01.RMS.A.1	Improving decisions for fuel treatment options **(98-1-8-06, 01-1-3-22)**	Greg J. Jones Jimmie Chew	jgjones@fs.fed.us jchew@fs.fed.us
01.RMS.A.2	Real-time fire monitoring nationwide **(01-1-5-03)**	Wei Min Hao	whao@fs.fed.us
01.RMS.A.3	New technology for monitoring smoke characteristics	Wei Min Hao	whao@fs.fed.us
01.RMS.A.4	Remote sensing, GIS, and landscape assessment tools for fire management **(98-1-1-07, 99-1-3-29, 00-1-3-19, 01-1-1-6)**	Robert E. Keane	rkeane@fs.fed.us
01.RMS.A.5	Fire management strategies for wilderness and other protected areas **(99-1-3-16, 01-1-1-05, 01-1-3-12)**	Carol Miller Anne E. Black	cmiller04@fs.fed.us aeblack@fs.fed.us
01.SRS.A.1	Prediction of fire weather and smoke impacts in the Southeast	Gary L. Achtemeier	gachtemeier@fs.fed.us
01.SRS.A.2	Tradeoffs of alternative vegetation management strategies **(01-1-2-09)**	Jeffrey P. Prestemon	jprestemon@fs.fed.us
01.SRS.A.3	Establishing a wildland-urban interface research and technology transfer unit for the South	Pete Roussopoulos	proussopoulos@fs.fed.us
01.SRS.A.4	Long-range forecasting of fire season severity	Scott Goodrick	sgoodrick@fs.fed.us
01.SRS.A.5	Southern regional models for predicting smoke movement	Gary L. Achtemeier	gachtemeier@fs.fed.us
02.NES.A.1	Regional climate and fire danger modeling for the New Jersey Pine Barrens	John Hom	jhom@fs.fed.us
02.PSW.A.1	Improving monitoring and modeling of smoke contributions to regional haze **(01-1-05-06)**	Andrzej Bytnerowicz	abytnerowicz@fs.fed.us
02.RMS.A.1	Enhanced prediction of fire weather and smoke impacts in the Rocky Mountains and Southwest	Karl Zeller	kzeller@fs.fed.us
02.RMS.A.2	A nationwide system to generate a daily emissions inventory of pollutants from fires (01-1-5-03)	Wei Min Hao	whao@fs.fed.us

[1] Number in bold and parentheses following some titles indicates links to Joint Fire Science projects listed in table 3.

Table 1—Research Projects[1] and Team Lead Scientists (continued)

Rehabilitation and restoration

Project ID number	Project title	Team lead scientist(s)	E-mail address
01.PNW.B.1	Predicting spread of invasive species after fuel reduction treatments and postfire disturbance **(99-S-1, 01B-3-3-16)**	Edward J. DePuit	ejdepuit@fs.fed.us
01.PSW.B.1	Effectiveness of postfire emergency rehabilitation treatments in the West **(98-1-4-12, 01-3-2-08)**	Jan Beyers Peter R. Robichaud	jbeyers@fs.fed.us probichaud@fs.fed.us
01.RMS.B.1	Hydrologic and geomorphic consequences of wildfire and fuels management options in southwestern forest and woodland ecosystems **(99-S-1, 99-1-3-13)**	Daniel G. Neary	dneary@fs.fed.us
01.RMS.B.2	Native plant materials for restoration of sagebrush steppe and pinyon-juniper communities **(00-1-1-03)**	E. Durant McArthur	dmcarthur@fs.fed.us
01.RMS.B.3	Dynamics of weed invasions and fire in the northern Rockies	George Markin	gmarkin@fs.fed.us
01.RMS.B.4	Effects of wildfire and fire management options on invasive and exotic species and pathogens **(99-S-1)**	Karen Clancy	kclancy@fs.fed.us
01.RMS.B.5	Factors affecting Great Basin watersheds' susceptibility to invasive plants **(00-1-1-03, 00-2-15, 01B-3-3-01)**	Jeanne C. Chambers	jchambers@fs.fed.us
01.RMS.B.6	Patterns of white pine regeneration after fire	Anna Schoettle	aschoettle@fs.fed.us
01.RMS.B.7	The role of grassland fire in managing exotic and woody plants	Deborah Finch	dfinch@fs.fed.us
02.PNW.B.1	Response of native and invasive exotic plants to fire and fuel reduction treatments in the interior Pacific Northwest	Catherine Parks	cparks01@fs.fed.us
02.RMS.B.1	Characterizing risks of wildfire and fuels management in aquatic ecosystems	Bruce Rieman Jason B. Dunham	brieman@fs.fed.us jbdunham@fs.fed.us
02.SRS.B.1	Modeling the effects of wildfire on sediment and nutrient loads in the Southeastern United States	James M. Vose	jvose@fs.fed.us

Hazardous-fuels reduction

Project ID number	Project title	Team lead scientist(s)	E-mail address
01.FPL.C.1	Hazardous-fuels reduction through harvesting underutilized trees and forest undergrowth and producing three-dimensional structural products	John F. Hunt	jfhunt@fs.fed.us
01.FPL.C.2	Utilization of small-diameter crooked timber for use in laminated structural boards through development of new sawing, laminating, and drying processes	John F. Hunt	jfhunt@fs.fed.us
01.NCS.C.1	Optimizing fuel reductions in time and space **(01-1-3-43)**	David Lytle	dlytle@fs.fed.us
01.NCS.C.2	Managing risk of fire on human and ecological communities in the wildland-urban interface	Eric Gustafson Tom Crow	egustafson@ tcrow@fs.fed.us
01.NES.C.1	Fuels and fire behavior in the central hardwoods **(99-S-1)**	Matthew B. Dickinson	mbdickinson@fs.fed.us
01.PNW.C.1	Ground-based support for mapping fuel and fire hazard **(98-1-1-05, 98-1-1-06, 01-1-7-02)**	David V. Sandberg	dsandberg@fs.fed.us
01.PNW.C.2	Fuel reduction and forest restoration strategies that sustain key habitats and species in the interior Northwest **(99-S-1, 01-1-3-25, 01-1-6-01)**	John F. Lehmkuhl	jlehmkuhl@fs.fed.us
01.PSW.C.1	Effects of fuel reductions on stream ecosystems **(00-2-05)**	Carolyn T. Hunsaker	chunsaker@fs.fed.us
01.PSW.C.2	Alternatives to fire for fuel reduction in California shrublands within coniferous forest	Robert F. Powers	rpowers@c-zone.net
01.PSW.C.3	The effect of prescribed fire on hydrologic and soil processes that affect erosion in semiarid systems	Ken Hubbert Mary O'Dea	khubbert@fs.fed.us modea@fs.fed.us

Table 1—Research Projects[1] and Team Lead Scientists (continued)

Project ID number	Project title	Team lead scientist(s)	E-mail address
01.PSW.C.4	Effects of wildfire and fuel treatments on California spotted owl	John J. Keane Peter A. Stine	jkeane@fs.fed.us pstine@fs.fed.us
01.RMS.C.1	Impacts of exotic weeds on fuel loading and fire regimes **(00-1-1-03)**	Nancy L. Shaw	nshaw@fs.fed.us
01.RMS.C.2	The relationship between forest structure and fire severity **(99-1-1-04, 00-2-19, 00-2-20)**	Dennis E. Ferguson Theresa B. Jain	deferguson@fs.fed.us tjain@fs.fed.us
01.RMS.C.3	Impact of fuel management treatments on forest soil erosion and production **(98-1-4-12)**	William J. Elliot Deborah Page-Dumroese	welliot@fs.fed.us ddumroese@fs.fed.us
01.RMS.C.4	Management alternatives for fire-dependent ecosystems in Colorado and the Black Hills **(98-1-5-01)**	Linda A. Joyce	ljoyce@fs.fed.us
01.RMS.C.5	Improved guidelines for fuels management in southwestern ponderosa pine and pinyon-juniper forests in wildland-urban interface areas **(99-S-1, 00-U-01)**	Carl Edminster	cedminster@fs.fed.us
01.RMS.C.6	Restoration techniques in lodgepole pine forests	Ward McCaughey	wmccaughey@fs.fed.us
01.RMS.C.7	Use of remote sensing to examine disturbance effects	John E. Lundquist	jlundquist@fs.fed.us
01.RMS.C.8	Riparian ecosystem dynamics in relation to fire in the Rocky Mountains **(01-1-3-19)**	Deborah Finch	dfinch@fs.fed.us
01.SRS.C.1	Wildfire risk in the Eastern United States	Steve McNulty	steve_mcnulty@ncsu.edu
01.SRS.C.2	Quantifying the ecological and economic tradeoffs of fire and fire surrogate options—Piedmont and Southern Appalachian Mountains **(99-S-1, 01-1-4-02)**	Thomas A. Waldrop	twaldrop@fs.fed.us
01.SRS.C.3	Quantifying the tradeoffs of fire and fuels management options—longleaf and slash pine ecosystems of the Atlantic and Gulf Coastal Plain **(99-S-1)**	Kenneth W. Outcalt	koutcalt@fs.fed.us
01.SRS.C.4	A system for mechanized fuel reduction at the wildland-urban interface	John Stanturf	jstanturf@fs.fed.us
01.SRS.C.5	Fire and herbicide combinations to reduce fire intensity **(00-2-27, 01-1-3-11)**	Joseph J. O'Brien	jjobrien@fs.fed.us
02.FPL.C.1	Developing tools to assess economic feasibility of processing wood removed in the course of hazardous-fuels reduction	Ken Skog	kskog@fs.fed.us
02.PNW.C.1	Integrated approach for assessing fire risk, disturbance patterns, and conducting analysis of fuel treatment strategies on large landscapes	Jamie Barbour	jbarbour01@fs.fed.us
02.PSW.C.1	Fire and fuels management, landscape dynamics, and fish and wildlife resources: study design for integrated research on the Plumas and Lassen National Forests	Peter Stine	pstine@fs.fed.us
02.RMS.C.1	Environmental and economic impacts of biomass reduction **(98-1-4-12, 01-3-2-08)**	William J. Elliot	welliot@fs.fed.us
02.RMS.C.2	Effects of wildland fire and fuel treatments on terrestrial vertebrates in intermountain forests **(01-1-3-25)**	William Block Victoria Saab	wblock@fs.fed.us vsaab@fs.fed.us

Table 1—Research Projects[1] and Team Lead Scientists (continued)

Community assistance

Project ID number	Project title	Team lead scientist(s)	E-mail address
01.NCS.D.1	Modeling people's responses to landscape treatments **(99-1-2-08, 99-1-2-10)**	John F. Dwyer	jdwyer@fs.fed.us
01.NCS.D.2	Community partnerships	Pamela J. Jakes	pjakes@fs.fed.us
01.PSW.D.1	Recreation and fire in the wildland-urban interface **(99-1-2-10)**	Deborah Chavez James Absher	dchavez@fs.fed.us jabsher@fs.fed.us
01.PSW.D.2	Firewise residential landscapes	Greg McPherson	egmcpherson@ ucdavis.edu
01.RMS.D.1	Building consensus on fire management	Brian Kent	bkent@fs.fed.us
01.RMS.D.2	Preventing residential fire disasters at the wildland-urban interface	Jack D. Cohen	jcohen@fs.fed.us
01.SRS.D.1	Impact of wildfires on local economies **(01-1-2-09)**	Jeffrey P. Prestemon	jprestemon@fs.fed.us
01.SRS.D.2	Fire protection in residential expansion areas	Terry Haines	thaines01@fs.fed.us
02.NCS.D.1	Mapping the wildland-urban interface and projecting its growth to 2030 **(99-1-2-08, 99-1-2-10)**	John F. Dwyer	jdwyer@fs.fed.us
02.RMS.D.1	Community knowledge, beliefs, attitudes, and practices concerning fire and fuels management in southwestern ecosystems	Carol Raish	craish@fs.fed.us
02.SRS.D.1	An Internet-based encyclopedia of southern fire science and management knowledge	Deborah Kennard	dkennard@fs.fed.us

Magge Brassil and Jeb Doran record vegetation recovery following wildfire on the Bitterroot National Forest.

Table 2—Summary of Accomplishments in Fiscal Year 2003

Accomplishment	Firefighting	Rehabilitation and restoration	Hazardous-fuels reduction	Community assistance	Total
Studies initiated	75	33	86	39	233
Agreements/contracts established	53	28	56	31	168
$$ value of agreements (1,000s)	2,658	805	2,812	1,901	8,176
Permanent scientists/professionals hired	6.61	0	3.5	1	11
Term scientists/professionals hired	9.50	4	16	1	31
Permanent technicians hired	0	0	4	0	4
Term/temp. technicians hired	10.25	48	90	6	154.1
Refereed publications	39	34	30	8	111
Nonrefereed publications	47	34	49	10	140
Presentations at scientific conferences	151	131	139	41	462
User bulletins, leaflets produced	34	7	17	9	67
Decision-support tools, models developed	42	5	14	3	64
Demonstrations, tours hosted	60	24	57	12	153
Significant consultations with:					
Regions, national forests, districts	64	68	83	44	259
States, State foresters	38	18	29	27	112
Tribal governments	2	3	4	2	11
County, local, governments,	5	14	7	54	80
Other	35	4	42	75	156
Short courses, workshops, training offered	31	18	46	11	106
Total number of attendees	603	912	1,412	968	3,895
Communities assisted	1	4	29	23	57
Fire management units assisted	30	6	36	15	87

Table 3—Joint Fire Science Program Research Projects[1] With Links to Forest Service National Fire Plan Research Projects

Project ID number	Project title	Team lead scientist
98-1-1-05	Photo series for major natural fuel types of the United States–phase II **(01.PNW.A.1, 01.PNW.C.1)**	Roger Ottmar
98-1-1-06	Application of a fuel characterization system for major fuel types of the contiguous United States and Alaska **(01.PNW.A.2, 01.PNW.A.3, 01.PNW.C.1)**	Roger Ottmar
98-1-1-07	Mapping fuels using remote sensing and biophysical modeling **(01.RMS.A.4)**	Robert Keane
98-1-4-12	Risk assessment of fuel management practices on hillslope erosion processes **(01.PSW.B.1, 01.RMS.C.3, 02.RMS.C.1)**	Peter Robichaud
98-1-5-01	Fire regimes and fuel treatments: a synthesis with manager feedback **(01.RMS.C.4)**	Phil Omi
98-1-5-03	Characterizing historical and contemporary fire regimes in the Lake States **(01.NCS.A.2)**	David Cleland
98-1-8-06	A risk-based comparison of potential fuel treatment tradeoff models **(01.RMS.A.1)**	David Weise
98-1-9-05	Implementation of an improved emission production model **(01.PNW.A.1, 01.PNW.A.2)**	David Sandberg
98-1-9-06	Modification and validation of fuel consumption models for shrub and forested lands in the Southwest, Pacific Northwest, Rockies, Midwest, Southeast, and Alaska **(01.PNW.A.1, 01.PNW.A.4)**	Roger Ottmar
99-S-1	A national study of the consequences of fire and fire surrogate treatments **(01.PNW.B.1, 01.RMS.B.1, 01.RMS.B.4, 01.NES.C.1, 01.PNW.C.2, 01.RMS.C.5, 01.SRS.C.2, 01.SRS.C.3)**	Jim McIver
99-1-1-04	Development and delivery of the fire and fuels extension to the Forest Vegetation Simulator for use by stakeholders to the Joint Fire Science Program **(01.RMS.C.2)**	Nicholas Crookston
99-1-2-08	Evaluating public response to wildland fuels management: factors that influence acceptance of practices and decision processes **(01.NCS.D.1, 02.NCS.D.1)**	Bruce Shindler
99-1-2-10	Demographic and geographic approaches to predicting public acceptance of fuel management at the wildland-urban interface **(01.NCS.D.1, 01.PSW.D.1, 02.NCS.D.1)**	Jeremy Fried
99-1-3-13	Carbon and nitrogen cycling by microbial decomposers following thinning and burning in a southwestern ponderosa pine ecosystem **(01.RMS.B.1)**	Daniel Neary
99-1-3-29	Southern Utah fuels management demonstration project **(01.RMS.A.4)**	Kevin Ryan
00-1-1-03	Changing fire regimes, increased fuel loads, and invasive species: effects on sagebrush steppe and pinyon-juniper ecosystems **(01.RMS.B.2, 01.RMS.B.5, 01.RMS.C.1)**	Jeanne Chambers
00-1-3-19	Monitoring fire effects at multiple scales: integrating standardized field data collection with remote sensing to assess fire effects **(01.RMS.A.4)**	Robert Keane
00-U-01	Cerro Grande postfire inventory and analysis **(01.RMS.C.5)**	Carl Edminster
00-2-05	Kings River and Lake Tahoe Basin demonstration sites for fuel treatments **(01.PSW.C.1)**	Carolyn Hunsaker
00-2-15	A demonstration area on ecosystem response to watershed-scale burns in Great Basin pinyon-juniper woodlands **(01.RMS.B.5)**	Jeanne Chambers
00-2-19	Stand and fuel treatments for restoring old-growth ponderosa pine forests in the interior West (Boise Basin Experimental Forest) **(01.RMS.C.2)**	Russell Graham
00-2-20	Treatments that enhance the decomposition of forest fuels for use in partially harvested stands in the moist forests of the northern Rocky Mountains (Priest River Experimental Forest) **(01.RMS.C.2)**	Russell Graham
00-2-27	Maintaining longleaf pine woodlands: is mechanical shearing a surrogate for prescribed burning? **(01.SRS.C.5)**	Jeff Glitzenstein
01-1-1-05	Can wildland fire use restore historical fire regimes in wilderness and other unroaded lands? **(01.RMS.A.5)**	Carol Miller
01-1-1-6	Historical wildland fire use: lessons to be learned from 25 years of wilderness fire management **(01.RMS.A.4)**	Matthew Rollins
01-1-2-09	A national study of the economic impacts of biomass removals to mitigate wildfire damages on Federal, State, and private lands **(01.SRS.A.2, 01.SRS.D.1)**	Jeffrey Prestemon Karen Lee Abt

Table 3—Joint Fire Science Program Research Projects[1] With Links to Forest Service National Fire Plan Research Projects (continued)

Project ID number	Project title	Team lead scientist
01-1-3-11	Duff consumption and southern pine mortality **(01.SRS.C.5)**	Kevin Hiers
01-1-3-12	Effects of prescribed and wildland fire on aquatic ecosystems in western forests **(01.RMS.A.5)**	David Pilliod
01-1-3-19	Effects of fuels-reduction and exotic plant removal on vertebrates, vegetation, and water resources in southwestern riparian ecosystems **(01.RMS.C.8)**	Deborah Finch
01-1-3-22	Optimizing landscape treatments for reducing wildfire risk and improving ecological sustainability of ponderosa pine forests within mixed-severity fire regimes **(01.RMS.A.1)**	Merrill Kaufman
01-1-3-25	Prescribed fire strategies to restore wildlife habitat in ponderosa pine forests of the intermountain West **(01.PNW.C.2, 02.RMS.C.2)**	Victoria Saab
01-1-3-43	Fire, management, and land mosaic interactions: a generic spatial model and toolkit from stand to landscape scales **(01.NCS.C.1)**	Thomas Crow
01-1-4-02	Fuel classification for the southern Appalachian Mountains using Hyperspectral Image Analysis and Landscape Ecosystem Classification **(01.SRS.C.2)**	Tom Waldrop
01-1-5-03	Automated forecasting of smoke dispersion and air quality using NASA Terra and Aqua satellite data **(01.RMS.A.2, 02.RMS.A.2)**	Wei Min Hao
01-1-5-06	Improving model estimates of smoke contributions to regional haze using low-cost sampler systems **(02.PSW.A.1)**	Andrezj Bytnerowicz
01-1-6-01	Fire and climatic variability in the inland Pacific Northwest: integrating science and management **(01.PNW.A.2, 01.PNW.C.2)**	David Peterson
01-1-6-07	Assessing the value of mesoscale models in predicting fire danger **(01.PNW.A.1)**	Sue Ferguson
01-1-6-08	Predicting lightning risk **(01.PNW.A.1)**	Sue Ferguson
01-1-7-02	Photo series for major natural fuel types of the United States—phase III **(01.PNW.C.1)**	Roger Ottmar
01-1-7-06	Techniques for creating a national interagency process for predicting preparedness levels **(01.PSW.A.2)**	Gerry Day
01-3-2-08	Risk assessment of fuel management practices on hillslope erosion processes (Phase II) **(01.PSW.B.1, 02.RMS.C.1)**	Peter Robichaud
01B-3-3-01	Effects of fire and rehabilitation seeding on sage grouse habitat in the pinyon-juniper zone **(01.RMS.B.5)**	Jeanne Chambers
01B-3-3-16	Effects of season and interval of prescribed burns in a ponderosa pine ecosystem **(01.PNW.B.1)**	Walter Thies

[1] Number in bold and parentheses following some titles indicates links to Forest Service National Fire Plan projects listed in table 1.

Installing thermographs to measure water temperature in Upper Cherry Creek, in the morning before the main burn period. Documenting riparian fire behavior on film. Left to right: Damian Cremins, biological technician; Matthew Burbank, biological technician; Ethan Mace, research crew boss.

Table 4—2003 Research Partners and Cooperators for Forest Service National Fire Plan Research

Partner/Cooperator	Firefighting	Rehabilitation and restoration	Hazardous-fuels reduction	Community assistance
Educational institution				
Auburn University (AL)			√	√
Australian National University	√			
Brigham Young University (UT)	√	√		
California Polytechnic University, San Luis Obispo				√
California State University, Fresno			√	
Capilano College, N. Vancouver, BC	√			
Clemson University (SC)			√	√
Colorado State University	√	√	√	√
Columbia University			√	
Desert Research Institute	√			
Eastern Oregon University		√		
Louisiana State University				√
Michigan State University	√			
Montana State University	√	√	√	
New Mexico State University				
North Carolina State University	√		√	√
Northern Arizona University		√	√	
Ohio State University			√	
Ohio University			√	
Oregon State University		√	√	√
Penn State University				√
Rutgers University Pinelands Research Station (NJ)	√			
San Diego State University				√
Scripps Institution of Oceanography (CA)	√			
South Dakota School of Mines	√			
Southern Oregon University				√
State University of New York, Albany	√			
Technological University of Plant Polymers (Russia)			√	
University of Arizona		√	√	
University of California, Berkeley	√		√	
University of California, Davis			√	
University of California, Riverside			√	
University of California, Santa Barbara	√		√	
University of Florida			√	
University of Georgia	√		√	√
University of Hawaii	√			
University of Idaho	√	√		
University of Illinois			√	
University of Massachusetts				√
University of Missouri, Columbia			√	
University of Minnesota			√	
University of Montana			√	

Table 4—2003 Research Partners and Cooperators for Forest Service National Fire Plan Research (continued)

Partner/Cooperator	Firefighting	Rehabilitation and restoration	Hazardous-fuels reduction	Community assistance
Educational institution (continued)				
University of Nevada	√	√		
University of New Mexico			√	
University of North Carolina			√	
University of Oklahoma			√	
University of Washington	√	√	√	
University of Wisconsin, Madison	√		√	√
University of Wyoming			√	
Virginia Polytechnic Institute and State University				√
Washington State University	√			
Yale University			√	
Private companies				
Adaptive Management Services, Pacific Southwest Region (CA)			√	
Air Science Corp. (OR)			√	
Associated Arborists of Chico (CA)			√	
Bearstar Enterprise (MT)	√			
Boise Cooperation			√	
Bolton-Emerson Americas, Inc. (MA)			√	
Carroll Nelson Associates (MT)	√			
Crescent Technology (WI)			√	
David Cook Tillage (CA)			√	
Digital Visions Enterprise Group (OR)	√			
ESSA Technologies (Canada)			√	
FireVision (WA)	√			
GC Micro Corp. (CA)	√			
Genesis Laboratory			√	
Geo Data (MT)	√			
Hollis Marriott (WY)	√			
INTECS International, Inc. (CO)				√
Integrated Resource Solutions (CA)				√
Jack Losensky			√	
Kruger Enterprises (MA)			√	
Longview Fiber Company			√	
Mantech Environmental Technology, Inc. (NC)			√	
MATCOM (CO)			√	
METI (TX)			√	
Patrick Freedom (MT)	√			
PBS Environmental Consultants (WA)			√	
Plumb Creek Timber Company			√	
R. Lamar (CA)	√			
Space Instruments, Inc. (CA)	√			
Systems for Environmental Management (MT)				√

Table 4—2003 Research Partners and Cooperators for Forest Service National Fire Plan Research (continued)

Partner/Cooperator	Firefighting	Rehabilitation and restoration	Hazardous-fuels reduction	Community assistance
Private companies (continued)				
Swan Ecosystem Center			√	
Technology Service Corp. (CO)	√			
Titan Systems, Inc. (OR)			√	
TSI, Inc. (MN)	√			
Wyoming Sawmill			√	
Government				
Beaverhead-Deerlodge National Forest	√			
Bitterroot National Forest	√			
Forest Service Forest Inventory and Analysis, Washington, DC		√		
Interagency Geographic Area Coordination Centers	√			
Los Alamos National Laboratory (NM)	√			
National Aeronautics and Space Administration	√		√	
National Forest System	√		√	
National Oceanic and Atmospheric Administration (TN)	√			
National Park Service			√	
Pacific States Marine Fisheries Commission (OR)	√			
Peaks Ranger District, Coconino National Forest (AZ)			√	
U.S. Department of the Interior	√			
U.S. Environmental Protection Agency	√			
U.S. Fish and Wildlife Service			√	
U.S. Geological Survey			√	
State government				
Minnesota Department of Natural Resources	√			
New Jersey Forest Fire Service	√			
New Mexico Department of Agriculture			√	
North Carolina Wildlife Resources Commission			√	
Northern Region Western Montana Planning Zone	√			
State Forest Fire Compact	√			
Washington Department of Natural Resources			√	
Nongovernment organizations				
Duck Creek Association (OR)			√	
Watershed Research and Training Center (CA)	√			
Middle Rio Grande Conservancy District (NM)			√	
National Center for Atmospheric Research			√	
National Council for Air and Stream Improvement, Inc.			√	
Nature Conservancy			√	
Point Reyes Bird Conservatory (CA)			√	
Tall Timbers Research Station (FL)				√
Tribe				
Southern Ute Tribe			√	

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