Fire, Fuel, and Smoke Science Program
Rocky Mountain Research Station

Charter Amendment Plan

Revise: **2005 3-Unit, Missoula Fire Sciences Laboratory Charter (Ten Problem Areas); expiration scheduled for 2010.**

Becoming: **2009 Fire, Fuel, and Smoke Science Program Charter (Six Focus Areas); interim charter revision leading towards complete rechartering in 2011.**

3/20/09

Signature	Title	Date
Recommended:		
	Program Manager	
	WO SPA Lead	
	WO Staff Director	
Approved:		
	Station Director	
Concurred:		
	Deputy Chief for Research & Development	

Fire, Fuel, and Smoke Science Program
Rocky Mountain Research Station

This documentation package includes ten sections:

1. Amending the Charter by Revision

Background.—Restructuring the science organization within the Rocky Mountain Research Station (RMRS) has consolidated scientists and research work units into seven Science Programs. The Fire, Fuel, and Smoke Science Program (FFS Program) is now comprised of all personnel and resources from the three former units at the Missoula Fire Sciences Laboratory (RWU-4401 Fire Behavior; RWU-4403 Fire Ecology and Fuels; and

RWU-4404 Fire Chemistry). In addition, one scientist (Research Meteorologist) from former RWU-4852 was also re-assigned to the FFS Program.

The three (former) units at the Missoula Fire Sciences Laboratory were chartered under a single, Lab-Wide charter; the charter was reviewed and signed in mid-2005 by our respective W.O. staff Director (Jimmy Reaves), as well as National Program Leads Susan Conard, Michael Hilbruner, and Al Riebau (see accompanying charter). This charter and proposed revisions were discussed at the fall, 2007 all-Program planning meeting attended by FFS Program scientists and staff, RMRS leadership, representatives from every new RMRS science Program, as well as W.O. R&D Forest Management Science (FMS) Director Carlos Rodriguez-Franco and National Program Leads Susan Conard and Mike Hilbruner. The meeting concluded with consensus on six Programmatic "Focus Areas" that would serve as new Charter problem areas (presented in section 2), and determined that these six focus areas could be effectively cross-walked to the existing Charter without requiring major revisions to the 2005 Charter. This decision was supported by both RMRS and National FMS leadership.

The proposed Focus Areas and Charter revisions were presented to WO R&D staffs in April, 2008 and were subsequently discussed with the FMS R&D staff group. Charter revisions, as submitted, were also reviewed by FMS staff in May, 2008 and again in November, 2008. The record of reconciliation for those reviews is available under separate cover.

Forest Service Manual (FSM) Requirements.—Chapter 4070 of the FSM addresses *Research Program Formulation and Documentation*. Section 4072.14b, *Revision of Research Work Unit descriptions and Program Charters*, states "Minor amendments [to charters] may be made in pen-and-ink changes, but major changes, such as adding or dropping a problem, require revision or a letter to the Washington Office for concurrence." Section 4072.14c also states "Program Charters are typically approved for 10 years."

Decision.— We submit the accompanying revisions under the rubric of "major changes," thereby requiring review of, and authorizations from both Station and National Program Leadership. Based on discussion and review of the 2005 Charter as well as consensus on the new focus areas and structure proposed for the RMRS Fire, Fuel, and Smoke Science Program, we therefore submit this package as a revision to the existing 2005 Charter, per FSM 4072.14b.

We request approval of these revisions be coincident in timeframe with authorization of the other RMRS Science Program Charters. However, we propose to seek broad review directed at formulating a new Charter in 2011—while FSM 4072.14c notes that Program Charters are typically approved for ten years, we recognize that the 2005 Charter to which these revisions apply is nearly four years old. Additionally, two national organizational and strategic planning efforts have presented both opportunities and imperatives for a thorough re-crafting of this Charter within the next 2-3 years. First, the national R&D Strategic Program Area (SPA) framework now identifies seven SPAs, each supported by logic models and business plans. The SPA framework includes well-defined responsibilities and directions for national oversight and guidance of field units aligned under each respective SPA. Specifically, new direction (currently in draft form)

will identify guidelines for Stations and WO staffs regarding development, review, and approval of Research Program Charters and RWUDs. Second, strategic vision for the Fire SPA is supported by the 2006 *"Wildland Fire and Fuels Research and Development Strategic Plan: Meeting the Needs of the Present, Anticipating the Needs for the Future"* (termed the *Fire and Fuels R&D Strategic Plan* hereafter). This Plan is expected to provide direction regarding the formulation of new Program Charters and RWUDs for all R&D units in the Agency whose focus is within the scope of the Fire SPA.

2. New FFS Science Program Narrative:
Mission and Six New Focus Areas

This Charter revision replaces ten Problem Areas (from the 2005 charter—see section #4 and appended document) with six new ones. While we call these "Focus Areas" in our Station's program charter development and strategic planning efforts, these are synonymous with "Problem Areas" in the context of FSM language for RWU and Program chartering.

Mission— The **Fire, Fuel, and Smoke Science Program** of the Rocky Mountain Research Station is chartered to conduct fundamental and applied research relating to wildland fire processes, terrestrial and atmospheric effects of fire, and ecological adaptations to fire. In addition, the Program develops associated knowledge tools and applications for both scientists and managers. The scope of work addresses four stages of wildland fire, including: the pre-fire environment; combustion and fire behavior processes; immediate (first-order) fire effects; and longer-term (second-order) fire effects.

Focus Areas— The Program's research, development, and applications efforts are organized around six primary focus areas:

1. Physical fire processes
2. Fuel dynamics
3. Smoke emissions and dispersion
4. Fire ecology
5. Fire and fuel management strategies
6. Science synthesis and delivery

Focus Area Narratives—

1. Physical fire processes
Using laboratory studies and theoretical physical modeling, informed and validated by field observations, improve our understanding of the fundamental, multi-scale, physical processes that govern fire behavior, including combustion processes, heat and energy transfer processes, atmospheric dynamics, and fire-fuel transitions from "well-behaved" to extreme events. In this focus area, we analyze the combustion process and the factors that determine fire behavior.

Expected outcome: Increased understanding of combustion helps managers and society anticipate: potential for high intensity fire; initial fire effects; effects of fuel treatments; potential for loss of life and destruction of property. We anticipate within-Program efforts and collaborations with partners resulting in a comprehensive physics-based fire modeling system that includes the full range of combustion environments and fire events observed in wildland fuels. This approach will incorporate new physics-based understanding into a three-dimensional environment that includes fuel structure, meteorology, and fire/atmosphere interactions. This system will be suitable for use by fire and fuels managers both for characterizing fire danger and predicting fire behavior, as well as by scientists needing to model fire for a wide range of purposes ranging from site-specific vegetation simulation to global carbon accounting.

2. Fuel dynamics

Develop consistent, accurate and comprehensive methods for quantifying wildland fuels and their variability along three gradients: spatial, size-class, and temporal (both seasonal and multi-year). In this focus area, we exploit field and laboratory studies to address

Expected outcome: Research on fuel dynamics helps managers describe the vegetation that burns during wildland fires. Improved information about fuels, including their 3-dimensional characteristics as well as patterns of change over space and time is used to predict seasonal and multi-year changes, and to more accurately predict fire behavior and fire effects. Specific outcomes include a suite of sampling strategies, improved data for fire behavior modeling and fuel hazard assessment, and improved fuel dynamics algorithms for incorporation into temporal models of fire behavior, fire danger, and fire effects. These products are critical for the next generation of fire models.

3. Smoke emissions and dispersion

Develop and test methods for implementing a realtime emissions inventory coupled with dispersion modeling for smoke emissions from wildland fires. Integrate fire remote sensing with field-validated models of emissions source-strength, plume rise, chemical transformation and dispersion. We use field observations, satellite data, and models to describe smoke's composition, its movement within a fire's heat plume, and its movement through the layers of the atmosphere.

Expected outcome: Work in this focus area will lead to improved estimates of emission concentrations over space and time resulting from wildland fire, in order to support public health and safety, visibility standards, and carbon budget applications, and movement carbonaceous emissions around the globe.

4. Fire ecology

Improve understanding of the interaction of fire-adaptive traits of plant species with varying fire severities in order to predict post fire succession. Improve understanding of treatment effects (prescribed fire with and without harvest or mechanical treatment) on fundamental ecosystem characteristics (nutrient cycling, carbon storage, nutrient cycling, long term fuel dynamics, and weed invasion). Improve understanding of treatment interactions (e.g. silviculture and fire, herbicide and fire, etc.). Field and laboratory

studies address how fires and fuel consumption affect plants and plant communities, how fires alater the flow of carbon and nutrients in ecosystems, and how fire affects weeds.

Expected outcome: Outcomes of this research contribute to improved conservation, appropriate ecological use of fire, improved management strategies for ecosystem restoration and maintenance as well as burned area restoration; and better, more defensible fuel management treatments. These outcomes are manifested through synthesis and delivery products as described in Focus Area 5—Fire and fuel management strategies.

5. Fire and fuel management strategies

Simulate landscape level interactions between changing climate, changing fire regimes, and vegetation under different management alternatives. Conduct fire history research to understand the drivers of historic fire regimes in order to improve our predictive ability for future fire regimes. We use case studies, modeling, and understanding of ecology to develop fire and fuel management strategies. Improvements to fire modeling systems based on physical fire processes and fuel dynamics research are directed towards improving the predictability of fire potential and fire behavior.

Expected outcome: Efforts in this focus area will improve the capacity to provide scientific input to fire and fuel management policies that result in 1) increased forest resilience, 2) maintenance of forest cover, 3) increased carbon capture and storage, and 4) mitigation of potential negative feedback loops between climate change and altered fire regimes. Improved fire danger rating and fire behavior prediction systems support fire and fuel management decision-making.

6. Science synthesis and delivery

Scientific publications form the foundation of science delivery. Synthesis of past research and integration of knowledge build on this foundation. There is a Programmatic commitment to express new science knowledge in forms usable by other scientists as well as by resource managers. While synthesis and delivery efforts will be anchored in the refereed scientific publications produced by program scientists, science delivery will include the entire range of communications media. Linkages and interactions among focus areas, RMRS Science and RD&A Programs, and other FS R&D units will be considered and described.

Expected outcome: Work in this focus area provides: computer programs and mentoring that help land managers apply research; presentations, classes, photo guides, field tours, training materials, and childrens educational programs; handouts and articles in journals and trade magazines; and a comprehensive web delivery program (firelab.org, soon to become firelab.gov). Success in this Focus Area depends largely on collaboration with users and others ro develop and test products and to develop new ways to bring science into application. The Program's Fire Modeling Institute (FMI) and our strong linkage to the Wildland Fire Management RDA Program are essential components to this strategy.

The Six Focus Areas in the Context of the Fire and Fuels R&D Strategic Plan—

The focus areas relate to the five Portfolios described in the Fire and Fuels R&D Strategic Plan in several important ways:

- Focus areas 1, 2, and 3 relate directly to Portfolio A (Core Fire Science), which includes the combustion process, complex fuels and fire emissions. We have parsed components of Portfolio A into these three focus areas to exploit the FFS Program's capabilities, resources, and partners in these respective focus areas. Research efforts by the FFS Program in these focus areas are relatively biome-independent, with national as well as international scope and relevance. The external peer review panel reviewing Fire and Fuels R&D Strategic Plan has strongly recommended that Core fire Science Portfolio work be directed at an aggressive program of work leading to the development of a next-generation fire behavior processor. The combination of knowledge and skills of FFS personnel, the combustion chamber and wind tunnel capacity at the Missoula Fire Sciences Laboratory, and strong partners makes the Program uniquely suited as a leader in core fire science.
- Fire ecology (focus area 4) is directly related to Portfolio B (Ecological and Environmental Fire Science), which includes research on the interactions among fire, other disturbance processes, and biological components of ecosystems and the environment. Integration of field, laboratory, and modeling capacity create a Program strength in addressing Portfolio B issues such as fire history and fire regimes, fire-vegetation interactions, biophysical processes, and carbon-flux/climate change.
- Focus area 5 (fire and fuel management strategies) is congruent with Portfolio D (integrated fire and fuels management research), which includes treatment effects on fire and fuel characteristics, treatment tradeoffs, and policy implications and impacts.
- Focus area 6 (Science synthesis and delivery) is a direct match to the Fire and Fuels R&D Strategic Plan's Portfolio E—develop and deliver knowledge and tools to policymakers, wildland fire managers, and communities.

3. Crosswalk from 2005 Charter to 2008 Revisions

Ten Problem Areas were described in the 2005 lab-wide charter for three research Work Units: 1. Fire Behavior (RMRS-4401); 2. Fire ecology and fuels (RMRS-4403); 3. Fire chemistry (RMRS-4404). Because this Charter Revision relies heavily on the legacy of the 2005 lab-wide charter, a generalized crosswalk of primary activities and capabilities from old to new Problem areas is provided on the following page to illustrate the continuity between the 2005 Charter and the new focus areas (Problem Areas) within the revised Charter.

Problem Area Missoula Fire Sciences Laboratory 2005 Lab-wide Charter		**Focus Area — 2008 FFS Science Program**					
		#1 Physical fire processes	**#2** Fuel dynamics	**#3** Smoke emissions and dispersion	**#4** Fire ecology	**#5** Fire and fuel mgt. strategies	**#6** Science synthesis and delivery
#1	Wildland fuel sciences						
#2	Fundamentals of fire physics and heat transfer						
#3	Fire-atmosphere interactions and extreme fire behavior						
#4	Remote sensing and information management technology						
#5	Fire ecology						
#6	Landscape fire dynamics, emissions, and ecology						
#7	Prevention of residential fire disasters during extreme wildland fire conditions						
#8	Fuels treatment and ecosystem restoration						
#9	Characterization of properties of smoke emissions						
#10	Forecasting long-range smoke transport						

4. NEW ORGANIZATIONAL STRUCTURE AND LEADERSHIP

The New RMRS Program structure does not include Project Leaders. For all RMRS Science Programs, the Program Manager supervises all PFT scientists. The objective is to facilitate cooperative research among scientists and to allow scientists to devote more time to science and less to supervision and administration. Within the FFS Program, three formal, standing Teams are identified. As shown in chart #1 of section 10, these include: 1. Fire Modeling Institute (FMI); 2. Technology Transfer/Science Delivery; and 3. Fire Chemistry. As with the overall RMRS consolidation of many RWUs into seven science Programs, we deliberately attempted to enhance integration and cross-disciplinary collaboration. Informal teams are organized around a research focus topic (see chart #8 of section 10—examples of inter-program working group teams). An individual can serve on more than one team. A team can be short-term or ongoing. All FFS Teams and working groups necessarily rely on and support each other for much of their work. Team structures may change both within the Program and within Teams as needs arise, providing a nimble and responsive workforce.

5. Infrastructure and Resources Unique to the FFS Program

The Missoula Fire Sciences Laboratory is unique in the world. Combustion science facilities include the largest controlled combustion environment (combustion chamber), a high-velocity wind tunnel for instrument calibration, and a low-velocity wind tunnel for wind-influenced burning experiments. A dedicated soil science laboratory includes burn tables and hoods, fuel and soil preparation equipment and instruments, and environmental chambers. The Program's remote sensing capabilities include a state-of-science direct broadcast MODIS sensor receiving station, an infrared instrument development and calibration laboratory, and a ground-based LIDAR system. A new Particle Image Velocimeter (PIV) instrument and software is being configured for integration into the combustion experiments. Both domestic and international collaborators from federal, University, and NGO units utilize the facilities and cooperate with Program scientists in exploiting the Program's laboratory resources.

6. 2005 "Planned Accomplishments" Mapped to the 2008 Revised Charter Problem Areas

Since these revisions are submitted as amendments to the 2005 Lab-wide charter, shown below are the 2005 "planned accomplishments" excerpted from the 2005 charter and listed here under the respective new 2008 Problem Areas.

1. Physical fire processes

- Continue current research cooperative agreements that are focused on developing new understanding of chemical, fluid dynamics and heat transfer processes in

wildland fire. Incorporate results from these cooperative projects into the framework of a stochastic based fire spread and intensity model. (2005 Charter, PA#2).

- Based on the *FARSITE* fire area growth simulator and current capability of CFD technology, develop a hybrid system that can be used as a research tool to increase understanding of fire/wind interactions but also used operationally to more accurately predict fire spread. This capability may permit researchers to accurately define which wind really matters to fire spread (i.e. is it the 20 foot wind, the mid flame wind or some other wind, what are the important aspects from a frequency domain perspective?). Integration of CFD techniques will be compared with other scaling approaches, such as mesoscale, gridded weather models. (2005 Charter, PA#2).
- Evaluation and testing of the LANL FireTec model using detailed spatially-explicit fuel data. (2005 Charter, PA#2).
- Complete the development of an in-house Particle Image Velocimetry (PIV) system that will permit researchers to accurately measure the temporal and spatial characteristics of the flow field in and around a spreading fire. This information and technology are critical to increased understanding of the processes driving convective energy transfer in wildland fire. This will contribute directly to current fire modeling efforts. (2005 Charter, PA#2).
- Complete a summary of current state of the science of radiation heat transfer and incorporate the newest technology into new fire modeling efforts. (2005 Charter, PA#2).
- Support ongoing cooperative studies that are directed at characterizing the ignition process for individual fuel particles. This work is focusing both on the heat transfer processes and the chemical processes at work during the ignition process and shows promise for providing new understanding into the ignition process. It will permit researchers to characterize similarities and differences between unconfined wildland fire spread and confined combustion (i.e. furnaces) on which most biomass combustion science is based. (2005 Charter, PA#2).
- New models will be developed for fire spread and behavior in discontinuous fuels and for identification of critical factors in plume-dominated and wind-dominated fires. (2005 Charter, PA#3).
- Methods for using computational fluid dynamics (CFD) software will be developed for improving fire intensity and behavior predictions within the BEHAVE/*FARSITE* family of models by providing a method for obtaining surface wind speed and direction data at the 10^1 to 10^2 meter scale as a function of synoptic or ridge-top flow speed and direction. Three specific products are anticipated: 1) an objective assessment of the utility of CFD codes to provide reliable, timely and accurate surface wind information. This will include an analysis of the impact of the gridded wind on the accuracy of fire behavior predictions; 2) a specific set of tools and methods for producing high resolution wind data with an assessment of the impact of both elevation data scale and wind

data scale on fire modeling predictive accuracy and 3) a recommended process by which this technology can be made available as an operational tool to fire incident management teams. (2005 Charter, PA#3).

- Research will provide new protocols for applying thermal infrared remote sensing technology for assessing: fire behavior, radiant heat flux, production and source strength, dispersion of smoke, and fire effects at various scales, including stem-level, stand-level, and watershed-level measurements at resolutions ranging from centimeters to kilometers. Deployment of these techniques will be "scalable," with a range of applications including laboratory, *in situ* field measurements, near-site oblique observations, airborne systems, and satellite remote sensing. (2005 Charter, PA#4).
- We will relate remotely-sensed measurements of radiant heat flux with models designed to predict fire behavior and effects.(2005 Charter, PA#4).
- If appropriate in the context of a next-generation fire behavior processor, and regardless, until such developments are completed, the BehavePlus fire modeling system will be expanded to include new research models as they become available (e.g. transition to crown fire, stem heating for tree mortality, and fuel consumption). BehavePlus predicts potential fire behavior and effects and can be used for real-time fire prediction, prescribed fire planning, and fuel hazard assessment. The BehavePlus, FlamMap, and *FARSITE* system will be a consistent set of decision support systems based on the same mathematical fire models. (2005 Charter, PA#6)

2. Fuel dynamics

- Future fire management will depend on spatially explicit inventories of fuels. New and novel approaches will be developed for mapping the fuels that control fire behavior and effects. Approaches will include remote sensing, simulation modeling, and statistical modeling. Specifically, we will investigate the potential for Lidar, MODIS, ASTER, and MISR to map fuel characteristics. Hyperspectral, high-definition, image fusion fuel mapping will be explored to determine the potential for fusion of hyperspectral imagery IKONOS, and other appropriate imagery to map surface and crown fuels. Remote sensing, gradient analysis, and ecosystem modeling will be integrated to map fuels for operational fire management. (2005 Charter, PA#1).

- Research will lead to models that describe how fuels vary as species composition and stand structure change in response to succession, disturbances, and climate change. Studies will result in an improved understanding (quantification) of horizontal and vertical continuity and how changing weather and terrain interact with fuel continuity to affect fire behavior. Research will lead to improved models of crown fuel characteristics to support crown fire prediction systems for fuels treatment design and Wildland fire management. Research will be conducted on a rangeland vegetation simulator for modeling fuel dynamics in grasslands and semi-arid woodlands. (2005 Charter, PA#1).

- A better knowledge of chemical composition of live and dead fuels will be developed for temperate, tropical and boreal ecosystems. (2005 Charter, PA#1).

- New, standardized field sampling methods will be developed in collaboration with the user community for monitoring post fire vegetation dynamics. The FIREMON database and manual will be used to disseminate this information. (2005 Charter, PA#5).

3. Smoke emissions and dispersion

- We will develop a nationwide emissions inventory of atmospheric pollutants produced by wildland fires every for to six hours daily in 500m X 500m resolution for most of North America. The information will be accessible on the Fire Laboratory's website. (2005 Charter, PA#6).
- A comprehensive emissions model will be developed in consultation with PNW-FERA to relate the emission factors of atmospheric pollutants from fires to combustion efficiency, and weather and vegetation conditions in temperate, boreal, and tropical ecosystems. The model will be used to predict emissions on the basis of combustion conditions. (2005 Charter, PA#9).
- We will develop the fundamental science of physical, chemical, and optical properties of smoke aerosol particles. (2005 Charter, PA#9).
- The technology of a mobile LIDAR (light detection and ranging) instrument will be applied to measure smoke plume height and smoke aerosol properties. A mobile laboratory will be equipped with the most advanced instruments to measure aerosol particles over prescribed fires and wildfires. (2005 Charter, PA#9).
- We will develop a nationwide system, the Weather Research and Forecast (WRF) - Smoke Dispersion Model, for operational use to forecast smoke dispersion and air quality downwind from large fires. The forecast results will be accessible from the Laboratory's web site. (2005 Charter, PA#10).
- The technology of WRF-Smoke Dispersion model will be transferred to other meteorological modeling projects being conducted by the Forest Service Fire Consortia for Advanced Modeling of Meteorology and Smoke (FCAMMS). (2005 Charter, PA#10).
- After the WRF-Smoke Dispersion model is fully developed for the continental U.S., we will transfer this forecasting technology to other countries, such as Australia, Brazil, Russia, and China. (2005 Charter, PA#10).
- A comprehensive, Internet-based spatial fire information system (location, intensity, burn area) will be implemented in cooperation with NASA GFSC and NOAA/NESDIS. (2005 Charter, PA#4).
- Daily maps of active fire locations, burned areas, fire radiative energy, and aerosol levels in a 1-km x 1-km resolution nationwide will be developed using MODIS data from NASA Terra and Aqua satellites. We will validate the satellite measurements by ground and airborne measurements. The information will be

available on the Laboratory's web site. The technology also will be implemented in cooperation with the Instituto de Pesquisas Espaciais (INPE), the Brazilian Space Agency, the Chinese Academy of Forestry, the Russian Academy of Sciences, and other foreign institutions. (2005 Charter, PA#4).

4. Fire ecology

- Research will develop new and modified ways of collecting fire history evidence across landscapes including tree fire scars, fire atlases, soil carbon, sediment cores, tree age structures, and satellite-based burn-scar time series analyses. These will result in improved guidelines for managers to determine historic range of variability and set restoration, mitigation, and adaptation goals. A simulation model will be developed to analyze fire scar and tree age structure that will allow managers to optimize landscape fire history sampling. This task is concerned with summarizing fire history data in a format that is useful for research and management. It leads directly into the next accomplishment. (2005 Charter, PA#6).
- This area of research includes prediction and mapping of fire regimes. Remote sensing, gradient analysis, and simulation modeling will be used to map fire regimes. This will result in new ways to map fire regimes across landscapes using a wide variety of approaches from rule-based classifications to regression analysis to simulation modeling. These results have application to prioritizing and scheduling fuel treatment and restoration activities. (2005 Charter, PA#6).
- Multivariate statistical techniques will be developed to identify periodicity and variability of fire frequency and severity from climate signals such as ENSO (El Nino Southern Oscillation), PDO (Pacific Decadal Oscillation), and other coarse-scale climate teleconnections. Development of these techniques is already underway with extensive collaboration with experts throughout the United States. This information will be used to help managers plan fuel treatment and restoration projects as well as to conduct long-range strategic planning of fire season severity. (2005 Charter, PA#6).
- New methods are being developed to identify regional episodes of severe fire years and to link these episodes to climatic variations, as well as to other disturbances, e.g., insect outbreaks. Fire history will be compiled and consolidated into a comprehensive fire history database for the nation and posted on the FRAMES website. (2005 Charter, PA#6).
- New techniques will be developed to map burn characteristics before, during, and after the fire has burned an area. Burn characteristics include fire severity, fire perimeters, and fire patchiness. (2005 Charter, PA#6).
- The Fire Effects Information System (FEIS) will be continually improved, augmented, and maintained, particularly by adding to the data base new synthesis for exotic and invasive species, with strong support by FS-A&FM and JFSP. Support for a more aggressive program of updates is also desired and will be sought (2005 Charter, PA#5).

- Exotic/weedy species invasion of forest and rangeland communities will be assessed as it varies with fire severity and fire suppression activities, with changes in fuel management, and with changes in fire regimes and dispersion pathways. Successes in the Interior West will be evaluated in other ecosystems. We will develop guidelines for fire managers to reduce the impacts of suppression and associated invasives. We will develop an improved understanding of post fire invasion of exotic species and will document this through a series of published papers. (2005 Charter, PA#5).

5. Fire and fuel management strategies

- Safety guidelines for determining fire-fighter exposure and safety zones will be refined and transferred to the wildland fire community. (2005 Charter, PA#3).
- Guidelines and models will be developed for use in prescribed fire for predicting interaction of multiple flame fronts. (2005 Charter, PA#3).
- The *FARSITE*, FlamMap, and Minimum Travel Time models will be used with landscape-level fuels data mapped under Problem 1 to develop guidelines for the placement of fuels treatments such that treatment priorities can be determined on the basis of minimizing the biophysical potential for fire loss. (2005 Charter, PA#6).
- New techniques will be developed to support ecosystem and fire assessments. This broad area is concerned with generating spatially explicit assessments of ecosystem condition, fire hazard, fire risk, and landscape condition for land and fire management. We will develop Fire Hazard and Risk Assessment Tools. Various methods of calculating and mapping fire hazard and risk will be done with the FIREHARM tool. We will calculate hazard as an expression of worst-case fire behavior, effects, and danger while we will calculate risk as a probability of occurrence of a particular fire behavior, effect, or danger index. This study will provide managers with improved priority-setting capabilities. We will use landscape fire succession models to quantify the historical range and variability of various landscape characteristics including patch size, largest patch size, cover type composition, and contagion. Then, we will develop the statistical algorithms to compare these historical variations to existing conditions to compute a landscape condition index that quantifies the degree of departure that the current landscape is from historical conditions. This outcome will directly support exploration of the implications of climate change. (2005 Charter, PA#6).
- A general assessment method of W-UI exposure will be developed for home owners and local fire protection authorities. (2005 Charter, PA#6).
- The Structure Ignition Assessment Model will be refined and completed, and an associated guide for identifying housekeeping details for reducing home ignition potential will be developed. (2005 Charter, PA#6).
- A community-wide WUI fire spread and home involvement model will be developed. The model will address structure-to-structure fire spread, and its development will involve close consultation and collaboration with other federal partners (DOC-NIST). (2005 Charter, PA#6).

- Recommendations of types of exterior building materials appropriate for various levels of flame and firebrand exposures will be prepared and disseminated. This work is informed through consultation with FS-Forest Products Laboratory, DOC-NIST, and non-governmental organizations. (2005 Charter, PA#6).
- The Fire and Fuels Extension to the Forest Vegetation Simulator developed in cooperation between the Fire Ecology and Fuels Research Work Unit, the Moscow Forestry Sciences Lab, and the Ft. Collins Service Management Center, allows managers and scientists to model the temporal effects of fuel treatment and the interaction of stand development and fuel dynamics. This program is widely implemented and we continue to work on its modeling capabilities, scientific content, and to help users incorporate it into various analysis projects, local and large scale. (2005 Charter, PA#8).
- The First Order Fire Effects Model (FOFEM) and the Fire Effects Information System (FEIS) are long-standing Fire Science Laboratory products that are used extensively by managers in planning and implementing fuel treatment and restoration projects. They are also used to evaluate the effects of wildland fires to develop post-burn management strategies, e.g., BAER and salvage. We will continue to develop and maintain FOFEM by synthesizing fire effects studies from across the United States. This will include periodic updates; i.e., new versions, when significant improvements occur, e.g., improved tree mortality models, improved fuel consumption models, etc., FOFEM will also be incorporated into a number of other products for assessing smoke production and fire effects at larger scales. (2005 Charter, PA#5).
- Simulation and modeling tools will be developed to understand and predict fire dynamics on landscapes. This research mainly involves the development of spatially explicit landscape fire models of various complexities and resolutions and the application of these models to various landscapes and situations. There are primarily three tasks in this research area: Model Development, Modeling Science, and Model Application. New and innovative models will be developed for investigating landscape fire dynamics. Model development is an interesting challenge because simple models are not robust or exploratory, but they are computationally efficient and easy to parameterize; whereas complex models may allow exploration of causation, but are difficult to parameterize and interpret and require copious computer resources. Moreover, the appropriate balance between management application and research investigation as modeling objectives must be obtained. (2005 Charter, PA#6).
- Fuel treatment study projects will be implemented in:
    - Pinyon-juniper on the Colorado Plateau and in the Great Basin;
    - Mixed conifer forests in the Sierra Nevada (Lassen NF) and Northern Rocky Mountains (Bitterroot NF, Lolo NF, Lubrecht Experimental Forest);
    - Weed invaded forests and rangelands in Montana, Utah, Oregon, Idaho, and Arizona; and

- Shrub-scrub wetlands in North Carolina (Dare County, Alligator River).

These areas represent areas where managers have critical problems in implementing fuel treatments. These problems include high resource values in the wildland urban interface, existing ecological degradation, low product values, and presence of exotic species. Treatment such as mastication, mechanical manipulation, and off-season fire applications are some that will be examined. Demonstration projects will be used for field trips and fire management training sites. Also, we will take advantage of wildfires to evaluate the effectiveness of past fuels management activities. Other study areas will be identified as knowledge is gained from work in these preliminary study areas. Project results will be used to develop treatment and restoration guidelines for managers. (2005 Charter, PA#8).

6. Science synthesis and delivery

- Research will advance the capabilities of the Wildland Fire Assessment System (WFAS) to provide fire weather and fire potential information as it changes throughout the year. Images and data will be available on the Internet. Sources of weather observations in addition to fire weather data will be used. Modeling for interpolating weather across the landscape will be incorporated. Improved models will be developed to use weather and satellite data to assess fuel condition and fuel moisture throughout the fire season. Methods will be developed to determine threshold values that can be used in fire suppression and prescribed fire applications. (2005 Charter, PA#6).
- Research products will extend and replace existing components in Wildland Fire Assessment System (WFAS). These products include: 1) a national fire potential map using gridded weather data and improved fuel moisture models. Products will be developed specifically to support decision makers, including the capability for "data mining." 2) high-resolution potential fire behavior for a selected landscape will be available several times per day, based on the FlamMap program and observed and forecasted weather data. These products will have application for all aspects of fire management, including suppression, prescribed fire, and the use of wildland fire for resource benefits. (2005 Charter, PA#4).

7. RMRS Station Relationships: FFS Program, LANDFIRE, the Rocky Mountain Center, and the Wildland Fire Management RD&A Program

LANDFIRE.—The LANDFIRE production unit is currently hosted at the Missoula Fire Sciences Laboratory in cooperation with the FFS Program. Future plans for LANDFIRE include an ongoing operations and maintenance (O&M) program as well as proposed new R&D work associated with exploiting the LANDFIRE products and new science with which to improve LANDFIRE protocols. These efforts are proposed to be conducted by new F&AM development and application units such as NIFFT. RMRS does not propose

to extend their direct R&D presence in LANDFIRE beyond the expected 2009 horizon. It is the expectation of RMRS, however, that the FFS Program may incorporate some current LANDFIRE and support staff back into the FFS Program.

Rocky Mountain Center.—The Rocky Mountain Center (RMC) is affiliated with the national FCAMMS and is currently hosted within the FFS Program. Negotiations are underway to create a virtual hosting the RMC fire products within the Wildland Fire Management RD&A Program, with supervision of RMC personnel shared by FFS Program and the Wildland Fire Management RD&A Program. One vacant scientist position (vice Zeller) will not be filled, and the RMRS will reallocate salary savings from that vacancy (previously funded through NFP dollars) to support RMC operations. The FFS Program is creating a post-doctoral term position to fulfill the vice Zeller responsibilities for and undetermined period of time, not to exceed four years. That position will be supervised by the FFS Program Manager.

Wildland Fire Management RD&A Program.—This RD&A Program is closely associated with the FFS Program, and is also a partner with FFS, the University of Idaho, and the University of Montana in a decision-support science partnership. Personnel, activities, and resources will be coordinated between the RD&A Program and the FFS Program as determined both by the partnership and by internal RMRS agreements, requiring modification to current Charters and agreements.

8. National Service and Leadership

Scientists and staff in the Program have significant commitment to, and involvement in both national and international fire research and management.

- The Program manager is co-lead of the self-directed Core Fire Science Caucus. Efforts by the Caucus lead to the draft language and vision used to define Portfolio A for the Fire and Fuels R&D Strategic Plan.
- The Rocky Mountain Research Station has the national lead responsibility on the Fire SPA for Portfolio A, Core Fire Science. The FFS Program Manager is delegated by the Station Director and WO Fire SPA Lead as Team Leader for Portfolio A. As Team Leader, the Program manager has facilitated the pursuit of a national Fire Science Advancement Plan, and continues as Team Leader and partner with WO Fire SPA Leads in further efforts at defining a national vision for advancing core fire science. The Program manager represented Portfolio A at the external peer review of the national Fire SPA. The Station's Fire SPA representative is a scientist in the FFS Program.
- A FFS Program scientist is the lead fire behavior scientist for both the Wildland Fire Decision Support System (WFDSS) and Fire Planning and Analysis (FPA) projects.