FIRE AND FUELS
PROGRAM CHARTER

Pacific Southwest Research Station

Review and Approval

(Adapted from FSM-4000-1)

CHARTER
FIRE AND FUELS PROGRAM
Pacific Southwest Research Station

Executive Summary

Managing fire and the vegetation conditions that fuel fire to accomplish multiple land management objectives is a paramount challenge to land managers throughout most of California, Hawai`i and the U.S. affiliated Pacific Islands. The contemporary conditions of fire and fuels that we face in this area present some of the most complex land management challenges found in the United States. Innovative and high quality science will play a pivotal role in guiding crucial management decisions that we expect to face in the future.

The purpose of our Program is to provide science-based knowledge, applications, and leadership to scientists, managers, policy makers, and communities. Research in the Fire and Fuels Program is coordinated and integrated with Department and Agency strategic plans, other PSW programs, other Stations, and Region 5 priority areas. The Program draws most significantly from the Fire and Fuels Strategic Planning Area (SPA) and also integrates issues that reach across multiple SPAs. Since fire crosses administrative boundaries, research performed in this Program is supportive of the "all lands" vision of landscape-scale conservation of USDA.

Research in the program will be focused on five problem areas that are designed to build on and develop fundamental knowledge of fire and fuels science and related disciplines. The five problem areas are

Problem Area 1: Improve measurement, modeling, and prediction of wildland fire and weather phenomena in complex landscapes and fuels.

Problem Area 2: Determine the ecological effects of fire and fire removal on landscapes throughout California, Hawai`i, and the U.S. affiliated Pacific Islands.

Problem Area 3: Evaluate the short and long-term outcomes of fuels, fire and post-fire management strategies.

Problem Area 4: Determine and quantify the interactions between climate, vegetation, and fire in the face of climate change and improve our understanding and predictability of these interactions in order to manage forests and wildlands more effectively.

Problem Area 5: Describe and quantify uncertainty and risk in a science-based decision-making framework for fire and land management planning

Our Program mission is to provide scientific findings that will improve management actions intended to enhance resiliency and sustainability of wildland ecosystems affected by fire and reduce the potential for adverse effects resulting from wildland fire, including loss of life and property.

R&D PROGRAM NUMBER

TBD

STATION

Pacific Southwest Research Station

R&D PROGRAM LOCATIONS

Albany, Davis, Redding, and Riverside, California
Hilo, Hawai`i

R&D PROGRAM TITLE

Fire and Fuels

PROGRAM MANAGER

Dr. Rick Bottoms

AREA OF APPLICABILITY

California, Hawai`i and the U.S. affiliated Pacific Islands. Work of the program will contribute to fundamental understanding of fire management in wildland ecosystems throughout the world. As fire crosses administrative boundaries, research performed in this Program is supportive of the USDA "all lands" vision of landscape-scale conservation.

ESTIMATED DURATION

The Fire and Fuels Program is chartered for 10 years (2011 – 2021) with a midterm review and potential charter revision after five years (2016). Amendments will be made to the charter as needed to address emerging issues.

MISSION

Provide scientific contributions that will improve management actions intended to enhance resiliency and sustainability of wildland ecosystems affected by fire and reduce the potential for adverse effects resulting from wildland fire, including loss of life and property.

OUTCOMES

The purpose of the Fire and Fuels research program is to provide scientific knowledge and applications to managers, policy makers, other scientists, and communities in order to achieve the following outcomes in a changing climate:

- A substantial increase in the acreage of fire resilient landscapes through use of scientifically derived forest management strategies that result in enhanced ecological conditions and increased ecosystem services such as high quality air and water, biodiversity, and stable carbon storage.
- Greater public acceptance for and reduced conflict around scientifically driven fuel and fire management strategies to restore resilient wildland landscapes.

- Enhanced strategic and tactical approaches to fire management and post-fire treatment in order to reduce the cost of land management and minimize the loss of life and property.
- Improved prediction of problematic fire years to facilitate efficient use of fire management resources and increase acres treated with fire.

JUSTIFICATION AND PROBLEM ANALYSIS

Given the importance of fire and fuels management in the United States, Forest Service Research and development has invested significant effort to define the research needed to facilitate accomplishment of the agency's goals. These analyses and program definitions reside in the *Wildland Fire and Fuels Strategic Program Area* (four different) portfolio documents which identified priority work that is regional or national in scope. Initially, R&D efforts in the Core Fire Science portfolio will direct resources to develop models of (1) moisture dynamics in the combustion environment, (2) energy transfer within heterogeneous and spatially non-uniform fuel beds, and (3) fire-atmosphere interaction. The three national priority areas for research in the Ecological and Environmental Sciences portfolio are 1) primary and secondary effects of fire on vegetation, 2) effects of varying fire regimes/characteristics on short and long-term watershed processes and conditions and 3) understanding, predicting and modeling effects of wild and prescribed fire on smoke emissions and air quality. A priority area for PSW is to describe and model the linkages between fire behavior and fire effects on habitat for sensitive wildlife. The priority work for the Social Fire Science portfolio is described in the Urban Ecosystems and Social Dynamics Program charter. The Integrated Fire and Fuels Management Research portfolio identified 5 high priority activities: 1) treatment effects on fire characteristics, 2) fuel treatment tradeoffs, 3) effects of fuel treatments on natural resources, 4) economics and markets for biomass and 5) bioenergy/biorefining. PSW has expertise to address priorities 1-3 and will need to develop the expertise for priorities 4 and 5. The Problem Areas identified in this charter align with these national priorities and reflect regional needs. The specific elements within each problem area define one or more studies needed to answer the question posed by the Problem Areas.

In California fire is typically the most influential agent of change that shapes the structure, function, and composition of the vegetation and habitat in a diverse array of Mediterranean-type ecosystems, conifer and mixed hardwood-conifer forests and a variety of grasslands and shrub lands — all adapted to periodic fire. Managing fire and fuels to accomplish multiple land management objectives is a paramount challenge to land managers throughout most of California, Hawai`i and the U.S. affiliated Pacific Islands. At one extreme there are heavily urbanized areas that border highly fire prone environments as in southern California and the Lake Tahoe Basin. At the other extreme, vast remote forests are currently subject to uncharacteristically high intensity fires resulting from fire suppression practices of the past 100 years and forest management constraints of the past 40 years. Fire influences the lives of nearly every citizen of the region and land managers require complex and detailed knowledge to make very difficult decisions about fuel, fire, smoke, and post-fire treatment management.

In Hawai`i, the U.S. affiliated Pacific Islands, and the southwestern deserts of California where fire was historically rare or non-existent, altered fire regimes supported by invasive plant species severely threaten native ecosystems. Over the last 100 years, non-native, flammable plants, particularly grass species have invaded the native ecosystems and the resulting change in fire occurrence is having a profound influence in the drier habitats of the islands and in the California deserts. Land and resource managers challenged to restore native ecosystems and prevent further loss require new scientific information and tools.

Highly altered fire regimes in complex biological, physical, and social landscapes produce unique fire management issues compared to the rest of the U.S. and the world. Because the nature of the modification of fire regimes is quite different from place to place, the research and management responses need also be quite different. In addition, recent accelerated rates of climate change and the impacts of invasive plant species have increased the role of fire throughout this region. Alteration in the extent and/or seasonality of fire has led to significant ecosystem transformation. Projected accelerated rates of climate change will only exacerbate the situation. The landscape changes driven by these new and powerful agents of change present an increasing challenge to present and future land management.

Large and destructive wildland fires in the Mediterranean-type ecosystem, the forests and woodlands of California, and in non-native invasive grasses in Hawai'i and the western Pacific have caused significant damage to life, property, and natural resources. An improved understanding of fire behavior under a wide range of weather and fuel conditions is necessary to provide defensible, science-based information and tools to help reduce losses to society and to maintain and improve the resilience and sustainability of wildland ecosystems. **How can we improve measurement, modeling, and prediction of wildland fire phenomena in complex landscapes and fuels?** Understanding the linkages between fire, fuels, weather, and topography is critical to the modeling and prediction of fire behavior. Measurement of fire behavior and meteorological data from plant to landscape scale is needed to understand the complexity of the phenomena and to provide information to understand fire effects, improve firefighter safety, improve prescribed fire success, and assess fuel treatment effectiveness. Current operational models do not adequately describe or model the physics, chemistry, and fire-atmosphere relationships necessary to improve fire behavior prediction in the complex fuel beds and terrain of California, Hawai'i , and U.S. affiliated Pacific Islands. Smoke production and transport are key issues that affect our ability to use prescribed fire as a tool. While the Fire and Fuels Program has limited resources to address smoke production and characterization, good collaborative relationships with RMRS's Fire, Fuels, and Smoke Program and PNW's Threat Assessment Program and university partners will allow us to address these issues in California and elsewhere.

Pressures of changing climate, expanding urbanization, invasive species and altered fire regimes threaten ecosystem integrity throughout California, Hawai'i and the U.S. affiliated Pacific Islands. A lack of information on the complex interplay of people, changing climate, seasonal weather variation, geology and fire on variable fuels, species and associated communities makes post-fire environmental response unpredictable**.**

What are the ecological effects of fire and fire removal on landscapes throughout California, Hawaii, and U.S. affiliated Pacific Islands? Advancing our knowledge on the ecological dynamics surrounding wildland and prescribed fire to will improve our understanding of the consequences for impacted species or communities. Emphasis will be placed on developing core ecological knowledge for fire and fuels management protocols to protect sensitive and at-risk habitats and species to optimize their stability through fire prevention, and to protect fire dependent species and habitats through fuel and fire treatments or post-fire management choices. Knowledge of the consequences of the lack of fire in ecosystems that historically burned frequently is needed. We recognize that because of the altered fire regimes of the region many sensitive species and habitats are at risk. .

Understanding fire cycle variability in diverse habitats requires linking pre- and post-fire abiotic and biotic conditions to ascertain resilience or adverse consequences (e.g., permanent change to vegetation communities) at multiple levels (e.g., species, associations, communities, landscapes). Invasive species presence may be crucial for untangling significant and evolving fire and fuel effects in some ecosystems. Integrating species and micro-site requirements with multiple trophic levels over time will be important to prioritize local and more global impacts of climate change and fire prevalence to preserve environmental integrity while protecting the valuable goods and services derived from our wildlands.

The complexity associated with managing landscapes prior to, during, and following wildfire necessitates an array of management strategies tailored to each set of conditions. Options are currently limited by the lack of societal acceptance and inability to implement treatments designed to mitigate fire hazard and increase ecosystem resilience. A body of literature exists that addresses tradeoffs among many pre- and post-fire management strategies; much information remains unknown regarding applicability and effectiveness of different approaches. This is especially true as more knowledge accrues on inherent heterogeneity in natural systems and as managers consider greater spatial and temporal scales. **What are the short and long-term outcomes of fuels, fire and post-fire management strategies?**

Ecosystems in California, Hawai'i and the Pacific Islands will become more vulnerable to loss with projected future climate changes resulting from rising greenhouse gases in the atmosphere. Recent research suggests western landscapes will be subject to significant shifts in water quality and availability resulting from geographical and seasonal shifts in rain and snow patterns that are likely to continue and be enhanced by climate change. Further, bioclimatic models predict that significant changes in plant distributions, including a loss of high-elevation species and an expansion of low-elevation woodland trees and shrubs, will likely be accompanied by increased fire and insect outbreaks related to extended seasonal drought periods. **What are the interactions between climate, vegetation, and fire in the face of climate change and how do we improve our understanding and hence predictability of these interactions in order to more effectively manage forests and wildlands?** An improved understanding of how such changes will likely progress and the role of fire in facilitating ecological reorganization is required to enable managers to minimize undesirable

outcomes. Species changes will likely influence fire occurrence and biogeochemical cycling. Work in this problem area will require collaboration with the Ecosystem Function and Health Program.

Land managers and fire management teams require information to aid in decisions they make, including strategic planning, real time decisions on active fires, and evaluating the results of management efforts when using adaptive management. Development of new and enhancement of existing simulation, optimization, and statistical models are needed. There is a need to better address the uncertainties of the fire environment and dynamic processes of resource deployment in the design of efficient and effective fire preparedness programs. A major concern is how to best estimate various risks associated with managing fires for both suppressive and prescriptive purposes; along with this there is the need to plan nationally shared protection resource programs. The Quadrennial Fire Review of 2009 emphasized the need for "… safety and risk management [to] be strengthened and more systematically incorporated into fire planning… New models, new scientific knowledge, and…risk management must be promoted and integrated throughout all capabilities and levels within fire management." The financial implications of the fire management problems identified at the local, regional, and national levels are important and must be addressed. **How does risk analysis assist evaluation of management options and what decision support tools are needed to support science-based decision-making?** For example, integrating severity-forecasting techniques into fire planning tools to estimate severity funding needs and allocation criteria will help land and resource managers develop better strategic and operational plans. Likewise, examining the benefits of hazardous fuel treatment to reduce fire risk and determining their effects on vegetation conditions over time is another potentially valuable analysis tool.

Focus and Scope

The focus of the program is to provide scientific information and tools to help managers achieve the outcomes listed above. The selected problems are derived from an understanding and appreciation of the principle contemporary land management challenges built upon the fundamental work accomplished by PSW scientists and others. Given that fire impacts almost every ecosystem within California and continues to haveprofound influences on many Hawaiian and Pacific Island systems, a central focus of the program will be an increased emphasis on integration among the problem areas within the Fire and Fuels Program and Problem Areas in all other PSW programs.

The Nation's most significant environmental threats – climate change, altered fire regimes, invasive species, loss and fragmentation of wildlands through urbanization, compromised air quality, drinking water shortages, and sea level rise – have prominent impacts in our region. Most, if not all, of the 2010 forest assessments produced by California, Hawai`i, Guam, and the U.S. affiliated Pacific Islands in response to the 2008 Farm Bill identified these environmental threats. Half of all threatened or endangered species found in the United States occur in the PSW region. Given the ecological and socioeconomic complexity of our area, the scope of this program is broad; approaches and methods used to solve the problems are potentially national and international in

scope. Applying cutting edge methods to address natural resource issues under the demanding circumstances in California, Hawai`i, Guam, and the U.S. affiliated Pacific Islands will lead to solutions that can be applied across the nation.

PROBLEM AREA SELECTION AND TIMELINE

Five problem areas will be the focus of the proposed work:

(1) Improve measurement, modeling, and prediction of wildland fire and weather phenomena in complex landscapes and fuels;

(2) Determine the ecological effects of fire and fire removal on landscapes throughout California, Hawai`i, and the Pacific Islands;

(3) Evaluate the short and long-term outcomes of fuels, fire and post-fire management strategies;

(4) Describe the interactions between climate, vegetation, and fire in a changing climate to improve our understanding of and ability to predict these interactions;

(5) Describe and quantify uncertainty and risk in a science-based decision-making framework for fire and land management planning.

We will work with land managers in California, Hawai'i, Guam and other U.S. affiliated Pacific Islands to evaluate use of wildland fire and alternative approaches to using fire to shape and influence ecosystems and examine options for treatment of landscapes to return them to a more resilient and self-sustainable condition. Development of decision support tools and technical support will provide the scientific information for science-based decision-making. Gaining a better understanding of wildland fire behavior and effects in California, Hawai`i, Guam and U.S. affiliated Pacific Islands will provide knowledge and tools to increase firefighter and public safety and health, minimize losses of life, property and natural resources, and improve management of fire-adapted and fire-impacted ecosystems.

Problem Area 1

Improve measurement, modeling, and prediction of wildland fire and weather phenomena in complex landscapes and fuels.

Planned Topics for Study

- Effects of moisture content, fuel structure, and condition on fire behavior in shrub and grass fuels. Complete in FY 18
- Effects of weather, topography, and fuel moisture, fuel structure, and fuel condition on fire behavior in forest and woodland fuels. Complete in FY20
- Description of dynamics of large-fire behavior including interactions of fire with wind and large-scale atmospheric circulations. Complete in FY 19

- Effects of treated fuels and suppression activities on fire behavior. Complete in FY 20

Approach to Problem Solution

Fuels and fire behavior experiments will be conducted at laboratory- and field-scale. Empirical data will be used to parameterize and check predictions from theoretical models. Aircraft-scale measurement will allow us to measure fire dynamics over the geographic extent of an entire wildland fire. Much of this work is continuation of efforts started under the National Fire Plan research program. New technologies and increased computing power will enhance measurements, modeling, and predictive tools.

The work in this problem serves, in particular, the actual fire-fighting forces assigned to suppress unwanted fires and to manage prescribed fires. An enormous investment of people and equipment is devoted each year to fighting fires in Region 5 with lives and significant property values at stake. Many advances in safe and effective fire-fighting resulted from research and development work and much more is possible. National Forest System staff in Fire and Aviation Management and state and local agencies benefit from improved strategies and approaches to safe and effective fire-fighting. The training and scientific knowledge provided to fire managers in Hawai`i and the Pacific Islands is based on research performed in the continental U.S. Information from the Florida Everglades and Puerto Rico may be most applicable to conditions in the Pacific Islands. Work in this problem area will address the potentially unique fire behavior faced by fire managers in the Pacific.

The clientele of the research in this problem area are fire behavior scientists, fuel and fire managers. Continued advancements in fire behavior knowledge will enable managers to employ more effective and safer approaches to managing wildland fires. Coupling these advances with progress in Problem Areas 4 and 5 and the Urban Ecosystems and Social Dynamics Program Problem Area l will enable strategies designed to reduce significantly the high cost of fighting fires and to reduce losses to communities in the Wildland Urban Interface (WUI).

Problem Area 2

Determine the ecological effects of fire and fire removal on landscapes throughout California, Hawai`i, and the Pacific Islands.

Planned Topics for Study

- Characterize the fire regimes that maintain the environmental integrity of forest, woodland, shrub, and grass ecosystems in California, Hawai'i, and U.S. affiliated Pacific Islands. Complete in FY 16
- Identify techniques to improve fuel and fire management to enhance ecosystem health and sustainability in California, Hawai`i. and U.S. affiliated Pacific Islands. Complete in FY 17

- Understand how changes in climate, land use, and plant species composition alter the fire regimes and ecosystem dynamics in California, Hawai`i and the U.S. affiliated Pacific Islands. Complete in FY 20
- Determine fire requirements and responses of threatened, endangered, sensitive, and high-interest species and of valued ecosystem goods and services in California, Hawai`i and the U.S. affiliated Pacific Islands. Complete in FY 20

Approach to Problem Solution

The approach to solving this problem will rely on empirical studies, indigenous knowledge, landscape analysis and simulation approaches that model fire variability and ecological process and function. We will use experimental approaches to examine the ecological effects of both prescribed burns and opportunistic wildland fires. Empirical studies will include field research and experimentation to determine historic fire regimes and test theories relating to the ecological effects of characteristic, managed, and altered fire regimes. Evaluating habitat or species resilience to fire type will be addressed by integrating landscape level features with remote sensing, geographic information, ground-based measurement and single species fire response. Results from empirical research will be incorporated into spatial and process modeling in order to better understand changes in normal and altered fire regimes. In addition, predictive models will be employed to determine how ecological processes will change in response to climate, invasive species, and fire suppression. Finally, understanding the ecological effects of fire will allow prioritization of restoration activities across the forest, shrub land, and grassland ecosystems in California, Hawai'i and the U.S. affiliated Pacific Islands.

This problem will serve the National Forest System and other land managers, political decision makers, resource advocates, public interest groups, and the general public. We will provide knowledge that improves our understanding of the role of fire in promoting healthy ecosystems along with the impacts of fire and fuels management activities in a dynamic environment with a special focus on Threatened and Endangered Species and valued ecosystem goods and services,

Problem Area 3

Evaluate the short and long-term outcomes of fuels, fire and post-fire management strategies.

Planned Topics for Study

- Determine how vulnerable current wildland systems in California, Hawai`i and the U.S. affiliated Pacific Islands are to uncharacteristic fire, and what strategies can be employed to mitigate vulnerability. Complete by FY 19
- Design fuel treatment strategies that mimic and/or promote the spatial and temporal complexity found in historical landscapes and/or with desirable fire regimes. Complete by FY 16

- Establish how to manage fire in landscapes that evolved with fire and require fire for long-term ecosystem health and resilience within a context of current societal constraints that restrict the use of fire. Complete in FY 18
- Evaluate and improve the hydrological and ecological effectiveness of post-fire stabilization, rehabilitation and restoration treatments in the context of societal expectations and acceptability. Complete in FY 19

Approach to Problem Solution

Retrospective studies, planned and opportunistic experiments, and modeling using a multidisciplinary approach will determine the outcomes of fuel treatments and fire management strategies. Evaluation of post-fire treatment options will be conducted in cooperation with Burned Area Emergency Response (BAER) teams as future fires present opportunities.

Fire and fuels management are becoming the dominant focus of land management agencies in much of the western U.S. Policy and management decisions depend on scientifically defensible strategies for mitigating the potential for and consequences of uncharacteristic or undesirable fire effects on ecosystems in California, Hawai'i and the U.S. affiliated Pacific Islands. We will provide the scientific basis for choosing appropriate management strategies to enhance long-term ecosystem sustainability through mitigating fuels and fire management concerns. Providing a more positive role for fire will provide a more sustainable and reliable production of economic goods (i.e., timber, hydropower, forest products, and recreation) and ecosystem services. Research products from this problem area will broaden land managers' options as they face pressure from growing human populations seeking use of and benefits from public lands in the context of changing climate regimes.

Problem Area 4

Determine and quantify the interactions between climate, vegetation, and fire in the face of climate change and improve our understanding and predictability of these interactions in order to manage forests and wildlands more effectively.

Planned Topics for Study

- Develop a modeling framework for the interactions between climate, vegetation, and fire that builds on existing knowledge and data. Complete in FY 16
- Describe sources of uncertainties in the modeling framework and identify and test spatial and temporal stochastic methods and models that quantify the uncertainties. Complete in FY 17
- Tailor the modeling framework to management applications such as strategic fire planning (forecasting regional and national seasonal fire potential) and land management planning (simulating the effects of climate-vegetation-fire interactions under different land management strategies and observing the effects on ecosystem goods and services including clean water, carbon and other nutrient dynamics). Complete in FY 17

- Identify key variables associated with atmospheric and oceanic circulation modes that can be used to forecast severe fire seasons from one to several years in advance. Complete in FY 18

Approach to Problem Solution

We will develop relationships from empirical evidence of past fires and climate from tree rings, lake sediments, and written historical records rather than focusing on theory based computer modeling. We are also concentrating on the Mediterranean Climate region of the Pacific Coast where the bulk of Federal fire management funds are spent. A better understanding of the influence of the dominant atmospheric circulation patterns on fire regimes should lead to the ability to predict better severe fire seasons with one or more years of lead-time. This will allow managers to better schedule fire related activities across the region and prepare communities and resource managers for upcoming fire activity.

Paleoecological studies provide one source of information to better understand the natural resilience of plant species and communities to rapid climate changes. Long ecological records provided by pollen, charcoal, tree rings, and other biological proxies offer an opportunity to examine the interactions among climate, vegetation, and fire over multiple time scales and during periods of past climate change. The data also provide insights into the importance of local conditions (i.e., topography, soil conditions, microclimate, etc.) in determining vegetation composition and disturbance regimes in the past.

Identification and establishment of a modeling framework is crucial to the solution of this problem. The Earth and atmosphere will be viewed as a system, within which mass and energy are exchanged between the atmosphere, land, and oceans according to governing laws that can be modeled mathematically. Ecosystems will be described by the characteristics that both influence and are influenced by the system dynamics. Fire, modeled as a change agent, depends on the characteristics of the vegetation, atmosphere and land at the time and place of its occurrence. The modeling framework will include empirical models, particularly when system processes are not fully understood, or ensemble system properties are required. Wildfire occurrence will be modeled as a stochastic point process, calibrated by fire occurrence data.

Land managers and policy makers will benefit from the knowledge, models, and decision-support tools that result from research in this problem area and related work in the other problem areas. Predictive Services at the national and regional fire coordination centers will be able to use these tools to improve short and long-term fire forecasts. Models developed from a better understanding of fire-climate-vegetation relationships will provide natural resource managers with knowledge to anticipate impacts of specific environmental variability and changes. The scientific framework of the research will be sufficiently robust so that the diversity of societal, physical, and ecological challenges that resource managers confront outside of California, Hawai`i and the U.S. affiliated Pacific Islands will also find useful guidelines. Models and tools developed for regional decision support will be adaptable to critical climate conditions and landscapes elsewhere. Models will also scale to the problem at hand. For example, the modeling framework will allow use of short-term climate and regional fire occurrence models for

strategic fire planning at the regional scale of geographic area coordination centers. Another application of the modeling framework is potentially evaluating the effects of climate change on fire risk in areas dominated by fire-adapted invasive grasses such as the Pacific Islands and the southwestern deserts.

Problem Area 5

Describe and quantify uncertainty and risk in a science-based decision-making framework for fire and land management planning.

Planned Topics for Study

- Investigate the relationship between decision outcomes, fire costs, and the combination of incentive structures and risk attitudes of individual fire managers. Complete in FY 17
- Develop and assess probabilistic models to provide short- and long-term predictions of fire threats. Complete in FY 16
- Study fire and fuels management policies and the policy-making process. Complete in FY 16
- Examine the public acceptability of fire management programs. Examine the organizational culture and acceptability of fire management programs within management agencies. Complete in FY 18
- Develop and provide decision-making tools for fire and land management planning.. Complete in FY 20

Approach to Problem Solution

Work in this problem area will involve PSW's Urban Ecosystems and Social Dynamics program. To evaluate fire policies and programs, we will develop new methodologies and adapt existing science and technology to create, manage and evaluate interactive and interdependent wildland fire resource and geographic information database systems supporting research of the program and its cooperators. We will also work with field and administration operations to improve data quality from initial data capture and input to data storage and stewardship. Stakeholders will be brought into the research process from the beginning to help us identify the type of tools or systems they need and potential design approaches. Initial prototype systems, strategies, or software tools will be made available for testing. Feedback from users will be gathered and modifications made to the prototype. Along with contributions from the various scientific disciplines found within the other problem areas of this program, work would require extensive use of statistical methods and testing, operations research, applied mathematics, social science, and economic analysis.

The main users of products developed in this area will include fire managers and individuals involved in decision-making processes related to fire and fuels treatment. Fire management agencies at the national, tribal, state, county, and city levels will be invited to take a participatory role in tool development. There will also be collaboration with researchers from academic institutes as well as from foreign government agencies addressing similar fire management issues. Research findings and decision support tools

will benefit managers, collaborators and other interested parties, such as other decision support tool developers. The aim of resulting products is in providing meaningful and accurate tools for decision-making and evaluating risk to the fire managers and planners.

ENVIRONMENTAL CONSIDERATIONS

The experimental, field-based work potentially has environmental impacts that are both local and offsite. Individual study plans will identify the environmental impacts associated with the work. Cooperators will perform the environmental analyses associated with their activities when we perform work done in conjunction with operational management activities such as prescribed burning and fuel treatment. These planning documents include burn plans, smoke management plans, EAs and EISs.

STAFFING PLAN AND COST ESTIMATES

Initially, the Fire and Fuels Program will consist of 27 permanent employees including nine research grade scientists (one GS-0150 Geographer, four GS-0408 Ecologists, two GS-0460 Research Foresters, and two GS-1340 Meteorologists, 17 permanent scientific support staff, a Program Manager, and a Program Assistant. These program members will be organized into two teams aligned with the research portfolios in the Fire and Fuels SPA. We do not expect the work on the entire suite of elements at any one time, and we anticipate using creative methods to expand and contract our workforce as necessary. We anticipate funding in the $3 to $4 million range with a rough distribution of:

Problem 1: 20%
Problem 2: 25%
Problem 3: 25%
Problem 4: 15%
Problem 5: 15%

The Fire and Fuels Program is a growth area for PSW and as funds become available we expect to hire additional scientist and support positions.

APPENDIX A: RELATIONSHIP TO STRATEGIES, OTHER PROGRAMS, OTHER STATIONS, AND REGION 5

Relationships to National Strategies and Goals

Fire is an important driving force on the American landscape. It is primary driver of ecological functions in many ecosystems around the United States and it is also a significant threat to life and property in many communities. The significance of fire is recognized in a variety of agency documents which provide guidance to the Forest Service such as the *USDA Strategic Plan FY 2010-2015*, the *USDA Forest Service Strategic Plan FY 2007-2012*, the *USDA Forest Service Research & Development Strategic Plan 2008-2012*, the *National Fire Plan*, and the USDA Forest Service Research & Development Strategic Program Area (SPA) for *Wildland Fire and Fuels* and related review documents.

USDA Strategic Plan

Two objectives of USDA Strategic Goal 2, "***Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources*****"**, are particularly pertinent to wildland fire and fuels in California, Hawai`i, and the U.S. affiliated Pacific Islands. These two specific objectives within USDA Strategic Goal 2 are objective 2.1: help to restore and conserve the Nation's forests, farms, ranches, and grasslands and objective 2.4: reduce the risk from catastrophic wildfire and restore fire to its appropriate place on the landscape. Objective 2.1 directs USDA agencies to work towards restoring declining ecosystems and protecting healthy ones to ensure the Nation's lands will be resilient to threats. Objective 2.4 strives both to prevent catastrophic wildfires while at the same time restoring fire to natural areas that are fire-dependant ecosystems and help reduce fuel loads, lessen the risk of damaging fires, enhance wildlife habitats, and restore ecological and watershed function and resiliency. The anticipated outcomes of the Fire and Fuels Program will directly contribute to both objectives.

Forest Service Strategic Plan

This research program also contributes to two of the Agency goals as defined in the *USDA Forest Service Strategic Plan 2007-2012*:

Goal 1: ***Restore, Sustain and Enhance the Nation's Forests and Grasslands*****.** All five objectives are relevant to this PSW research program:

Objective 1.1: Reduce the risk to communities and natural resources from wildfire,
Objective 1.2: Suppress wildfires efficiently and effectively.
Objective 1.3: Build community capacity to suppress and reduce losses from wildfires.
Objective 1.4: Reduce adverse impacts from invasive and native species, pests, and diseases.
Objective 1.5: Restore and maintain healthy watersheds and diverse habitats.

Our problem areas and planned studies within each, coupled with coordination with the other PSW research programs will address each of these objectives with direct and relevant results.

Goal 7: ***Improve the Scientific Basis for Sustainable Natural Resources Management*** (including high-quality research responsive to current/future priorities, and facilitation of increased use of research-derived information, tools, and applications). This goal encompasses the overall mission of Forest Service R&D. The Fire and Fuels Program will provide science and technology solutions for clients' and partners' priority issues in ways they find effective and useful for sustainably managing forests and grasslands.

Forest Service Research and Development Strategic Plan
The related objectives within the *USDA Forest Service Research & Development Strategic Plan* are Objectives 1.A, 1.C, and 7.B-D. The Fire and Fuels Program addresses:

Objective 1.A: Develop prevention, mitigation, treatment, and short- and long-term restoration methods and strategies for disturbances (e.g., fire, air, and water pollution; invasive species; extreme events);
Objective 1.C: Advance understanding of ecosystem structure, function, processes, and their interaction with social processes at multiple scales to effectively manage dynamic landscapes.
Objective 7.B: Develop and deploy more effective methods for transferring scientific information, technologies, and applications to public and private sectors.
Objective 7.C: Develop and deploy a risk-based approach to choosing management interventions related to invasive species, fire management activities, and extreme events.
Objective 7.D: Develop and deploy analysis and decision-support systems to minimize costs of land management and protecting lives and property.

All of the PSW Fire and Fuels Program anticipated outcomes will make substantive contributions to these objectives.

The Fire and Fuels program will also produce information and tools pertinent to several national fire programs and policies including the National Fire Plan and the 10-Year Cohesive Strategy and subsequent revisions.

Wildland Fire and Fuels Strategic Program Area (SPA)
The Wildland Fire and Fuels SPA seeks to focus and enhance R&D capacity in five portfolio areas:

• Core fire science, including physical fire processes, fires characteristics at multiple scales, and fire danger assessment.
• Ecological and environmental fire science, including fire effects on ecosystem components, and fire and environmental interactions.
• Social fire science, including public interactions with fire and fuels management, socio-economic aspects of fires and fuels management, and organizational effectiveness.

• Integrated fire and fuels management research, including management strategies at multiple scales; treatment and disturbance effects on ecosystem components; and forest operations, including biomass utilization and product development associated with fire and fuel management activities.
• Science delivery and applications.

The five problem areas articulated in this Fire and Fuels Program Charter are closely aligned with the first four of these SPA focal areas. Science delivery is considered a cornerstone for all of our research outputs. Given the importance of fire and fuels management in the United States, Forest Service Research and Development has invested significant effort to define the research needed to facilitate accomplishment of the agency's goals. These analyses and program definitions reside in the *Wildland Fire and Fuels Strategic Program Area* (four different) portfolio documents which identify priority work that is regional or national in scope. Initially, R&D efforts in the Core Fire Science portfolio will direct resources to develop models of (1) moisture dynamics in the combustion environment, (2) energy transfer within heterogeneous and spatially non-uniform fuel beds, and (3) fire-atmosphere interaction. The three national priority areas for research in the Ecological and Environmental Sciences portfolio are (1) primary and secondary effects of fire on vegetation, (2) effects of varying fire regimes/characteristics on short and long-term watershed processes and conditions and (3) understanding, predicting and modeling effects of wild and prescribed fire on smoke emissions and air quality. A priority area for PSW is to describe and model the linkages between fire behavior and fire effects on habitat for sensitive wildlife. The priority work for the Social Fire Science portfolio is described in the Urban Ecosystems and Social Dynamics Program charter. The Integrated Fire and Fuels Management Research portfolio identified 5 high priority activities: (1) treatment effects on fire characteristics, (2) fuel treatment tradeoffs, (3) effects of fuel treatments on natural resources, (4) economics and markets for biomass and (5) bioenergy/biorefining. PSW has expertise to address priorities 1-3 and will need to develop the expertise for priorities 4 and 5.

Relationships to other PSW Research Programs, other Research Station Strategies and Other Programs within the Forest Service

Science development and delivery at PSW will be multi-dimensional. All four of the program areas anticipate close coordination and cross-program interaction and collaboration. Mechanisms to enable and encourage this include cross-program project initiation, interdisciplinary projects with geographic emphasis, and periodic competition for funding based on selected research themes.

PSW has also identified a number of crosscutting scientific themes and has developed strategic plans for the themes addressing water and climate change. Each of these strategic plans has identified an approach to facilitate opportunities to engage in these complex areas of multi-disciplinary research. The PSW Executive Team and the Station Leadership Team provide broad oversight for the research direction, coordinate with the Washington Office, and allocate funding. PSW Program Managers work with regional partners, PSW teams, and other programs and stations on strategic planning and provide

general information about the program. The PSW scientists and their partners perform the basic and applied research that crosses over all of the programs of the PSW. Team Leaders guide the individual program elements and help coordinate research within and across teams and across programs. Science delivery is included in each of the strategy's research focal areas.

The Fire and Fuels Research Program also has close ties to the Rocky Mountain Research Station's Fire, Fuel, and Smoke Science Program, and the Pacific Northwest Research Station's Threat Characterization and Management Program each of which have related and overlapping responsibilities for addressing research on fire and fuels management in western forests. Where possible and strategic, efforts will be coordinated and integrated across all three of the western research stations where problems and challenges are shared and solutions are better served through these partnerships. While the Fire and Fuels Program has limited resources to address smoke production and characterization, good collaborative relationships with RMRS's Fire, Fuels, and Smoke Program and PNW's Threat Characterization and Management Program and university partners will allow us to address these issues in California and elsewhere.