The Fire and Fire Surrogates Study: Providing Guidelines for Fire in Future Forest Watershed Management Decisions

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Abstract.—As part of the 1998 Joint USDA / USDI Fire Science Program, the Fire and Fire Surrogates Study was proposed to establish and evaluate cross-comparisons of fuels treatment practices and techniques to reduce wildfire risk. This study evaluates prescribed fire, thinning, and various mechanical treatment methods for treating, removing, or using woody biomass. Site-specific and study-wide evaluations will assess watershed impacts, soil disturbance, vegetation responses, wildlife changes, ecological consequences, social impacts, economics, and potential effects on wildfire size, severity, and cost. The study design is flexible to address local treatment variations and effects and will be installed at 10 locations representative of Interior Washington-Oregon, Northern California, Sierra Nevada, Rocky Mountain, Southwest Ponderosa Pine, Southern Pine, and mixed hardwood-oak forest ecosystems. This paper outlines the study components and discusses the potential for providing guidance on the treatment of fuels and use of fire for future watershed management decisions.

Introduction

Many forests in the Western United States, especially those with historically short-interval, low- to moderate-severity fire regimes, are too dense due to long-term fire exclusion and short-term reductions in timber harvesting (Parsons and DeBenedetti 1979). These forests have excessive quantities of fuels that increase their risk of catastrophic, severe, stand-replacing wildfires. Fire of this magnitude causes severe impacts on watershed resources and greatly complicates future watershed management (Agee 1993, Neary 1995, DeBano et al. 1996, DeBano et al. 1998).

Widespread silvicultural treatments are needed to restore ecological integrity and reduce the high risk of destructive, uncharacteristically severe fires in these forests (Weatherspoon and Skinner 1996). However, the appropriate balance among thinning, mechanical fuel treatments, and prescribed fire is often unclear. For improved decision making, resource managers need better information about the consequences of alternative management practices involving fire and mechanical / manual treatments.

Long-term, interdisciplinary research should be initiated to learn the consequences and tradeoffs of alternative fire and fire surrogate treatments. Ecological, economic, and social aspects must be included as integral research components. Such research will determine which fire ecosystem functions can be emulated satisfactorily by other means, which may be irreplaceable, and the management implications of either decision. The human dimensions of the problem are equally important. Treatment costs, utilization economics, and social and political acceptability influence decisions about treatment alternatives. Such research must be a cooperative effort, involving land managers, researchers, and other interested parties.

A team of scientists and land managers, with support from the USDA / USDI Joint Fire Science Program (http://www.nifc.gov/joint_fire_sci/index.html), is designing an integrated national network of long-term research sites to address this need. The steering group and other participants in this national Fire and Fire Surrogates (FFS) study represent federal and state agencies, universities, and private entities, from a wide range of disciplines and geographic regions. The study will use a common experimental design to promote broad applicability of results.

Objectives

The goal of the proposed FFS research is to quantify the ecological, economic, and social consequences of alternative fire and fire surrogate treatments in a variety of forest types and conditions in the United States. Priority is given to forests with low- to moderate-severity natural fire regimes. The specific objectives of the FFS study are:

1. Quantify the effects of fire and fire surrogate treatments on specific core response variables.
2. Provide an overall research design that: a) establishes and maintains the study as an integrated national network of long-term interdisciplinary research sites using a common core design to

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promote broad applicability of results; b) allows individual site distinction for statistical analysis and modeling, while being a component of the national network; and c) provides flexibility for investigators and other participants to augment, without compromising, the core design to address locally-important issues and to exploit local expertise and other resources.

3. Develop and validate models of ecosystem structure and function, and successively refine recommendations for ecosystem management.
4. Establish cooperative relationships, identify and establish network research sites, collect baseline data, implement initial treatments, document short-term responses to treatments, report results, and use research sites as demonstration areas for technology transfer to professionals and for the education of students and the public.
5. Develop and maintain an integrated and spatially-referenced database to archive data for all network sites, promote the development of multi disciplinary and multi-scale models, and integrate results across the network.
6. Identify, develop, and field test response variables or measures that are sensitive to treatment and are technically and logistically feasible for widespread use in management contexts.

Research Approach

Experimental Design

The benefits of an integrated study with multiple experimental sites located around the country, such as the FFS study proposed here, can be enhanced if a core experimental design is used. The core experimental design (i.e., elements common to all research sites in the network) consists of the following components.

Treatments

The following FFS treatments will be implemented at each research site: 1) untreated control, 2) prescribed fire only with periodic reburns, 3) initial and periodic thinning followed by residue removal and / or mechanical fuel treatment without prescribed fire, and 4) initial and periodic thinning followed by prescribed fire. Between thinning intervals, fire could be used without any other treatment one or more times. These treatments span a useful range both in terms of realistic management options and anticipated ecological effects. The non-control FFS treatments (treatments 2, 3, and 4) must be guided by a desired future condition (DFC). The DFC will be defined by the vegetation component of the ecosystem by specifying such targets as diameter distribution, species composition, canopy closure, spatial arrangements, and live and dead fuel characteristics. The following fire-related minimum standard will be a starting point for DFCs throughout the FFS network: Each non-control treatment will be designed to achieve stand and fuel conditions such that, if impacted by a head fire under 80th percentile weather conditions, at least 80% of the basal area of overstory trees (predominant, dominant, and codominant trees) will survive.

If this starting point is met for a research site, the DFC should incorporate additional management goals into the site and stand conditions and stakeholder expectations. Beyond the fire-related minimum standard for DFCs and the general treatment definitions given above, it is infeasible and undesirable to prescribe detailed definitions of a core DFC or to prescribe detailed treatment specifications that would apply to all research sites. Each research site must provide this detail to ensure consistent application of treatments at that site.

Replication and Plot Size

Each treatment will be replicated 3 times at each research site, using either a completely randomized or randomized block design. The core set of 4 treatments will be represented in 12 treatment plots at a research site. Each of these 12 core treatment plots will consist of a 10-ha measurement plot surrounded by a buffer. Core variables will be measured in each 10-ha plot. The buffer will receive the same treatment as the measurement plot it surrounds and will be at least as wide as the height of a best site potential tree. Where feasible, the replicated plots will be supplemented by much larger (200 to 400 ha or more) areas treated to the same specifications to promote the study of large-scale ecological and economic / operational questions.

Response Variables

A major aspect of the common design proposed for this study is a set of core response variables to be measured at all the research sites. Core variables encompass several broad disciplinary areas including fuel and fire behavior, vegetation, soils and forest floor / hydrology, wildlife, entomology, pathology, treatment costs and utilization /

economics, and social sciences. Corresponding disciplinary groups have been responsible for developing the core variables and associated measurement protocols including coordinating across groups to ensure consistency, compatibility, and non-duplication of data collection efforts. Intraplot sampling of all variables will be keyed to a 50-m square grid of permanent sample points to be established and maintained in each measurement plot. Spatial referencing of all data to the grid will promote both spatial and cross-disciplinary analyses.

The study is designed to balance the values of an integrated national network of research sites having a common design against the needs at each site to retain flexibility to address important local issues and to use expertise and other available (objective 2). Accordingly, at the discretion of investigators and other participants at a site, the core design can be augmented (provided it is not compromised) by adding FFS treatments, one or more DFCs, response variables, or replications, or by increasing treatment plot size (by increasing buffer width, the 10-ha measurement plot and core data collected within it would remain unchanged). However, such additions generally would require additional funding sources because, except where additions to the core design are specifically justified, the Fire and Fire Surrogates Study only supports implementing the core design at each site.

Research Site Locations

In selecting research locations, we have developed and used the following set of criteria. Each site must:

1. Represent forests with historically short-interval, low- to moderate-severity fire regime and a currently high risk of uncharacteristically severe fire.
2. Represent widespread forest conditions (site characteristics, forest type and structure, treatment history) that need and will benefit from fire or fire surrogate treatments, and in which such treatments are feasible.
3. Contribute to balancing the overall network through regional representation or land ownership type.
4. Have an adequate land base available.
5. Involve cooperators who are committed to and capable of participating in the program.
6. Include land managers with the ability and willingness to implement experimental treatments successfully within the required time frame, repeat treatments over time, and commit selected sites for long-term research uses.
7. Have partnerships that exist across agencies and with universities, and between researchers and managers. The proposed initial network comprises 10 main sites and 1 satellite site (with less than the full suite of core treatments).

All initial sites represent forests with a historically short-interval, low- to moderate-severity fire regime (table 1). Seven sites are in western coniferous forests, ranging from the Pacific Northwest to the Southwest. On all these sites, ponderosa pine is an overstory component,

Table 1. Proposed study sites.

Site or Geomorphic Province	Land Ownership	State
Mission Creek	Wenatchee N.F.	WA
Hungry Bob/Blue Mountains	Wallowa-Whitman N.F.	OR
Lubrecht Experimental Forest/ Northern Rocky Mountains	University of Montana	MT
Klamath Province	Klamath and/or Shasta-Trinity N.F.	CA
Kings District Study Area	Sierra N.F. and Sequoia-Kings Canyon N.P.	CA
Southwestern Plateau	Coconino N.F. and Kaibab N.F.	AZ
Jemez Mountains	Santa Fe N.F.	NM
Ohio Hill Country	Wayne N.F., Ohio Div. of For., Mead Paper Corp., The Nature Conservancy	OH
Southeastern Piedmont	Clemson Experimental Forest	SC
Southeastern Coastal Plain	Myakka River State Park	FL

but the composition of other conifers varies, and topographic and soil parameters differ substantially. Two sites are in the Southeastern United States (one in the Piedmont and one on the coastal plain) and are dominated by mixtures of slash pine and hardwoods. Rounding out the network is a site in the oak-hickory type of Ohio. Collectively, these sites comprise a network that is national in scope. Depending on the level of interest and support available, future sites in the same or other fire regimes may be added to the network.

Watershed Management Implications

Increasing wildfires in the United States in the past decade have raised widespread concerns about forest health, wildfire hazard, and potential damages to watershed condition. Fuel treatment prescriptions based on information from this study are needed to guide decisions in the 21st century to maintain and restore the quantity and quality of watershed resources.

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