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Prescribed Fire Monitoring in Sequoia and Kings Canyon National Parks[1]

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ABSTRACT: The prescribed fire monitoring program in Sequoia and Kings Canyon National Parks is designed to document and predict fire behavior and fire effects. Data are collected before the burn and for 10 years after on vegetation (trees and shrubs), pests and diseases, and fuel loadings. Fire effects are related to observed fire behavior. This paper describes the purpose of the monitoring program, monitoring methods, and data analysis and evaluation.

INTRODUCTION

The goal of the fire management plan for Sequoia and Kings Canyon National Parks (Bancroft and Partin 1979) is to maintain or restore the natural fire regime as one of the processes within these parks. The natural fire management zone in Sequoia and Kings Canyon National Parks, in which almost all lightning fires are allowed to burn, includes 727,000 acres (≅294,000 ha), or close to 84 percent the total area of these parks. The other 16 percent is also generally managed as a natural area but requires prescribed burning[2] to remove 4azardaus fuels before natural fire can be allowed to burn.

These two phases of the fire management program are closely linked. The techniques, prescriptions, and objectives of the prescribed burning program exe guided by the behavior and effects of natural in. similar vegetation types that have been relatively unaffected by fire suppression because of their more remote location in these parks.

Fire monitoring therefore has two aspects. First, the short-term guide for these parks (Nichols 1983) focuses on predicting and documenting fire behavior immediate postfire effects such as scorch height fuel reduction. Because prescribed natural fires and prescribed burns may involve thousands of acres and persist for several weeks, accurate prediction of fire behavior is critical if public safety and various legal constraints are to be uncompromised.

The second aspect is more subtle. The goal of the fire management program is to restore or maintain the natural fire regime. The function of long-term monitoring (Ewell 1983) is to document that this is being done within a specific vegetation type by prescribed burns, subsequent natural fires in prescribed burned areas, and

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[2] Editors' note: please refer to Foreword for comments on prescribed fire terminology.

natural fires in remote areas.

Previous studies in these parks generally have reported on fire's effects from prescribed burns. Two studies involved natural fires in the Sugarloaf Valley in Kings Canyon (Greenlee and others 1979; DeBenedetti and Parsons 1979), and three have dealt with fire history (Kilgore and Taylor 1979; Pitcher 1980; Warner 1980). Nevertheless, monitoring emphasis generally has been on the short-term effects of fire, although the natural fire study by Greenlee included long-term herb recovery and tree regeneration. Studies by Parsons and DeBenedetti (1979), Bonnicksen and Stone (1981), and Vankat and Major (1978) addressed successional changes resulting from fire suppression.

Use of the long-term monitoring guide is the first attempt to record preburn ecosystem variables and fire characteristics and to follow fire-induced changes over several years in these parks. The forest ecosystem variables that are measured as part of the long-term fire monitoring program include those recommended by the Prescribed Fire Monitoring and Evaluation Guide (van Wagtendonk and others 1982). These include intensive tree measurements, shrub and seedling cover by species, fuel loading appraisal by individual size classes, and general site characteristics. The following sections review the monitoring methods, data analysis, and evaluation.

MONITORING METHODS

Permanent 0.25-acre (0.l-ha) plots are stratified by tree overstory composition as described by Rundel and others (1977). The mixed conifer type is further divided into sequoia mixed-conifer, white fir-mixed conifer, and mixed conifer (Parsons and DeBenedetti 1979). Before the fire at least four plots are set up on the area to be burned, and one control plot is set up outside the burn area. Within the boundaries of each plot, vegetation, fuel loadings, slope, and soil type are relatively uniform. The plots are as similar as possible to the control plot's vegetation and physical characteristics. The control plot is in the same drainage or as close as possible. The plots are 164 by 66 ft (50 by 20 m) and divided into four quarters as shown in figure 1. The 164-ft (50-m) midline is placed parallel to the contour of the slope. General plot information such as midline compass bearing, Universal Transverse Mercator (UTM) coordinates, general location description, soil texture, aspect, and slope are recorded. Photographs are taken at two fixed points. The time of season and the previous winter's precipitation as compared to the average year are noted, as well as the stage of the flowering plants, so that the plot may be resampled at approximately the same phenological period.

For each tree within the plot, diameter at breast height (4.5 ft [1.4 m]), crown position, tree damage, live crown ratio, and presence of forest pests or diseases are determined. Postfire tree measurements are as follows: the scorch height and live crown scorched on each tree; minimum, maximum, and average char height on the bole; and estimated mortality as described by Dieterich (1979)
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Every tree is numbered, tagged, and mapped for each quarter section of the plot. Other tree species not sampled inside the plot, but found in the same ecotype surrounding the plot, are noted. Overstory canopy cover is estimated for all species and for each species.

Trees less than breast height (small trees) axe sampled separately. The small trees in an area (328 ft (100 m) are tallied by species, number, height class, and cover. Small tree species not sampled, but found inside the plot, are noted

Random direction 49-ft (15-m) transects are placed. at 32.8, 65.6, 98.4, and 131.2 ft (10, 20, 40 m) along the midline using Brown's planar intercept method (Brown 1974) to estimate fuel loading. Litter depth (needles and woody material less than one-fourth inch [0.64 cm)) and litter and duff depth (all litter and decomposed material except woody material) are measured at five points along the transect line. Each transect line is exten8ed across the midline for an additional 16.4 ft (5 m) for a 65.6-ft (20-m) shrub transect. The distance intersected along the line by shrubs is recorded for each shrub species. Again, shrub species not sampled but found within the plot are noted.

As a plot burns, rate of spread and flame length at 24.6 ft (7.5 m) on the fuel transects are observed and recorded. Windspeed and direction, relative humidity, and temperature are the weather variables measured. The fire type (head or backing) and wind and fire slope direction (up, dawn, or cross slope) are noted. Litter, duff, and 10-hour fuel moisture are determined by sampling and fuel moisture scale. Photographs are taken from the two photo points and of the four fire behavior measurement points.

Resamp1ing is to continue for 10 years with intervals as follows: before and after fire and 1, 3, 5, and 10 years after fire with the exception of small trees, which are also sampled 2 years after fire. Some variables are not measured at each sampling interval because of the time required to detect any changes. The 10-year-monitoring period may be extended if a longer period is necessary to obtain sufficient data and associated trends.

DATA ANALYSIS

Significant results are identified within individual plots, between control and burn plots, and between plots of the same vegetation type. Forest successional changes are analyzed by overstory and understory changes by species density, size class (by diameter or height), distribution in space (dispersed, aggregated, clumped, or

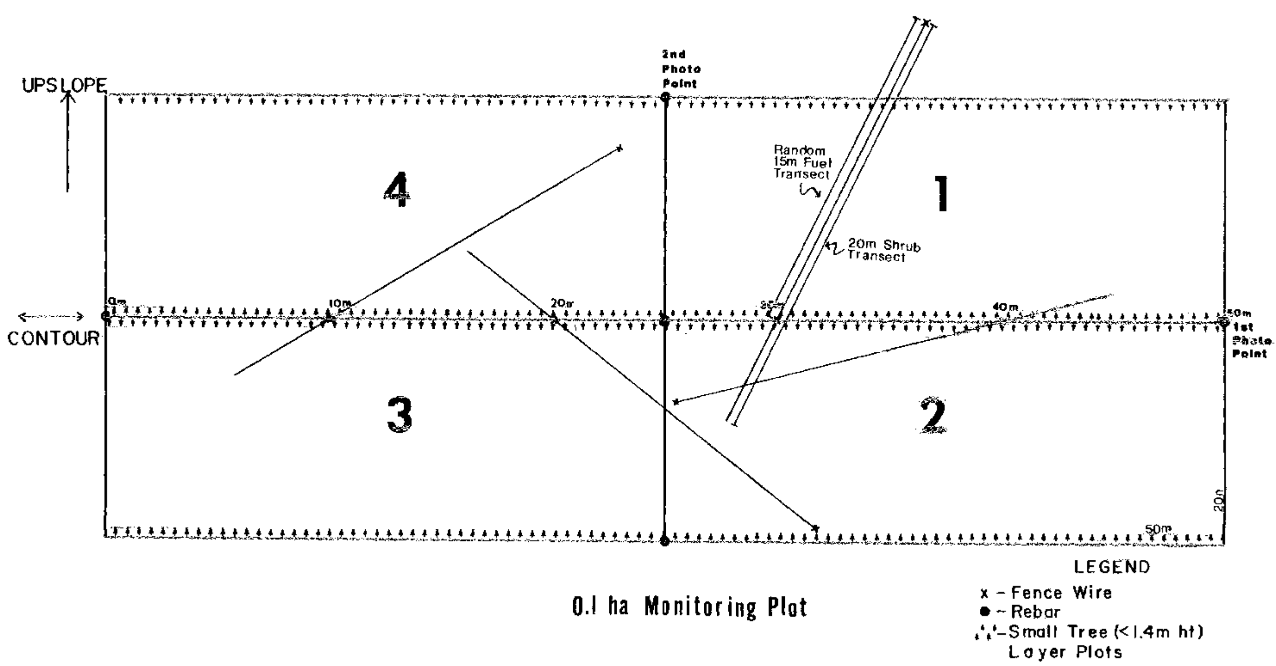

Figure 1.--Schematic diagram of the long-term fire monitoring plot for Sequoia and Kings Canyon National Parks.

random), dominance, and cover. Reduction and accumulation of fuels are also analyzed. Fire-related and nonfire-related results are to be determined by comparing burn plots with control plots.

All results are correlated with one or more of the following observed or predicted fire behavior variables: flame length, rate of spread (spread component), fireline intensity, burning index, ignition component, reaction intensity, energy release component, and heat per unit area. The predicted fire behavior variables are calculated from the Fire Behavior and Fire Danger programs using the observed fire behavior, weather, and fuel moisture data taken on the monitoring plots (Deeming and others 1977; Rothermel 1983). The observed plot data are also used to develop park-specific fuel models with the new BEHAVE system (Andrews 1983).

EVALUATION

The data collected are applied to preestablished, quantifiable objectives. Restoring or maintaining natural tree composition and size class distribution, improving sequoia regeneration, and reducing fuel loadings are examples of objectives research has helped to quantify. For example, research into fire scars has provided information on the natural fire regime in terms of fire size, intensity, behavior, and season of burning. Given this information, monitoring shows whether specified management strategies are restoring or maintaining this fire regime.

As prescribed fire objectives become more specific, the adequacy of the monitoring program may be more readily determined and the program can be improved as necessary. Unless a thorough monitoring program is developed, managers will not be able to document that prescribed fire program's objectives are being achieved.

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