

PLANTATION CHARACTERISTICS AFFECTING DAMAGE FROM WILDFIRE

Carl N. Skinner
Geographer
and

C. Phillip Weatherspoon
Supervisory Research Forester

Pacific Southwest Research Station, USDA Forest Service
2400 Washington Ave., Redding, CA 96001

ABSTRACT. Relationships between (1) degree of damage in plantations caused by the fires in northern California in 1987 and (2) prior management activities and other factors are summarized. Postfire aerial photography was used to assess scorch and consumption of tree crowns (the selected measure of fire damage). The variables that most strongly influenced fire damage were those most directly related to management activities--site preparation method and level of damage in adjacent stands. The strong relationship between damage level in plantation and damage level in adjacent stands suggests that intensive treatments in plantations alone may not adequately reduce fire hazard. These data suggest that a broader neighborhood or landscape level approach may be necessary.

INTRODUCTION

Following the extensive wildfires in late summer and fall of 1987 in California, we undertook a large-scale study to detect relationships between (1) degree of damage caused by the wildfires of 1987, and (2) prior management activities, fuelbed characteristics, and site/stand factors that might be expected to influence fire behavior and associated fire effects.

The fires of 1987 were numerous and widespread, with many burning for weeks (Reider 1988). Because of the extensive area and time involved, the conditions under which these fires burned varied considerably in contrast to the typical escaped fire which burns thousands of acres in a few hours or days under extreme conditions. This variety provided a rare opportunity to explore the relationships of past management activities and other factors with the subsequent damage from the fires on a broad scale.

This paper summarizes a study on the Hayfork Ranger District of the Shasta-Trinity National Forests and includes some additional preliminary findings from the Klamath National Forest (KNF). We summarize approach and findings in this paper for both plantations and other types of stands because of the important relationship found between the level of damage in plantations and the level of damage in adjacent stands.

METHODS

The reader is directed to Weatherspoon and Skinner (1995) for greater detail concerning methods and results.

General Approach and Selection of Variables

The retrospective nature of the study constrained the collection of data to postfire aerial photos, existing data bases and records, and consultation with current and former district employees. We did not attempt to field verify these data or collect new data.

Data on plantations were collected and analyzed separately from those on uncut and partial-cut stands because conditions, susceptibility to fire damage, and nature of the available data varied substantially between these groups.

Crown scorch or crown consumption was our selected measure of fire damage since it could be interpreted on aerial photos. Percent of trees having substantial crown scorch or crown consumption was the basis for defining the following fire damage classes (FDCs):

- 0 No burn—used only for plantations in which fire burned to the edge but not through most of the plantation because of fuel conditions in the plantation, not because of barriers such as firelines
- 1 Light underburn—less than 10% of trees with 50% or more crown scorch
- 2 Moderate damage—10 to 50% of trees with 50% or more crown scorch
- 3 Heavy damage—greater than 50% of trees with 50% or more crown scorch, less than 50% of trees with crowns consumed
- 4 Extreme damage—greater than 50% of trees with crowns consumed

For each of the two groups of stands, a set of independent variables that seemed related to fire damage and probably available from existing records was determined (see Weatherspoon and Skinner [1995] for lists of variables considered).

Data Collection for Plantations

An FDC for each plantation was determined using both the color infrared and color aerial photos. Descriptions of fire damage included in postfire surveys were used when available—for approximately 10% of plantations—to check and calibrate the photo-based ratings.

Additionally, uniformity of damage was categorized as either (1) relatively uniform within the plantation, (2) spotty or patchy, (3) decreasing in severity from the edge inward, or (4) increasing in severity from the edge inward.

The aerial photos also were used to assess the degree of damage in the adjacent stand in the direction from which the fire apparently came.

Data Collection for Uncut and Partial-Cut Stands

Polygons characterized in the Shasta-Trinity National Forests' Geographic Information System (GIS) were used to represent uncut and partial-cut stands in this study.

The postfire aerial photos, along with prefire orthophotos, were used to assign the FDC to each stand and, independently, to verify uncut/partial-cut status of the stands.

Data Analysis

We analyzed the data for plantations and uncut/partial-cut stands separately.

Ordinal logistic regression (SAS 1990) was used to select the best model to relate significant independent variables with FDC for each stand type.

RESULTS AND DISCUSSION

The effects of several variables on FDC in plantations were found highly significant as for their effect on FDC in the logistic regression models (Table 1). These variables are individually discussed below. Readers are referred to Weatherspoon and Skinner (1995) for detailed discussion of resulting model performance.

Table 1. Variables associated with damage in plantations.

Variable	Direction of Association*
Damage in adjacent stand	+
Site preparation method	
None	+
Machine piled/burn piles	0
Broadcast burned	-
Grass cover	+
Forbs cover	-
Deer brush dominated vegetation cover	-
Elevation	-

* + = associated with higher FDCs or positively correlated

- = associated with lower FDCs or negatively correlated

0 = associated with intermediate FDCs

Fire Damage in Plantations

Damage in Adjacent Stand—As might be expected, fire damage to plantations was strongly associated with damage in the adjacent stand in the direction from which the fire apparently came. More damage—i.e., higher intensity—in the adjacent stand was generally associated with greater damage in the plantation. A preliminary analysis of data from the KNF indicates a similar relationship between damage in plantations and damage in adjacent stands.

Site Preparation Method—FDC and site preparation method were strongly related. The few plantations that had received no treatment burned completely and severely. Broadcast burned units suffered significantly less

damage, and the machine pile/burn units suffered intermediate damage. A preliminary analysis of data from the KNF indicates a similar relationship of damage in plantations associated with site preparation method.

Dissimilar successional patterns following the two site preparation methods may account for much of the differences among the methods. Data analysis showed that vegetation often associated with lower FDCs was more commonly found in broadcast burned plantations, whereas the opposite was found for the machine pile/burn plantations. Vegetation groups that were statistically significant in the models are discussed below.

Grasses—Percent cover of grasses was positively related to FDC: more grass was associated with more damage—i.e., with greater proportions of the higher FDCs. This is consistent with the relatively continuous, dry, and flashy fuelbed provided by most grasses in late summer and early fall. Higher grass cover was found more commonly in the machine pile/burn plantations.

Forbs—Forbs tended to have an effect opposite that of grasses on FDC. Greater cover of forbs was associated with lower FDCs. Forbs were more commonly associated with broadcast burned plantations.

Deer brush—Greater cover of a common vegetation group dominated by deer brush (*Ceanothus integerrimus*) was associated with lower FDCs when assessed as a univariate variable though it was not selected by our multivariate model for Hayfork data. The deer brush vegetation group was probably not selected for inclusion in the model because it is quite strongly related to the broadcast burn site preparation method. Our preliminary analysis of Klamath NF data indicates that the deer brush vegetation group is associated with lower FDCs there as well.

Elevation—Elevation was negatively related to FDC—i.e., damage decreased with increasing elevation. This relationship may result partly from the generally cooler, moister environment associated with increasing elevation, and partly from changes in vegetation composition.

Uniformity of Damage in Plantations

Site preparation method was the only factor related to uniformity of damage, and it was highly significant. Untreated plantations burned quite uniformly (and severely) and differed markedly from treated units. Broadcast burned units showed the greatest tendency for fire damage to decrease from the edge of the unit inward—i.e., for the plantation apparently to retard the spread and intensity of the fire. They differed significantly from machine piled units, which tended more toward a spotty burn pattern. No instances were observed in which fire damage increased from the edge of the plantation inward.

Fire Damage Levels in Stands Adjacent to Plantations

Since FDCs in plantations were strongly related to FDCs in stands adjacent to the plantations, the factors related to FDCs in partial-cut and uncut stands are discussed below. Factors selected by our analysis as associated with FDC in these other stands were stand treatment status, primary species, and slope orientation or aspect (Table 2).

Table 2. Variables associated with damage in other stands.

Variable	Direction of Association*
Stand treatment status	
Uncut	-
Partial-cut/fuels treated	-
Partial-cut/fuels untreated	+
Primary tree species	
Douglas-fir	-
Ponderosa pine	+
Aspect	
North	-
West	0
East	0
South/Flat	+

* + = associated with higher FDCs

- = associated with lower FDCs

0 = associated with intermediate FDCs

Stand Treatment—Uncut stands suffered the least fire damage, followed by partial-cut stands with fuel treatment; partial-cut stands with no treatment had the most damage. Preliminary analysis of Klamath NF data suggests a similar relationship there.

Only in four compartments had stands received any kind of fuel treatment, consisting either of lop and scatter (mostly 15 yr before the fires) or underburning (mostly 5 to 6 yr before the fires). When those four compartments were analyzed separately, the general relationships among the stand treatments were similar to those in the overall study. However, there was a greater difference between the partial-cut/treated stands and the partial-cut/untreated stands. Additionally, in those four compartments there was essentially no difference between the uncut stands and the partial-cut/treated stands in proportions of FDCs.

Primary Tree Species—Stands in which ponderosa pine was the primary species sustained more damage than stands dominated by Douglas-fir. This was likely the result of differences in fuel bed characteristics. As pine stands are often found on warmer and drier sites, with generally more open stand structure, they may be prone to more intense fire, especially in the absence of natural fuel reduction cycles (frequent fires) because of fire suppression activities.

Aspect—FDC was significantly affected by aspect. North aspects were associated with the least damage, south/flat aspects (combined in our analysis) with the greatest damage, and west and east aspects with intermediate damage.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Interestingly, the variables having the greatest potential impact on fire damage to plantations tend to be those most directly related to management activities: site preparation and damage in adjacent stand. Although some difference in fire damage was found between machine piled and broadcast burned plantations, a much larger change attributable to the site preparation method was that between treatment and no treatment. There has been an increasing tendency recently in some areas for managers to leave clearcut areas untreated for various reasons. Our results suggest, however, that in short-interval, low- to moderate-severity fire regimes (Agee 1993) such as those on the Hayfork District, Klamath National Forest, and widespread elsewhere in the West, non-treatment may represent an undue risk of loss of high-value plantations.

Damage in the adjacent stand also proved to be an important predictor of damage in plantations. Damage in the adjacent stand depends on the fuelbed and related conditions in the stand. Thus, this factor may have significant management implications for plantation protection: management activities and site/stand conditions that favor reduced fire damage in uncut or partial-cut stands also tend to decrease the severity of damage in adjacent plantations. This finding supports the need for a landscape perspective in managing fuels.

The dominant variable for uncut/partial-cut stands was stand treatment, which was also the variable most directly reflecting management activities. Clearly, stands that had been partial-cut with no subsequent fuel treatment suffered the most fire damage. Our results suggest, for the short-interval, low- to moderate-severity fire regimes studied here, that if fuels are left untreated, damage from wildfires could increase significantly. No comparison of wildfire hazard between plantations and uncut/partial-cut stands is provided by this study.

Another group of variables significantly related to FDC and under some degree of management control was species or groups of species of vegetation. Vegetation management activities in plantations—mostly site preparation and release treatments—generally are intended to reduce species that compete severely with conifer seedlings and favor those that are less competitive. Our results suggest that flammability of alternative vegetation complexes and implications for plantation protection also should be considered in vegetation management decision making. In uncut/partial-cut stands, the dominant species in the stand had an influence on FDC. This finding suggests that managers should be more sensitive to natural fire regimes and species-related variations in fire hazard in planning landscape-scale fuels management strategies.

A large number of plantations and other stands, covering a considerable range of conditions, were included in this study. Results should be at least indicative for an area well beyond the Hayfork District and the Klamath National Forest.

LITERATURE CITED

- Agee, J. K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Covelo, CA. 493 pp.
- Reider, D. A. 1988. California conflagration--recounting the siege of '87. Journal of Forestry 86:5-8.
- SAS Institute Inc. 1990. SAS technical report P-200, SAS/STAT software: CALIS and LOGISTIC procedures, release 6.04. SAS Inst. Inc., Cary, NC. 236 p.
- Weatherspoon, C. P. and C. N. Skinner. 1995. An assessment of factors associated with damage to tree crowns from the 1987 wildfires in Northern California. Forest Science 41: 430-451.

PROCEEDINGS

SEVENTEENTH ANNUAL FOREST VEGETATION MANAGEMENT CONFERENCE

*January 16 - 18, 1996
Red Lion Inn
Redding, California*

1995 EXECUTIVE BOARD

OFFICERS

Joe Sherlock, Chair
USDA Forest Service
P.O. Box 100
Mi-Wok Village, CA 95346
(209) 586-3234

Mike Landram, Vice Chair
USDA Forest Service
630 Sansome Street
San Francisco, CA 94111
(415) 705-1866

Stuart Gray, Secretary-Treasurer
Churn Creek Vegetation Management
8246 Churn Creek Road
Redding, CA 96002
(916) 221-3505

COMMITTEE CHAIRS

Mike Landram, Program Chair
USDA Forest Service
630 Sansome Street
San Francisco, CA 94111
(415) 705-1866

Gary Fiddler, Research Chair
USDA FS, Silviculture Development Unit
2400 Washington Avenue
Redding, CA 96001
(916) 246-5455

DIRECTORS

Robert Brenton
Jones & Stokes
2700 V Street
Sacramento, CA 95818-1414
(916) 737-3000

Vanelle Carrithers
DowElanco
28884 S. Marshall Road
Mulino, OR 97042
(503) 829-4933

Duane Nelson
USDA Forest Service
2999 Fulton Avenue
Sacramento, CA 95821
916-978-4543