

Research Improves Prediction of Yosemite NP Fire Behavior

By Jim Benedict and Jan van Wagtenonk

Fire has played a dynamic role for millennia in Sierra Nevada forests. Many plant communities in Yosemite have been adversely affected by years of suppressing naturally occurring fires. Trends in plant community succession have been altered, resulting in unnatural shifts in the composition and structure of Park ecosystems. The natural mosaic of diverse vegetation types is slowly being replaced by dense stands of fire-intolerant plants, especially at lower elevations of the Park. Yosemite's forests also have become increasingly susceptible to catastrophic wildfire as both living and dead fuel loads continue to increase.

To restore fire as a natural process in Yosemite's forests it is necessary to have information about fire behavior in the various Park ecosystems. Fire behavior is dependent on weather, topography and fuels. Of these, data on fuels are the most difficult to obtain. Prescribed burning, natural fire management, and fire suppression programs all require both generalized and detailed information on the abundance, distribution, and characteristics of ground fuels within Park ecosystems.

Fuels information gathered prior to a burn aids fire behavior prediction; fuels data gathered before and after a burn reflects fire effects on fuel loads. The commonly used methods for estimating pre- and post-burn ground fuel loading include: (1) fuel sample collection for laboratory drying and weighing; (2) a planar intersect technique; and (3) photo series for estimating forest residues.

Each of these methods has specific applications for fire management planning. Fuel sample collection and analysis was found to be extremely time consuming and burdensome for most management purposes; it is now used primarily for fire research purposes. Brown's (1974) planar intersect technique derives fuel loadings from calculations using intercept tallies, average diameter measurements, correction factors and constants. However, as ground fuels become less uniform in size, shape, distribution and orientation, the length of intersect line required to estimate the average fuel loading on an area increases dramatically (Pickford and Hazard 1978).

Photo Method

An even quicker inventory method eliminates the need to tally fuel particle intercepts on tens of thousands of feet of intersect line. Photo series were developed to make fast, easy, and inexpensive estimates of residue which are adequate for most management needs (Maxwell and Ward 1980). The user is required only to match an observed fuel characteristic with a series of photographs that depict various cover types and stand ages at different fuel loading levels. The user obtains fuel loading values from the data sheet accompanying the selected photo (or interpolates a value between photos).

Knowledge of Sierra fuel characteristics is extremely limited. Research being conducted in Yosemite was designed to build upon and expand the fuel inventory techniques described above. Brown developed his technique for inventorying dead and down woody fuels using data from northern Rocky Mountain conifers. Work by Ryan and Pickford (1978) in



Measuring and collecting ground fuels beneath a pure stand of old-growth white fir (Abies concolor).



Collecting ground fuels beneath a pure stand of old-growth red fir (Abies magnifica)

the Blue Mountains of Oregon and Washington and by Sackett (1980) in the Southwest has revealed that use of Brown's Rocky Mountain data can result in significant differences in estimating fuel loadings when comparisons are made based on locally collected correction factors.

The first objective of the fuels research has been to quantify for the 22 Sierra conifers the factors required in Brown's fuel loading equations. Species specific data were collected on specific gravity, squared average-quadratic mean diameters, and the average secant of non-horizontal particle angles. These values will not only increase the reliability of fuel loading estimates but also will increase the accuracy of the photo series developed to quantify forest fuels in the Sierra in which only Brown's inventory technique was used to estimate fuel loadings within the photographed stands (Maxwell and Ward 1979, Blonski and Schramel 1981).

Duff Correlations

The second objective of the fuels research has been to develop correlations between duff depth and duff weight for forest floor fuels beneath each of the 22 conifers. Within Sierra forests the quantity of fuels within the duff layers frequently exceeds the quantity of dead and down woody fuels on the surface of the forest floor. Duff fuels are an important component of the forest fuels of the Sierra, yet Brown's inventory technique provides only for the averaging of three duff depth measurements with no calculations of duff weight or other characteristics. These correlations will permit the manager to make depth measure-

ments and predict the loading of duff fuels.

The third objective of the fuels research is to use fuel characteristics information to develop a fuel model for each of the Park's forest types. Fire behavior prediction requires that fuels data be incorporated into fuel models. Computer based models of wildland fire behavior (Albini 1976) currently use 13 stylized fuel models to characterize a variety of vegetation types throughout the country. These models generalize the fuel characteristics of the vegetation being burned. In addition to fuel loadings by size class, the fuel models include values for surface-to-volume ratios, fuel density, heat of combustion, total mineral content, and silica-free ash content. These values are being collected. Use of the fuel models requires a great deal of professional or subjective judgement.

Fuel Models

There has been a strongly felt need among fire managers and researchers for a method to interface fuel inventory procedures in natural fuels with fire behavior prediction models. To meet this need Burgan and Rothermel (1979) at the Northern Forest Fire Laboratory in Missoula have developed an interactive, tutorial computer program that utilizes field fuel inventory information to develop site-specific fuel models. The fuel models are compatible with current fire behavior prediction models, such as the TI-59 Fire Behavior CROM (Burgan 1979). Fuels data from the Sierra will be used in the fuel model computer program to develop a site-specific fuel model for each of the Park's forest types. These models will improve the Yosemite fire management staff's ability to predict fire intensity and rate of spread within each of the Park's 15 forest types.

All of the field work and most of the laboratory work have been completed. The results from data analyses will be available in three to six months. The published results will appear in a year or a year-and-a-half.

Benedict is research biologist and van Wagtendonk is research scientist with the National Park Service at Yosemite NP.

Because of the usefulness to management of the listed publications, the entire Literature Cited is herewith reproduced.

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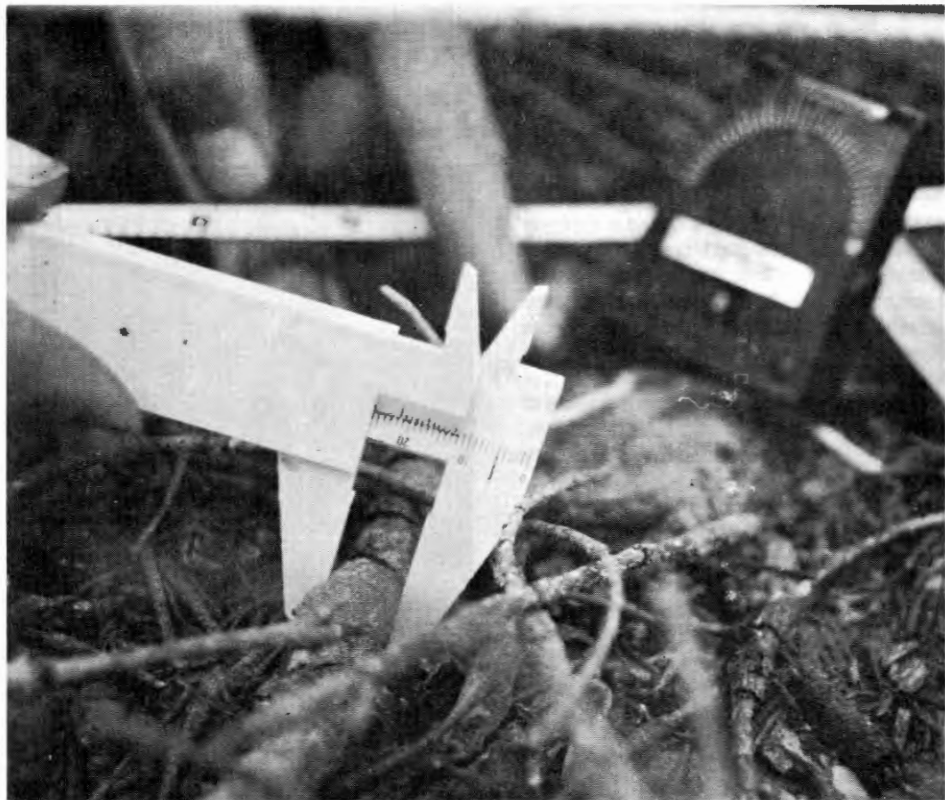
Cutting a section out of a log that was located within a 20 x 50 cm. sampling frame beneath a pure pole-stand of lodgepole pine (*Pinus contorta* var. *murrayana*).

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Callipers and protactor level used to measure the diameters and non-horizontal angles of intersected dead and down woody fuel particles.