THE OAKLAND-BERKELEY HILLS FIRE: LESSONS FOR THE ARBORIST[1]

by Pavel Svihra

Abstract. As the pressure of people wishing to live in urban forests continues to grow, the fire problem becomes more serious for these residents. The most recent firestorm in the densely populated Oakland-Berkeley Hills in the San Francisco Bay Area killed 25 people and destroyed 3,011 houses. Damage is currently estimated at $1.5 billion. Vegetation management is an important factor for fire speed control and a structure's survival. Effective silvicultural and arboricultural practices can change fire hazardous landscapes into safer ones in which flame intensity can be controlled by firefighters and residents have a chance to escape.

For some, the devastating 1991 Oakland-Berkeley Hills fire was related to poor performance by firefighters, local government's inadequate preparedness, arson, or negligence. Others blamed vegetation that was not resistant to fire. While any of these conditions may contribute to a fire's swift surge, the problem is much more complex. The pressure of people wishing to live in the urban forest is going to grow and the fire problem will become more and more serious if preventive measures are not taken.

Research shows that fire is an ecological factor. It is now evident that fire is not a minor or abnormal factor, but a major one, which has been shaping the character of vegetation for millennia in this region (1). Some parts of the greater San Francisco Bay Area have vegetation characterized as "coastal chaparral" in which the shrub life-form is predominant; other areas are known as "oak savanna" in which broad-sclerophyll woodland dominates with scattered trees occupying a wide belt between marshlands and grasslands. Europeans radically changed the vegetation by introducing very flammable annual grasses and about 200 other exotic plant species (2). *Eucalyptus globulus* (blue gum) and *Pinus radiata* (Monterey pine) also were widely planted, so it is not surprising that both of these highly flammable species burned readily in the recent fire (Fig.1). They also produce thick duff (leaves, needles, bark, twigs) which decomposes very slowly and contributes to fuel accumulation.

It should be stressed, however, that native plants also build up flammable fuel over time. For example, native perennial grasses die back to the ground in the late summer or fall, producing a fine, dry material. When weather is dry and windy, and this fuel is ignited, fire spreads very rapidly. It is misleading to claim that dwellings would be safer surrounded by native, less combustible vegetation than among introduced species, if no additional fire prevention measures have been taken (Fig.2).

New ecosystems created by human occupation are likely to persist, so the horticulturist, arborist, landscape architect or urban forester has no choice but to respond to existing conditions. The subject of this article is to define how homeowners, with the help of professionals, can modify and adjust flammable vegetation on homesites, based on an analysis of the recent conflagration, perhaps the most destructive urban forest fire in United States history.

Chronology of the Fire

On Saturday, October 19, 1991, at 11:13 A.M., the Oakland Fire Department responded to a brush fire in the Oakland Hills canyon area. Two helicopters were called after it was upgraded to a five-alarm fire. About 120 firefighters were on the scene and the fire that spread into five acres was declared extinguished by 4:40 P.M. Units stayed on the scene to ensure that all hot spots were extinguished; at 6:41 P.M., "cold conditions" were observed. As a precaution, hose lines were left around the burn perimeter. In the evening the crew was sent to check for hot spots again. No

1. Presented at the annual conference of the International Society of Arboriculture in Oakland in August of 1991.

Fig. 1. A panorama of burned slopes with a few hundred houses destroyed. In this case, young groves of *Eucalyptus globulus* and *Pinus radiata* were both responsible for the swift conflagration. Notice that several hundred pines were improperly pruned (topped) for a view in front of house rows (arrow). This practice stimulated "mat-like" regrowth in the crown tops which denied light to the branches below, creating dead and highly flammable debris.

flare-ups were found.

On October 20, two engine companies were sent to check the area again and pick up hoses. They arrived on the scene at 8:50 A.M., walked through the burned area, and detected hot spots. At 10:58 A.M. the Santa Ana winds burst suddenly and the officer in charge transmitted the message, "We have embers blowing into the unburned vegetation." At 11:05 A.M. a second alarm was called (four engines were dispatched to the area); at 11:07 the third alarm was called (two additional engine companies were dispatched), then at 11:18 A.M. the fourth alarm was called (two engine companies were added). Sometime between 11:05 and 11:18 A.M., helicopters were summoned. At 11:26 A.M. the sixth fire alarm was requested and the firestorm gained such momentum that it jumped the eight-lane California Highway 24.

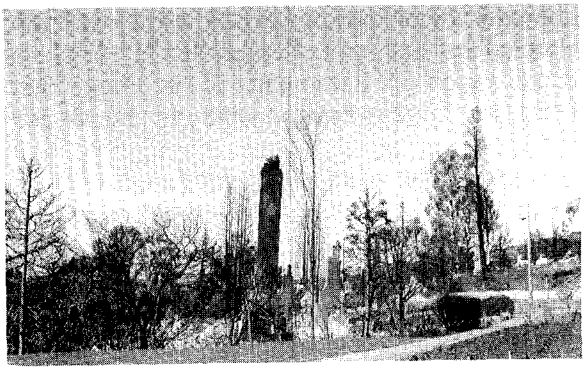

Fig. 2. As the fire spread to flatland, roof type instead of vegetation became a major factor. Radiating heat from burning structures ignited vegetation in the surrounding landscape, regardless of whether the species was native or less flammable. The picture shows a few dozen species — none survived.

A total of 400 engine companies with 1,844 firefighters fought the blaze; 25 lives were lost; more than 1,500 acres, including 3,011 houses and multiple residences, were burned. Damage is currently estimated at $1.5 billion, although no final determination has yet been made, nor is it known how many, if any, shrubs and trees survived within the 1,500 acres affected. Despite all the modern firefighting technology involved, this firestorm was almost impossible to stop until humid marine air returned and the dry hot winds died down (3).

How Weather Conditions Affect the Extent of Conflagration

According to historical records, there have been four major fires in the Oakland-Berkeley Hills area and each was associated with the same weather pattern: high atmospheric pressure over the Great Basin desert and a low in southern California (4). This pattern occurred on September 16, 1923, September 22, 1970, and December 10, 1980. The point of fire origin of the 1970 fire was similar and weather conditions were almost identical to those on October 20, 1991.

Wind circulates in a clockwise pattern around a high and counter-clockwise around a low. This strong flow pushes the normally present marine layer off the California coast, followed by hot dry winds coming westward from the Sierras. The air overheats even more as it drops to the valleys, until it reaches the greater San Francisco Bay Area. This pattern occurred on October 20, 1991, when high wind speed and low humidity lasted for several hours. According to 30 years of data collected on the University of California at Berkeley campus, an average of four days of this kind of weather can be expected annually (4).

But besides this weather pattern, another fact remains clear. At the same time the quantity of dead fuel (leaves, twigs and branches) is increasing in the late summer and early fall, the moisture content of the remaining live vegetation is drastically decreasing (5). Thus, less energy is required for ignition and a destructive fire may start without the presence of Santa Ana winds.

Can Vegetation Fuel Buildup Be Controlled?

In an as yet unpublished study of the Santa Barbara fire (a joint study by the California Department of Forestry and Fire Protection and University of California at Berkeley), E. Foote, K. Gilless, and R. Martin examined housing design, landscaping, transportation network, and defensive action (6). Results suggest that landscape design is the second most important factor (after roof type) that determines a structure's survival. Vegetation clearance around the house is very important. Thus, enforcement of vegetation clearing ordinances is not harassment — it improves the probability of structure survival. When house survival was rated according to the distance from the house of 1'- to 3'-high vegetation (Fig. 3), the pattern was clear; as the distance increased, structure survival increased. The same relationship existed for vegetation 4' to 10' high. The data for trees showed the same pattern: the more distant trees were from the house, the greater chance of the structure's survival.

In 1985 the University of California began an aggressive fire management program on the Berkeley Campus, which consisted in part of replacing flammable plant species (particularly *Eucalyptus)* with less combustible native vegetation. Methods included goat grazing, but only on small areas because this is an extremely expensive way to control vegetation. Prescribed fires, if carefully

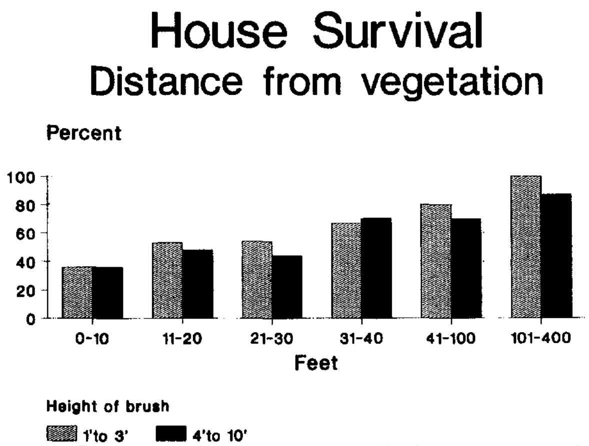

Fig. 3. Destruction by an urban forest fire is closely related to the vegetation clearance around houses. Whether vegetation was 1' to 3' or 4' to 10' tall, the trend was the same — a finding of significance to the urban forester, arborist and landscape architect (after Foote, Gilless and Martin).

planned and controlled by local fire departments, can eliminate flammable debris close to homes and other structures (7).

Managing Vegetation to Reduce the Fire Hazard

Complete protection from fire has not always resulted in a more productive environment for human needs (1). Considering the incredible speed with which the Oakland-Berkeley Hills firestorm took lives, property and vegetation, one must wonder whether silvicultural and arboricultural practices can improve the fire safety of dwellings. Plant growth, senescence, mortality, diseases, insects and numerous environmental factors lead to fuel increase. This fuel accumulation may be depleted through decay, fire, or physical removal (5). While accumulation of live and dead fuels may follow different patterns, the urban forester in cooperation with the arborist can modify existing vegetation to reduce the fire hazard (Fig. 3). The objective is to prune and remove trees and shrubs in a hazardous landscape so that, even under the most severe conditions, the fire and flame intensity can be controlled by ground firefighting crews:

- Remove grassy fuels, clean away all overhanging branches and brush for 30 feet around all dwellings (8,9).

- Remove highly flammable brush from around each home for a distance of not less than 100 feet (6,10).

- Thin shrubs growing within 100 feet from each house into individual plants. Such thinning should be carried out to a distance of five times shrub height (8).

- Build a fire trail. Clear a 6-foot-wide trail near the outer edge of the fire-protected area to slow down a running ground fire (9).

- Eliminate "ladder fuel" configurations in vegetation growing within100 feet of structures (ladder fuel configuration refers to the growth of a plant community in a succession like the rungs of a ladder — leaves, grasses, small shrubs, large shrubs, and trees) (Fig. 4). Removal or alteration of these "rungs" reduces the chances for the fire laddering up into the most destructive crown fire (8).

- Thin trees by cutting branches so that crowns are 10 feet or more apart to reduce the probability of fire moving laterally between them (8).

Fig. 4. A typical example of the ladder fuel configuration which helped to destroy a house. In its journey upward, the fire jumped the street, ignited *Juniperus* sp., spread up to *Cotoneaster* sp., followed by *Prunus cerasifera*, until it became a crown fire in Cedrus deodora. Walls collapsed, leaving a forest of chimneys.

- Prune trees to raise the lowest level of the crowns far enough from the ground to reduce the probability of a surface fire getting into the crowns.

- Prune all dead branches; cut down and remove dead shrubs and trees.

- Apply all known cultural practices (irrigation, fertilization, etc.) that improve health and vigor of trees/shrubs around homesites.

Major conflagrations are usually followed by revised building codes. It is essential to consider the arborist's, horticulturist's, landscape architect's and urban forester's views of vegetation management around homesites in formulating these codes.

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Résumé. La gestion de la végétation est un important facteur pour le contrôle de la vitesse de propagation du feu et la survie des édifices et de leurs résidants. Des pratiques sylvicoles et arboricoles efficaces peuvent changer des feux imprévisibles de champs en des feux contrôlés.

Zusammenfassung. Grünplanung ist ein wichtiger Einflußfaktor auf die Ausbreitungsgeschwindigkeit eines möglichen Brandes und das Überdauern von Gebäuden und Überleben der Bewohner. Eine wirkungsvolle Forst- bzw. Gartenbaupraxis kann feuergefährdete Landschaften zu sicheren Landschaften umgestalten.