Comparison of Fuel Load, Structural Characteristics and Infrastructure Before and After the Oakland Hills "Tunnel Fire"[1]

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Abstract: Structures rebuilt after the Oakland Hills "Tunnel Fire" in 1991 are different in many aspects when compared to their predecessors. Data obtained from the city of Oakland indicate homes have been rebuilt 28 percent larger (square feet). About 50 percent of the homes destroyed have been rebuilt, and building permits have been issued for an additional 16 percent. New construction mandates facilitated by local and State laws have resulted in the following requirements: class A roofs, chimney spark arrestors, 1-hour siding for exterior walls, 30-foot clearance of wildland vegetation. Domestic vegetation is not regulated. Average structural fuel load consumed in the fire was 11.5 kg/m^2. Larger homes built after the fire will produce higher structural fuel loads. Improvements in infrastructure such as roads and water supplies have not occurred. Improvements have occurred in communication systems. Increases in structural fuel load accompanied by modest improvements in infrastructure may increase the fire risk in this urban/wildland intermix.

Vegetation is a critical fuel component in urban/wildland intermix fires. Without an active fuel management program, vegetative fuels will accumulate. Many vegetative fuels also have a large amount of fine fuels with a high degree of horizontal and vertical continuity; fuels of this type can produce extreme fire behavior when conditions are dry.

The structural fuel component of the urban/wildland intermix is often neglected. In many cases the structural fuel load can be larger than the adjoining wildland fuel load. Combustion characteristics are much different in structural and wildland fuels but both can affect fire behavior of intermix fires.

Changes in infrastructure, building materials and vegetation management have been slow or non-existent following most urban/wildland intermix fires. The public as well as local and State agencies have short memories after such events. Several positive steps have been taken after the Oakland Hills "Tunnel Fire" in northern California that will reduce the probability of such an event occurring again, but many other problems remain.

This paper will review the changes which have occurred and will summarize the structural and wildland fuel consumed in the Tunnel Fire.

Methods

Wildland vegetation inventory was accomplished by using NASA false infrared aerial slides (1:6,000 and 1:12,000) taken after the Tunnel Fire. The slides were projected over a 1.0 by 1.3 meter map of the fire area and perimeters were drawn around each vegetation type. Numerous trips were then taken to the burned area to improve the map. This information was used to create a second map that was further improved by the use of a set of 32 aerial color prints (1:6,000) taken after the fire by Pacific Aerial Surveys. The final map was digitized, and areas of each polygon were calculated, by using the geographical information system ATLAS.

Structural fuel load was calculated by using the average amount of lumber used to build a home in the western United States (American Forest and Paper Association 1990). The land area occupied by structures was determined using the geographical information system. Structural fuel load was assumed to be homogeneous over the area occupied by the structures.

Information was obtained on post-fire construction from the City of Oakland. Local fire officials were contacted to determine concerns in this post-fire urban/wildland intermix.

Results

The fire perimeter enclosed 615.2 hectares and was divided into categories:

Vegetation Category	*Area (ha)*
Eucalyptus (*Eucalyptus globulus*)	132.1
Monterey pine (*Pinus radiata*)	56.3
Northern California coastal scrub	109.7
Grassland	2.9
Coastal scrub and grassland mosaic	28.5
Monterey pine and coastal scrub mosaic	2.3
Coast live oak (*Quercus agrifolia*) and coastal scrub mosaic	19.2
Structures	246.2
Highways	18.0

The number of structures totally destroyed by the fire was 2,305 (Gordon 1994). Assuming the average home uses 13,000 board feet of lumber to construct (American Forest and Paper Association 1990), this results in a structural fuel load of 11.5 kg/m^2 (50.8 tons/acre). This value of structural

[1]An abbreviated version of this paper was presented at the Biswell Symposium: Fire Issues and Solutions in Urban Interface and Wildland Ecosystems, February 15-17, 1994. Walnut Creek, California.

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fuel load is conservative because it does not include any of the interior components of a structure, although it is in accord with the average United States structural fuel load of 14 to 21 kg/m^2 (Bush and others 1991).

Examination of post-fire construction permits indicates homes have been rebuilt on average 28 percent larger. Local requirements of new construction include class A roofs, chimney spark arrestors and 1-hour siding for all exterior walls. State and local requirements of a 30-foot clearance between structures and wildland vegetation are also enforced.

Domestic vegetation is not regulated by local or state agencies. Some domestic vegetation is highly flammable. The heat released from one mature tam juniper (*Juniperus sabina* var. *tamariscifolia*) surpassed 2 megawatts within 1 minute of ignition (Stephens and others 1993). In that study mature junipers were harvested and burned at different moisture contents. Results from that study (Stephens and others 1993) along with videotape of the Oakland Hills fire demonstrate that domestic vegetation can provide an efficient vector for transmitting fire into a structure.

Conclusion

Structures in the post-fire urban/wildland intermix in the Oakland Hills will be built with more flame-resistant materials, but increases in the size of the structures will increase structural fuel load. Infrastructure such as water supply and road systems has not been improved, increasing the fire risk in this urban/wildland intermix.

Wildland and structural fuels must be managed to reduce risk in the urban/wildland intermix. Domestic vegetation must also be managed to reduce risk in the intermix. Emergency infrastructure must be improved to reduce the loss of life and property from these fires. Firefighting helicopters could be used for initial attack on urban/wildland intermix fires. Early detection and response would be required for effective fire suppression using helicopters.

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