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CALIFORNIA DEPARTMENT OF FORESTRY

FIRE PREVENTION NOTES

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This article (which is divided into two units was published in the June and July, 1976 issues of Fire Line) was originally presented at the 1974 spring meeting of the Western States Section of the Combustion Institute. The topic is timeless in scope; however, it is of extreme pertinence to Californians at the present time due to the severe drought conditions that currently prevail. The material in the first unit of the article defines the problems of the "Urban/Wildland fire interface," and the second unit illustrates some recorded cases, and proposed solutions to the problem. Everyone in California, or any other drought stricken state, needs **is to** recognize our present situation and heed for the advice offered by Mr. Butler.

THE URBAN/WILDLAND FIRE INTERFACE

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PART I

ABSTRACT

Houses built in canyons and up and down steep hills covered with native vegetation pose a fire hazard from large wildland fires that run out of control. The threat is accentuated because the interface separating the two classes of inflammable materials is hard to recognize, has not been widely studied, and is not the responsibility of any agency.

The root of the problem is the desire of people to live in rural surroundings. One solution to the problem is for the homeowner to find out what steps should be taken to render his home safe from fire and then to follow them. Everyone who lives in the urban/wildland interface may find immediate answers to fire prevention questions from local firemen.

INTRODUCTION

When houses are built in clearings among trees and natural vegetation or along the bottoms of canyons whose walls are covered with native brush and grasses, there is usually serious fire potential. A house in the woods, where leaves, twigs, cones, needles are constantly dropping to the ground and increasing fuel loading, is vulnerable to a fire originating in the forest.

Very commonly, within distances of a few feet, two distinct and non-compatible environments can be recognized: the house, where fire must be controlled at all times, and the wildland, where fire is a perfectly natural part of the ecology. The boundary between these two environments is called the interface. This paper attempts to define the urban/wildland fire boundary, to examine the hazards it poses, and to suggest what needs to be done to reduce the loss of life and property when large fires run out of control and pass from natural vegetation into urban fuels.

Some of our ancestors recognized the fire hazards of this interface better than we do because they periodically found themselves trapped downwind from a raging prairie fire. The following account was written by Henry Lewis[1] in 1848 to accompany one of his water colors that showed an advancing fire front and pioneer women and children huddled around the wagons, while the men are frantically mowing the grass and piling on the downwind side:

> "The dry grass, which often reaches the height of a man on horseback, burns with terrific speed, and in a few minutes the flames spread for miles. If there is a strong wind, whole clumps of burning grass sail through the air like fiery meteors, and as far as the eye can reach, (and) the horizon is shrouded in a black cloud of smoke under which a sea of flame covers the earth. When the immigrants are surprised by a prairie fire, they mow down the grass on a patch of land large enough for the wagon, horse, etc., to stand on. They then pile up the grass and light it. The same wind which is sweeping the original fire toward them now drives the second fire away from them. Thus, although they are surrounded by a sea of flames, they are relatively safe. Where the grass is cut, the fire has no fuel and goes no further. In this way, experienced people may escape a terrible fate. Unfortunately, it sometimes happens that immigrants who do not understand these conditions venture out into the prairie and then, because they lack experience of guides who know the country, they perish miserably in the flames."

This description provides a special situation of the urban/wildland fire interface and what happens when it is crossed. It also suggests the transient nature of this type of fire and how it depends on the time of year, the weather conditions, and the nature of the ground fuels. The fact that this account was illustrated and documented in 1854 indicates that many people knew about the fire hazards of prairie fires and what steps to take to survive.

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[1]Henry Lewis, Das Illustrite Mississippithal, Arnz and Company, Dusselforf, Prussia, 1854.

MEANING OF THE FIRE INTERFACE

An interface exists wherever buildings are close to native vegetation because under appropriate conditions the buildings and vegetation are both fuel that will support an uncontrolled fire. Interface hazards are present when a wildland fire spreads into the flammable materials of a house.

The urban/wildland interface is hardly of interest to those who live in rural settings where the annual rainfall and ambient moisture conditions do not permit the native vegetation to dry out and support fire. Weather conditions in the coast redwoods of northern California and in much of western Oregon and Wasington inhibit fire situations that lead to conflagrations.

In central and southern California, however, winter rains provide ample moisture for vigorous plant growth. The long hot summers that often follow dry out the ground fuels so that they are easily ignited and burn vigorously. From September to May, the usual westerly winds frequently reverse, and hot dry air from the deserts and mountains descends into the coastal valleys. As this airflow increases, intense winds, called "Santa Anas," or "foehn" often reach velocities of 50 or more miles per hour, further drying up any moisture remaining. This sets the stage for an uncontrolled fire.

In its simplest terms, the fire interface is any point where the fuel feeding a wildfire changes from natural (wildland) fuel to man-made (urban) fuel. An interface may be a single spot in a building where fire can enter. If this point is vulnerable and unattended, fire may then propagate inside the house. For this to happen, wildland fire must be close enough for its flying brands or flames to contact the flammable parts of the structure. The interface includes all conditions that may lead to fire spreading through natural vegetation into a building.

However, if a fuel break, such as a wide street or a spacious lawn, is wide enough and the exterior walls and roof of the building are non-flammable, there is little danger from a wildland fire, although there are exceptions in all of these general observations. One of the purposes of this paper is to identify what the fire interface is and how to recognize its potential hazard.

THE ROOT OF THE PROBLEM

The root of the problems described here stems largely from an almost universal desire to live in a natural or rural environment. The words of writers like Thoreau and John Muir can readily be savored by the man who has been working all day in a city jungle, if in the evening he can return to his home where the only things he can see are the blue of the sky and the green leaves shielding him from all eyes. In planning their first home young couples delight in selecting a site covered with native growth. This desire is not lost on the architect who furnishes intriguing perspective drawings showing a house nestled among trees.

After the decision is made to construct a house in the woods, an interface is soon formed. Although its existence is rarely recognized by the newcomer, a distinct line separates the house area from the wildland. On one side of this imaginary line, every possible effort is made to prevent fire but on the other side of the same line, fire is an intimate part of the ecology and a recurring boon to maintaining its natural balance.

RECOGNIZING THE HAZARD OF THE INTERFACE

Firemen are most perceptive in recognizing the existence of hazards associated with an urban/wildland interface for they are the ones who witness its breaching and therefore have first-hand information. All the consequences of poor planning, indifferent maintenance, and especially the disregard to existing rules and regulations about brush clearance become all too clear when a large wildland fire advances into an urban area.

Recommendations have been published by the University of California, the U.S. Department of Agriculture, Pacific Southwest Forest and Range Experimental Station, and the County of Los Angeles Fire Department on how to cope with the wildland/urban fire interface. It seems obvious that developers and architects should apply information that is readily available on how to build in a wildland setting. For those who already live in such surroundings, there are preventive measures that will ensure better fire protection. There is no lack of recommendations on what to do, but executing such simple matters as weed abatement is not a popular activity. Strict regulations in force in many municipalities specify the minimum brush clearance area around a home, but enforcement remains difficult.

One solution to the interface problem is prescribed burning, but experts are far from agreement on just how to do it. There are serious legal complications when a prescribed fire exceeds the planned boundaries and spreads into adjoining land. Costs in 1971 for prescribed burning of chaparral are estimated at $13.50 per acre; any large area therefore represents a major investment. Because of its cost and the risk of a major breakthrough into private lands and perhaps into houses, prescribed burning remains an uncertain method for controlling large wildland fires, as pointed out by Wilson.[2]

WHEN FIRE DEPARTMENTS ARE OVERWHELMED

In simplest terms, the objective of all municipal fire departments is to save lives and property. Their manuals of instruction, their training, and their equipment are all focused on fires that occur in buildings, one building at a time. When a fire moves through a residential district, and a dozen houses are involved simultaneously, as happened in the Chatsworth area of Los Angeles in 1970, there is little that any fire department can do except to select houses that are not yet fully involved and concentrate on saving them.

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[2] Carl C. Wilson, To Burn or Not to Burn, paper presented to the Wildlife Society and the Wildlife Federation Joint Coordinating Committee, San Francisco, California, February 23, 1971.

Underlying nearly all fire control practices in cities is the assumption that there will be an adequate supply of water in the mains; without water a fireman can accomplish little with a hose and nozzle. Although water pressures rarely fail in normal operations, serious drops in water pressure happen all the time when wildfire threatens many homes. (This situation has been well illustrated in the movie, "Design for Disaster.")[3]

When the interface between wildland and urban fuels is breached, methods of fire fighting employed by state and U.S. Forest Fire Departments are often the only ones that work. Construction of firebreaks ahead of the flame front, dropping fire retardants from the air, and backfiring are common techniques that every forester and fire boss understand and regularly use. But bulldozing a firebreak across a row of houses ahead of the fire front is simply impractical for many reasons. It is almost unknown for an urban fire department to consider the possibilities of firing all the houses on one side of a street to form a break where the fire can be stopped.

This dilemma has been described by Walsh[4] in these words:

> "...Primary factors at serious structural fires may include endangered occupants; buildings of different types of construction, height, age, and area; structural collapse: various occupancies and industries with their inherent hazards; unique fire spread; backdraft explosions; vehicular traffic; presence of fixed systems (stand pipes, sprinklers); and others. Some major activities at woodland sites, such as establishing firebreaks and applying special extinguishing agents from planes, are inappropriate for fire in buildings."

In the same year, Broido[5] elaborated on the interface problem in a reply to Walsh:

> "...This statement (Firebreaks are inappropriate) is no doubt true if one considers the usual urban fire situation involving one or at most a few buildings. However, I have yet to see a meaningful description of how an urban department plans to handle a mass fire situation like the Chicago fire in 1871, the San Francisco fire in 1906, and the Hobart, Tasmania fire in 1967."

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[3] Design for Disaster, motion picture of the Malibu fire, Los Angeles Fire Department, 1971.

[4] Charles, V. Walsh, "A Fire Service Viewpoint of Woodland and Urban Fire Situations", Fire Abstracts and Reviews, Vol. 9, No. 1, p. 52 (1967).

[5] A. Broido, "Woodland Fire Research and Urban Fire Situations," Fire Abstract and Reviews, Vol. 9, No. 3, p. 249 (1967).

Within three years after this exchange took place, California experienced again a series of uncontrolled fires that breached the interface, leaving some 900 homes in ashes, and causing 14 deaths and a loss of $250 million.[6] In each case fire in adjacent wildlands went out of control, jumped wide streets and spacious lawns, crossed canyons, and went up and down steep hills, sweeping the ground clear of fuel--whether houses, brush, trees, or grass. Descriptions of how the fire jumped from one house to the next are similar: each house supplied fuel to the flames, which the wind carried to the next house in line, like falling dominoes.

WHAT HAS BEEN DONE

Accounts of large fires usually begin with a listing of the number of lives lost and the value of the property destroyed and conclude with some description of what the fire departments did to control the fires. No better resume' of the response to the disastrous fires in California has been published than "California Aflame,"[7] part of which reads:

> "While it was a time of disaster, it was also a time of triumph for human resourcefulness, engineering, and compassion. Under provisions of the State Fire Disaster Plan, professional firemen from hundreds of county, city, and community fire departments joined the wildland fire protection forces of the California State Division of Forestry and the U.S. Forest Service for a common, organized effort. Firemen and equipment converged on the fires from many directions, assisted by other government agencies, private organizations, and various industries. Private individuals worked separately and also combined into impromptu groups to aid the destitute and to assist firemen on the line. Here there was no generation gap. 'Long hair' worked side by side with 'short hair' and 'hard hats'; young and old found a cause in which they could join harmoniously. This great human phalanx which stood against a tenacious enemy had its rewards."

In light of the suggestion that fire departments have little use for techniques used in fighting forest fires, the following words of Wilson[5] are encouraging:

> "In Los Angeles County, the County and City Fire Departments use helicopters to scout fires, drop retardants (and) transport injured personnel and equipment to critical streets and highways when they were impassible."

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[6] Carl C. Wilson, "Commingling of Urban and Forest Fires," Fire Abstracts and Reviews, Vol. 13, No. 1, pp 35-43 (1971).

[7] "California Aflame, September 22 - October 4, 1970," Resources Agency, Department of Conservation, State of California, November 1971.

[5] A. Broido, p 249.

One of the ironies of the interface problem is that most of the technical aspects of fire control of wildland have already been solved. The identification of the most inflammable species of plants, the annual accumulation of ground fuels, and the cyclic nature of wildland fires in southern California have been documented by Philpot and Rothermel.[8] A task group on California's wildland problem[9] has issued a report containing recommendations for its solution. Many California counties have adopted some of these recommendations that are directed to som e 31 agencies participating in various types of remedial action. Each of these groups has an interest in the wildlands and is very concerned with the consequences of large uncontrolled fires. The Resources Agency has issued a document describing the fire hazard severity,[10] setting forth the fire conditions in all counties of the state. An elaborate plan to reduce the fire hazard of the Berkeley-Oakland hills[11] recommends fuel breaks by means of the proper vegetative management. All these projects, however, focus on the wildland side of the interface.

At least one study[12] has shown the "...most cost effective way of protecting the Santa Monica Mountain area from wildfire is for all houses to have approved roofs and 100 feet of brush clearance." This is one of the few studies that recognizes the protective value of the interface and what can be done to strengthen it.

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[8] Richard C. Rothermal and Charles W. Philpot, "Fire in Wildland Management Predicting Changes in Chaparral Flammability, Journal of Forestry, Vol. 71, No. 10, October 1973.

[9] Recommendations to Solve California's Wildland Fire Problem, Task Force on California Wildland Fire Problem, Department of Conservation, Resources Agency, State of California, June 1972.

[10] A Fire Hazard Severity Classification System for California's Wildland, Division of Forestry, Department of Conservation, Resources Agency, State of California, April 1, 1973.

[11] The Vegetative Management Plan for the Eucalyptus Freeze-Affected Areas in the Berkeley-Oakland Hills, University of California Agricultural Extension Service, Alameda County Office, California, undated.

[12] Ronald A. Howard et al, Decision Analysis of Fire Protection. Strategy for the Santa Monica Mountains: An Initial Assessment, Stanford Research Institute, Menlo Park, California, October 1973.

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PART II

TWO DISCIPLINES IN FIRE RESEARCH

Judging from the literature, the urban/wildland fire interface does not appear to interest anyone in government at any level. The report, "America Burning"[13] does not mention the subject, even under a special heading called "Ambitious Sets of Goals for Research." A symposium, "The Role of Fire in the Intermountain West,"[14] held in 1970 consisted on some 20 papers on wildland fires, but not one paper mentioned the fire interface. The Year Book of Science and Technology for 1973[15] does not mention the fire interface under the heading "Urban Fire."

It seems that researchers who are paid to study the behavior of wildland fires have given little consideration to how fire crosses the forest boundary and enters the city, and those who concentrate on the physics and chemistry of fires in buildings have little to say about exterior combustibles, which normally play a small role in ignition.

The "Directory of Workers in the Fire Field"[16] lists 1,143 people, of whom only 66 are identified as forest fire workers, but no fire workers from the National Park Service are listed. The Leopold Report[17] has been referred to many times as the document of the greatest significance to the Park Service because of its emphasis on the role of fire in maintaining our national parks in their natural state.[18] The National Park Service program of prescribed burning is based on keeping the interface intact; i.e., keeping fire within given areas and out of occupied areas and allowing fire to play its natural role in shaping the wildland environment. References to these major efforts by the Park Service are rare in reports on urban fire research.

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[13] America Burning, report of the National Commission on Fire Prevention and Control, U. S. Government Printing Office, Washington, D.C., 1973.

[14] The Role of Fire in the Intermountain West, Intermountain Fire Research Council, School of Forestry, University of Montana, 1970.

[15] Stanley B. Martin, Urban Fires, Yearbook of Science and Technology, McGraw-Hill Book Company, New York, New York, 1972.

[16] "Directory of Workers in the Fire Field," NASA, CR-121149, Aerospace Safety Research and Data Institute, Lewis Research Center, 1973.

[17] A.S. Leopold, et al., "Wildlife Management in the National Parks," American Forests, Vol. 69 (4), pp 32-35, 61-63, 1963.

[18] Bruce Kilgore, "Restoring Fire to the Sequoias," National Parks Magazine, Vol. 44, No. 277, pp 16-22, October, 1970.

The separation between the two broad disciplines of fire research and forestry begins with young people when they elect to pursue either career. Undergraduate forestry students take courses in forestry, some engineering, and a little chemistry and physics. Perhaps on the same campus others of the same age who plan to enter a fire engineering field will study engineering, economics, a little architecture, and again some chemistry and physics. Each may finish four years of study without recognizing the existence of the urban/wildland fire interface.

Firemen are sometimes categorized into two classes: those employed by city fire departments as "structural firemen"; and those employed by federal, state, and county agencies to protect forests and lands covered with brush, weeds, and grasses as wildland firefighters. At the working level these two groups frequently merge in operations where both urban and wildland areas are involved, especially in parts of California where county fire protection services are provided by the State Division of Forestry. These men are acutely aware of the interface and the consequences of breaching; they also see at first-hand the long range results of poor planning, sloppy maintenance, and indifference to the most elementary fire protection measures.

THE SHADOW ZONE

A fire chief may live throughout his professional career without confronting the questions posed by the commingling of urban and wildland fuels. Similarly, many foresters active in fire research may never encounter the interface; or if they do, they are not called on to make decisions on how to control fires in houses. There is no compelling reason why foresters should be required to study the ASTM tests for fire resistance of timber beams, for example. By the same token, the fire engineer who is active in the application of fire codes to building materials will find very little use for a detailed knowledge of the effects of the packing ratio on fire spread in pine needle duff.

Thus, the interface itself remains a shadow--not well defined and of little interest either to the architect or to the forester. In the meantime, nature continues to produce new supplies of fuel each year, building up the loading little by little. In almost every community a few houses pose a serious fire threat to an otherwise tidy neighborhood because the weeds are uncut and blowing leaves fill the gutters and pile up gracefully, but dangerously, around the base of the walls or under the deck. Such a house has a built-in fuel link between adjacent wildlands and all the other nearby structures. Attempts to legislate rules and regulations for brush clearance have met with only partial success; it is not a popular subject.

When confronted with an uncertain interface, the resident or prospective buyer must inform himself of the facts. The stimulus to do this should be suggested by real estate agents, bankers, builders, and certainly city and county planning boards.

FUEL COUPLING ACROSS THE INTERFACE

Very little theoretical work or modeling has been done on the way fire spreads from a wildland area into an urban area, partly because of the lack of in-depth studies of the local situation at the time of the fire. What is needed to understand the problem of fire spread is an estimate of: the fuel loading on each side of the interface, the geometry of the exterior walls of the house, the terrain, how the wildland fire approached, and the meteorological conditions at the location of the breach. It is customary to quote wind velocities at the time of a fire by referring to the nearest weather station data, but firemen are all too familiar with the difference between the "official" wind velocity and what they find at the site, especially in hilly terrain.

Plans to prevent disaster and execution of such plans have been very successful; the efforts to save lives and property have paid off handsomely. But documenting the heroic efforts of whole communities to save their homes and to stop the advancing fire front[7] should not be confused with documenting the causes for fire spreading across the interface. Everyone understands that at the time of a holocaust, when lives and property are endangered, there is no way that careful objective observation can be made by anyone.

The essential element necessary for fire to spread across the interface is fuel coupling. Since this spread takes place at a time of extremely high emotional response of the people closest to the interface, they are the ones whose subsequent memories of how and where the fire spread are probably the most valid. Both residents and firemen are witnesses to fire spreading from one house to the next, from burning grass and shrubs to the nearest garage, wooden fence, or exposed porch.

Collection and interpretation of eye witness accounts of events occurring during a large fire are one source of information from which the nature of the fire interface can be understood. If eye witnesses are interviewed shortly after the holocaust and before their memories have dimmed by reading press stories of dramatic rescues and brave action of citizens that saved a life or a house, their anecdotes furnish valuable information on just how the fire in the wildland fuels moved into the urban; i.e., the fuel coupling.

Only one report[19] included actual interviews with people who owned houses that were often saved by self-help, as well as interviews with people who had to stand by and watch their homes go up in flames. Most of the material in the next section was taken from this report, "The Great Oakland, Los Angeles, and San Diego Fire of September 22 to 29, 1970," which refers to the fires in California in September, 1970.

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[7]"California Aflame, September 22-October 4, 1970," Resources Agency.

[19]R.S. Alger, et al., The Great Oakland, Los Angeles and San Diego Fires, September 22-29, 1970, NOLTR 71-229, Naval Ordinance Laboratory, White Oak, Silver Spring, Maryland, November 9, 1971.

ANALYSIS OF THE INTERFACE

The following interpretations of interviews, together with on-site inspection within a few days after the fires bear directly on how to model the interface. Until there are more input data, generalizations must remain tentative.

When fire attacks from the outside of a house, one of the main considerations is the combustibility of the exterior materials used in construction. The materials that we refer to as "urban fuels" include the buildings themselves and exterior structures such as fences, trellises, poles, outdoor furniture, and plants and shrubs brought in by the owner for landscaping.

All houses examined in the survey had an Achilles heel where fire could gain entry. Very few structures had both noncombustible roofs and exterior walls. Many buildings had stucco walls and a few had asbestos, cement, or aluminum siding, but very few combined these materials with tile or asbestos shingle roofs. In areas where the fire attacked both walls and roofs, the majority of the buildings had roofs of tar and gravel, composition shingles, or cedar shakes. The few buildings with noncombustible exteriors were conspicuous for their survival.

THE MALIBU FIRE

In Malibu Canyon, the fire traveled several miles down the canyon, finally dying out at the beach. Beach houses, sandwiched among Malibu Road, Alternate Highway 101, and the ocean would apparently be quite safe from a fire traveling through the wildland areas to the east and north. The fuel break here was a 60 foot wide highway, flanked on the uphill side by a cut bank reaching up 10 to 20 feet above the level of the road.

The bank was devoid of vegetation and thus offered what appeared to be an excellent fuel break. Above the cut, houses were sparse, but the vacant lots contained dry grass and small clumps of weeds and brush.

The beach houses were of conventional construction, frequently with patios extending from the front of the house to the beach. Many of these houses were set on pilings. High wooden fences and garage fronts provided a solid barrier to shield the house from traffic along the highway. These fences were about 6 to 12 feet from the edge of the road and were often no more than 15 feet from the wall of the house.

Landscaping on the road side of the fence usually consisted of a few small shrubs, rock-covered borders, and specimen shrubs such as tall Yew and Juniper bushes. Because space is at a premium, front yards were narrow, so that the front walls of the houses came close to the fence. Wall materials were cedar shakes, asbestos siding, stucco, and concrete blocks. Building separation ran 25 to 36 feet, and most of the front and rear sides of the houses were composed of windows.

When the fire arrived at the top of the cut bank, it promptly jumped the highway, igniting several houses on the ocean side. Upwind at this point there were no structures that could have furnished firebrands sufficient to cause ignition, but burning grasses and low shrubs provided the kind of fuel necessary for brand formation. As soon as one house was ignited, fire spread to the neighboring house and did not stop until it literally ran out of fuel.

Some distance inland in Malibu Canyon is the Sierra Retreat, which provided a unique combination of fuels on both sides of the interface. Since the buildings were Spanish style with stucco exterior walls and tile roofs, they were relatively immune to fire from the outside. Once the palatial manor house of Rancho Malibu, the original 40 room structure had been expanded with additional wings of stucco and tile. Located 225 feet above sea level and nearly a mile from the ocean, the Franciscan-run retreat sits on top of a hill that looks like an island in the middle of the canyon. This hill has a flat top of some 2.7 acres.

During the peak of the fire, which was burning in the wildland fuels around the base and up the hillside, the wind swirled around the hill with sufficient velocity to blow off his feet one man who remained at the retreat. This witness recovered and tied himself to a water tower to prevent a recurrence; he reported that he saw firebrands the size of small trees flying through the air. Such brands can easily break windows and, despite the noncombustible construction of the exterior wall, the buildings were ignited. About 90 minutes after the fire front passed the retreat, Father Cronin, two deputies, and another man returned and fought the fire for six hours to save the remaining buildings.

THE CHATSWORTH FIRE

The homes destroyed in the Chatsworth area of Los Angeles were in a new subdivision where the oldest house was less than five years old and there were no wildland fuels. It was separated from the nearest wildland fuel in Limekiln Canyon by an orange grove and a windbreak consisting of a single row of eucalyptus trees bordering the grove. All the houses in this subdivision had stucco exteriors and cedar shake roofs. Since all the trees and plantings were young, the yards appeared quite open. This open feeling was enhanced by generous setbacks and wide streets. Building separation ran 30 to 50 feet, and the swimming pools and cement patios in the back yards provided added fuel breaks. Tall adobe brick fences separated the houses, thus completing a well-planned firebreak to stop flames that might be blown along the ground.

In this area the interface between the wildland and the urban fuels is an orange grove, but spot fires set by firebrands carried the fire into the groves. Well watered orange trees are very fire resistant, but the dry leaves and grass on the ground carried the fire to the tree trunks, many of which were damaged. However, the real culprit was the single row of eucalyptus trees whose bark provided an excellent source of firebrands. These brands were easily carried across the wide streets and spacious front lawns and fell on the cedar shake roofs. Residents described the fire in the eucalyptus windbreak as sounding almost like a string of firecrackers going off, and then flaming debris from these trees literally rained down on the roofs of the houses.

At this time, no firemen were available to assist the homeowners whose roofs were soon blazing. As soon as the roof of the first house was ablaze, its shingles then supplied fuel for the firebrands for other houses. There appears to be little difference between eucalyptus bark and leaves and cedar shingles as a good source of firebrands. This fire was a classical example of fire spread by firebrands falling on combustible roofs. Evidence both from residents and inspections of the path of the fire support the conclusion indicates the firebrands were the only spread mechanism.

Many houses were saved by the occupants with the courage and strength to remain on the roofs with garden hoses, wetting down the shingles and extinguishing the firebrands as soon as they landed. The evidence of the firebrand origin and size was clear in this area because many of the firebrands landed in the swimming pools, all of which were full of water, and were immediately extinguished and were floating on the surface several days later.

CONCLUSIONS

No single agency or group of people can be held responsible for the unresolved problem of the urban/wildland fuel interface. It is too easy to suggest that this is a community problem, because the interface is barely recognized, even by the people who write environmental impact studies. There is no apparent slowing down of economic pressures that push developers to build in wildland areas where cyclic fires are an inherent part of the ecology. As Wilson[6] says, "From all that has happened, it is clear that the commingling of urban and rural fires is a national problem. And the potential for disaster is growing faster than our ability to cope with it."

In terms of saving houses from fire, the individual can be very effective, particularly if he starts soon enough. In the ideal case, fire prevention should commence with the selection of a building site. The location of the nearest fire department, the accessibility of roads leading to the site and their widths, the size of water mains, and the source of water supply should all be examined. The most valuable source of facts about the behavior of fire in a locality is the local fire department, which has a wealth of information that is always available to any resident or visitor.

Fire prevention should also be discussed with the architect and builder during the planning stage. Unfortunately, building codes offer little assistance in many of the areas discussed here, but the onwer should press the architect and builder to ensure that they do the best they can to minimize the spread of fire from flying brands, flames, or thermal radiation from nearby structures. There are no secrets about which exterior building materials are inflammable and which are fire resistant. If one is in doubt about the reality of the matters discussed here, a simple test would be to pull up a bunch of dry grass and test its flammability with a match. Flames will race through it just as they do in an uncontrolled fire in hills and valleys.

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[6] Carl C. Wilson, "Commingling of Urban and Forest Fires."

Every person whose home is exposed to a wildland environment and hence must depend on the interface to protect himself and his possessions, has an obligation to study the penalties of ignorance. At the very least, he should make the effort to speak with a fireman, ask his opinion on fire prevention measures, listen with care, and apply his suggestions.

With just a little knowledge and some modest efforts, there is no reason why residents who live with a fire interface cannot duplicate the efforts of the early settlers who crossed the plains when the grass was tall and dry.