The Community Protection Zone: Defending Houses and Communities from the Threat of Forest Fire

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Summary

The protection of houses and communities from the threat of forest fire depends upon the proper treatment of the wildland-urban interface (WUI), the area directly adjacent to houses and communities. The protection of the house depends entirely on treatment of the home ignition zone—the house itself and the area within 60 meters (200 feet) of the house. This is necessary to protect the house from the various forms of ignition present during forest fires, regardless of what treatments are implemented in the adjacent forest. In addition, an overlapping community protection zone can provide opportunities for firefighters to protect other flammable features of a community. The largest community protection zone required under maximal conditions is less than 500 meters (1640 feet) wide. However, most communities require treatment extending less than 400 meters (1312 feet) from the house.

Introduction

Current efforts to protect communities from the threat of forest fire are being planned without consideration for what is actually effective at protecting houses and communities from forest fires. Considering the current risks and the limited resources available for the implementation of fuels reduction projects, individual projects and strategic plans need to utilize the best available science to develop the most effective and efficient methods for protecting houses and communities. At the same time, the focused treatment of the WUI is necessary in order to avoid inadvertently damaging adjacent forest ecosystems and wildlife habitat with poorly planned and ineffective projects. This paper includes an extensive review of all the available scientific literature in an effort to determine what is actually necessary and effective at protecting houses and communities from the threat of forest fire. WUI treatments that provide effective protection from forest fires can be implemented relatively quickly in and around the homesite (the house and its immediate surroundings), and with a minimum of impact on the wildland forest.

Protecting the House

Effective fire protection eliminates opportunities for ignition of the house: a structure that does not ignite does not burn, regardless of what occurs around it. Forest fires can ignite houses in three ways: 1) flames of the burning forest can provide enough radiant heat, without reaching the house directly, to ignite the surface of the house; 2) flames of the burning forest can reach the surface of the house through

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surrounding vegetation; and 3) firebrands (burning embers from a fire) can be carried by wind to fall on or near the house. The first of these threats can be effectively treated by breaking up forest fuel continuity within a maximum of 60 meters of a house; the second requires removal of vegetation immediately adjacent to the house; and the third is addressed by treating the house itself.

In order for a forest fire to ignite a house without reaching it directly, the fire must provide sufficient radiant heat for long enough to raise the temperature of the surface of the house to its ignition point. Experimental studies and modeling have shown that partial removal of trees within 40 meters (132 feet) of the house protects it against radiant ignition from the flames of a forest fire that is torching and crowning (Cohen and Butler 1998, Cohen 2000a). These studies assumed severe conditions, and lesser distances may suffice. Another study (Davis 1990) found a precipitous drop in structural ignition with a distance of only 20 meters between the house and forest vegetation. Therefore, a treatment extending 60 meters (200 feet) from the house provides a margin of safety to account for particularly steep slopes or tall trees, and protects against scorching of exterior walls.

The number of trees that must be removed is a function of site-specific factors. The goal of the treatment is to break up any flame front sufficiently that radiant heat is not great enough to ignite the surface of the house over the duration of the exposure to the flame front. This does not require the removal of all vegetation within the home ignition zone. In fact, trees that are adequately spaced from the house and the surrounding forest can provide heat protection by blocking the radiating heat of the forest fire. Vegetation with the potential to produce smaller flames can safely be located relatively close to the house (Cohen and Butler 1998).

Even when the house is protected from the intense heat of the flame front, there is a serious threat of the house igniting from direct contact with flames from nearby shrubs, firewood, or even dried grass and needle litter. In fact, a large proportion of the houses that burn during forest fires do not ignite from intense crown fire, but from a relatively low-intensity surface fire (Cohen 2000b). Fire can burn grass and needle litter right up to the surface of the house, or ignite a tree, shrub, or structure (such as a deck or shed) near the house. A minimal break in the continuous surface fuels (such as a simple rake line around the perimeter of the house) can be effective in preventing direct ignition (Cohen 2000b). For this reason, homesite protection includes eliminating continuous ground fuels that lead from the forest to the house. This can be accomplished with rock landscaping, cement sidewalks, green grass, or by raking away needles and dried vegetation.

The most dispersed source of home ignition is firebrands, burning embers generated by the forest fire. Firebrands can be lifted high into the air and carried by wind to ignite fires miles ahead of the forest fire. They can be blown onto the roof of the house or into any exposed flammable area, causing fires that can ignite the house even if the forest fire is miles away. Therefore, firebrands are an extremely dangerous source of ignition on and adjacent to houses (Cohen and Saveland 1997). Even highly effective fire prevention or suppression miles from the homesite, cannot adequately protect houses from this threat of ignition. Similarly, WUI treatments that neglect to treat the houses will be dangerously ineffective at protecting houses and communities from firebrand ignitions.

Because of the threat of firebrand ignitions, reducing the flammability of the house itself is absolutely necessary, regardless of the vegetation treatment in the surrounding forest, and regardless of the distance between the house and the adjacent forest. These basic treatments are essential elements in any community protection plan. In general, treating the house against firebrands involves using fire-resistant materials in the building of the house and adjacent structures, especially roofs and wooden decks; covering or removing flammable materials from corners and nooks where firebrands can accumulate; and clearing roofs and gutters of dead branches, leaves and needles.[1]

[1] Three public agencies in the West provide information to homeowners on how to treat their house and property to protect them from the threat of forest fire. The National Wildland/Urban Interface Fire Program (Firewise) and the California Department of Forestry both recommend that homeowners remove hazardous fuels within 30 feet of the house. The Colorado Department of Forestry provides the following recommendations: remove all flammable vegetation from within 15 feet of the house, and create a defensible space of reduced fuels extending 75 to 125 feet from the house. The treatments described here surpass all of these, and include recommendations by the US Forest Service Fire Sciences Laboratory (Firelab).

Community Protection Zone

Additional thinning beyond the home ignition zone may enhance the ability of firefighters to safely defend community space. Creating an area of reduced fuels immediately adjacent to the community can provide options for firefighters to control fire in this space, and can provide a safety zone - and area where firefighters are "free from danger, risk, or injury"(Beighley 1995). This requires breaking up fuel continuity at greater distances from houses than necessary to protect the homes themselves, because injury to humans can occur with a fraction of the heat and time required to ignite wood (Cohen and Butler 1998).[2]

Experimental studies and modeling have shown that the width requirements of the firefighter safety zone are related to the average sustained flame length of the forest fire flame front at the edge of the safety zone (Butler and Cohen 1998). The sustained flame length is significantly different from the maximum observed flame length, which includes tall flame bursts that do not produce heat of the same magnitude as sustained flames. The calculations in this paper approximate the maximum potential sustained flame length as twice (2X) the height of the average overstory tree at the site (not to be confused with the maximum tree height). These calculations use the maximum possible values for every variable so that the results far over-estimate the actual physical requirements for community protection zone. In effect, the calculations below incorporate a large safety factor by adopting a strong bias toward maximum values, including the range of high winds and steep slopes, whether or not such conditions are present or physically possible.

The great majority of WUI communities in the West are surrounded by trees between 10 and 50 meters (33 and 165 feet) tall. Using a 2X factor, the maximum sustained flame length for a tree 50 meters (165 feet) tall is 100 meters (330 feet). A calculation of four times (4X) the sustained flame length is used to determine the minimum distance required for a community protection zone to effectively act as a safety zone under these assumptions of maximum conditions (Butler and Cohen 1998). Using a 4X factor, a forest fire with a sustained flame length of 100 meters (330 feet) requires a community protection zone 400 meters (1312 feet, or approximately ¼ -mile) wide.

There are extremely few communities surrounded by forests that consist of trees with an average height greater than 50 meters (165 feet), and it is highly unlikely that trees of any height can produce sustained flame lengths greater than 100 meters (330 feet). However, the maximum possible treatment to create a community protection zone was determined by assuming an average overstory tree height of 60 meters (200 feet). A community protection zone in such a forest could conceivably require a treatment 480 meters (1600 feet) wide.

It is important to note that creation of community protection zone does not require the removal of all trees within the area. It involves thinning the forest to create breaks in the continuity of tree crowns, and removing ladder fuels and small-diameter understory trees. Of course, the community protection zone treatment is dependent on the site conditions, such as forest type, average tree height, and slope. Rules of thumb recommend reducing crown cover to less than 35%, with a minimum of 10 feet of open space between crowns; pruning branches up to 10 feet high; and removing small-diameter understory trees or spacing them the same as the overstory trees (Anderson and Brown 1988, Schmidt and Wakimoto 1988). It is important to retain trees, particularly large, fire-resistant trees, in the community protection zone, because trees suppress the growth of highly flammable brush, limiting the amount of vegetative maintenance needed, as well as reducing wind speeds, and blocking heat from the forest fire.

A properly implemented community protection zone treatment can reduce the area required for the home ignition zone treatment described in the previous section. The distance requirement for the home ignition zone treatment is based on the assumption of a continuous, uninterrupted flame front. However, the community protection zone treatment breaks up the forest fuels facing the house, decreasing the ability of the flame front to provide enough heat to ignite the house. Nonetheless, the community protection zone is not a replacement for treatment in the home ignition zone. Treatment of the home ignition zone is an integral and critical component of an effective community protection zone. That is, the

[2] The calculations are based on a burn injury limit of 7 kW/m^2 (Braun et al.1980, Butler and Cohen 1998; 2000). Human burn injury limit is the amount of heat required to injure a firefighter not using a personal fire shelter, over the duration of a flame front during a forest fire.

community protection zone will not be effective without implementing the homesite treatment.

Firefighting Strategy

It is important to note that the strategy proposed in this paper differs from the strategy proposed by Cohen (2002). Cohen recommends that the house and the immediate surroundings be properly treated before a forest fire occurs, and immediately following a forest fire, firefighters and homeowners can focus on extinguishing fires ignited by firebrands and other small fires as they occur. If necessary, the firefighters can move to a safe stand-by location as the fire front passes, and then return to the houses immediately afterward to suppress any subsequent fires.

The strategy proposed in this paper includes the assumption that some communities will choose to place firefighters along the boundaries of the community, regardless of the fact that such action may not increase the survival of houses. However, the strategy proposed in this paper does not preclude the opportunity for firefighters to remove to a safe stand-by location. Consequently, firefighter safety also requires that homeowners appropriately treat their houses and properties. Even though the flames from a burning house may not be nearly as high as those produced in a forest fires, a house will burn much longer than the duration a forest fire burns in one location, and a burning house can create a serious threat of ignition to a neighboring house (Cohen and Butler 1998). Because firefighters should not be caught between a burning forest and a burning house, fire management agencies should perform assessments of all individual houses before determining that a neighborhood is a safe and appropriate area in which to work during a fire.

Beyond the Community Protection Zone

Vegetation management beyond the structure's immediate vicinity has little effect on house ignitions (Cohen and Saveland 1997). Cohen (1999) stated, "*The evidence suggests that wildland fuel reduction for reducing home losses may be inefficient and ineffective. Inefficient because wildland fuel reduction for several hundred meters or more around homes is greater than necessary for reducing ignitions from flames. Ineffective because it does not sufficiently reduce firebrand ignitions.*" In short, a properly implemented homesite treatment provides complete protection for the house; a fireline in the community protection zone can provide additional protection against encroaching ground fires that can ignite houses if the home ignition zone treatment is not properly implemented; and treating the forest beyond the community protection zone provides no additional protection for houses or communities. Certainly, there are reasons to treat the forests outside the WUI, but such forest restoration projects should be based entirely on ecological objectives, which may include forest health improvement and fire risk reduction.

Maintaining the WUI

The more tree thinning is used to treat the WUI, the greater the need for near-term precautions against fire hazard and for long-term maintenance. Thinning greatly increases the immediate fire hazard because it creates a large amount of highly flammable slash and debris, and the open forest structure produces conditions in which there are drier and warmer surface fuels, and higher wind speeds. This increased fire hazard must be mitigated as soon as possible following the thinning operation. This can only be accomplished by reducing surface fuels and debris, and the most efficient and effective methods may be prescribed burning, or chipping followed by removal of the remaining fuel. Some sites may require an initial pile burn followed by a broadcast burn. In other cases, it may be necessary to utilize an incremental approach, in which a series of prescribed burns is used to remove fuels.

Subsequent prescribed broadcast burns may also be the most efficient and effective for maintaining the WUI treatment over time. Such burning would maintain lower fuel loads within the forest, as well as reduce the growth of highly flammable shrubs and understory trees. Regular (possibly annual) maintenance is critical for maintaining the community protection zone.

Prioritization

The US Departments of Agriculture and Interior defined the interface community as having a population density of 250 or more people per square mile, and the intermix community as having 28-250 people per square mile (USDA/USDI 2001). While this should certainly not be taken as any hard definition, it does serve as a guideline for the prioritization of projects. The WUI communities can be categorized as interface (neighborhoods extending into the forest), intermix (groups of houses within the

forest), and individual properties (isolated inholdings) within the forest, and can be prioritized in this order by relative risk to lives and property, and by relative amount of protection gained from each project.

Interface communities contain the greatest number of houses and people per square mile. Furthermore, because of the relatively dense development and extensive road systems in interface communities, WUI projects involve a relatively small area per house and are relatively easy to implement. Therefore, WUI projects for interface communities can provide the greatest protection for the greatest resources (houses and people) with the smallest amount of time and effort, and should be prioritized for extensive projects. This is not to say that all WUI communities and houses should not be protected from the threat of forest fire. Certainly, homesite treatments should be implemented as soon as possible on all WUI communities and houses. This would provide immediate and complete protection for the houses until the site can be assessed for the implementation of a community protection zone treatment.

Conclusion

A focused treatment of the wildland-urban interface can provide houses and communities with real and effective protection from the threat of forest fire. Treatment of the home ignition zone—the house itself and the surrounding area up to 60 meters from the house—provides the house direct protection to from the various ignition sources of a forest fire. The treatment of the homesite alone can effectively protect the house from the threat of forest fire, regardless of what other treatments are implemented in the WUI. Creation of a community protection zone can provide an additional safety zone where firefighters can safely defend flammable features of a community other than the buildings alone. This community protection zone does not require the removal of all trees, and entails treatment for less than 500 meters from the house.

The highest priority should be given to WUI projects that protect interface communities (neighborhoods extending into the forest). Such projects can provide the greatest protection for the greatest resources (houses and people) with the smallest amount of time and effort.

Citations

The U.S. Forest Service Intermountain Fire Sciences Laboratory, based in Missoula, Montana, is responsible for much of the most recent research regarding the physical effects of forest fires on houses and structures. Many publications by the Fire Lab staff can be read or downloaded on the website www.firelab.org.

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