Fire Urban Forestry

Preventing DISASTER

Home Ignitability in the Wildland–Urban Interface

Wildland-urban interface (W-UI) fires are a significant concern for federal, state, and local land management and fire agencies. Research using modeling, experiments, and W-UI case studies indicates that home ignitability during wildland fires depends on the characteristics of the home and its immediate surroundings. These findings have implications for hazard assessment and risk mapping, effective mitigations, and identification of appropriate responsibility for reducing the potential far home lass caused by W-UI fires,

By Jack D. Cohen

Once largely considered a California problem, residential fire losses associated with wildland fires gained national attention in 1985 when 1,400 homes were destroyed nationwide (Laughlin and Page 1987). The wildland fire threat to homes is increasing and is commonly referred to as the wildland—urban interface (W-UI) fire problem. Since 1990, W-UI fires have threatened and destroyed homes in Alaska, Arizona, California, Colorado, Florida, Michigan, New Mexico, New York, and Washington. Extensive or severe fires in Yellowstone in 1988, Oakland in 1991, and Florida in 1998 attracted much media coverage and focused national attention on wildland fire threats to people and property

Federal, state, and local land management and fire agencies must directly and indirectly protect homes from wildfire within and adjacent to wildlands. Davis (1990) indicated that since the mid-1940s, a major population increase has occurred in or adjacent to forests and woodland areas. Increasing residential presence near fire-prone wildlands has prompted agencies to take actions to reduce W-UI fire losses.

When an apparently all-encompassing, seemingly unstoppable W-UI fire occurs, the rapid involvement of many homes over a wide area produces a surreal impression; some homes survive amid the complete destruction of surrounding residences. After the 1993 Laguna Hills fire, some termed this seemingly inexplicable juxtaposition a “miracle.’ Miracles aside, the characteristics of the surviving home and its immediate surroundings greatly influenced its survival.

Wildland fire and home ignition research indicates that a home’s exterior and site characteristics significantly influence its ignitability and thus its chances for survival. Considering home and site characteristics when designing, building, siting, and maintaining a home can reduce W-UI fire losses.

W-UI Fire Loss Characteristics

W-UI residential fire losses differ from typical residential fire losses. Whereas residential fires usually involve one structure with a partial loss, W-UI fires can result in hundreds of totally destroyed homes. Particularly during severe W-UI fires, numerous

overestimate the heat transfer because the severe-case assumptions designate a homogeneous, black-body radiating flame front. Real flame fronts do not meet these assumptions and produce a significantly smaller radiant heat flux by comparison. For a given flame front, the SIAM calculations represent an extreme-case estimate of radiant heat transfer, and thus an extreme-case estimate of ignition potential.

Given the duration of the experimental heat flux (65 seconds), we can calculate the heat flux and corresponding distance required for ignition. At 65 seconds, the ignition time graph (*fig. 2)* indicates ignition at a flame distance of less than 30 meters. If the heat flux duration is extended by a factor of five to 325 seconds, the flame distance for ignition is less than 40 meters. By comparison, the 10-meter wall sections in the crown fire experiment did not ignite without flame contact and all burns produced little or no scorch to wall sections at 20 and 30 meters. The W-UI fire case studies indicated approximately 90 percent survival with a vegetation clearance on the order of 10 to 20 meters for homes with nonflammable roofs. Thus, the case studies support the general flame-to-structure distance range of 10 to 40 meters as found through modeling and experiments.

However, firebrands can also cause homes to ignite during wildland fires. Although firebrands capable of ignition can originate from a fire several kilometers away, homes can only be threatened if the firebrands ignite the home directly or ignite adjacent flammable materials that then ignite the home.

Analyses of potential home ignitions using modeling, experiments, and case studies did not explicitly address firebrand ignitions. However, firebrand ignitions were implicitly considered because of the firebrand exposures that occurred during the crown fire experiments and the case studies. The experimental crown fires provided a firebrand exposure that resulted in spot ignitions in the dead wood and duff around the wall sections hut not directly on the walls. In the case studies, firebrand ignitions occurred throughout the areas affected by the Bel Air and Painted Cave fires. The high survival rate for homes with nonflammable roofs and 10- to 20-meter vegetation clearances included fire-brands as an ignition factor, thus indicating that firebrand ignitions also depend on the ignition characteristics of the home and the adjacent flammable materials.

Conclusions

The key to reducing W-UI home fire losses is to reduce home ignitability. SIAM modeling, crown fire experiments, and case studies indicate that a home's structural characteristics and its immediate surroundings determine a home's ignition potential in a W-UI fire. Using the model results as guidance with the concurrence of experiments and case studies, we can conclude that home ignitions are nor likely unless flames and firebrand ignitions occur within 40 meters of the structure. This finding indicates that the spatial scale determining home ignitions corresponds more to specific home and community sites than to the landscape scales of wildland fire management. Thus, the W-UI fire loss problem primarily depends on the home and its immediate site.

Consequently if the community or borne site is not considered in reducing W-UI fire losses, extensive wildland fuel reduction will be required. For highly ignitable homes, effective wildland fire actions must riot only prevent fires from burning to home sites, but also eliminate firebrands that would ignite the home and adjacent flammable materials. To eliminate firebrands, wildland fuel reductions would have to prevent firebrand production from wildland fires for a distance of several kilometers away from homes.

Management Implications

Because home ignitability is limited to a home and its immediate surroundings, fire managers can separate the W-UI structure fire loss problem from other landscape-scale fire management issues. The home and its surrounding 40 meters determine home ignitability, home ignitions depend on home ignitability, and fire losses depend on home ignitions. Thus, the W-UI fire loss problem can be defined as a home ignitability issue largely independent of wildland fuel management issues. This conclusion has significant implications for the actions and responsibilities of homeowners and fire agencies, such as defining and locating potential W-UI fire problems (for example, hazard assessment and mapping), identifying appropriate mitigating actions, and determining who must take responsibility for home ignitability

W-UI fire loss potential. Because home ignitions depend on home ignitability, the behavior of wildland fires beyond the home or community site does not necessarily correspond to W-UI home fire loss potential. Homes with low ignitability can survive high-intensity wildland fires, whereas highly ignitable homes can be destroyed during lower-intensity fires.

This conclusion has implications for identifying and mapping W-UI fire problem areas. Applying the term wildland-urban interface to fire losses might suggest that residential fire threat occurs according to a geographic location. In fact, the wildland fire threat to homes is not a function of *where* it happens related to wildlands, but rather to *how* it happens in terms of home ignitability. Therefore, to reliably map the potential for home losses during wildland fires, home ignitability must be the principal mapping characteristic. The home threat information must correspond to the home ignitability spatial scale, that is, those characteristics of a home and its adjacent she within 40 meters.

Home fire loss mitigation. W-UI home losses can be reduced by focusing efforts on homes and their immediate surroundings. At higher densities where neighboring homes may occupy the immediate surroundings, loss reductions may necessarily involve a community. If homes have a sufficiently low home ignitability, a community exposed to a severe wildfire can survive without major fire destruction. Thus, there is a need to examine the reduction of wildland fuel hazard for the specific objective of home protection. There are various land management reasons for conducting wildland vegetation management. However, when considering the use of wildland fuel

hazard reduction specifically for protecting homes, an analysis specific to home ignitability should determine the treatment effectiveness.

Responsibility for home ignitability. If no wildfires or prescribed fires occurred, the wildland fire threat to residential development would not exist. However, our understanding of the fire ecology for most of North America indicates that fire exclusion is neither possible nor desirable. Therefore, homeowners who live in and adjacent to the wildland fire environment most take primary responsibility for ensuring that their homes have sufficiently low home ignitability. Homes should not be considered simply as potential victims of wildland fire, but also as potential participants in the continuation of the fire at their location.

A change needs to take place in the relationship between homeowners and the fire services. Instead of home-related presuppression and fire protection responsibilities residing solely with fire agencies, homeowners must take the principal responsibility for ensuring adequately low home ignitability.

The fire services should become a community partner providing homeowners with technical assistance as well as fire response in a strategy of assisted and managed community self-sufficiency (Cohen and Saveland 1997). For this approach to succeed, it must be shared and implemented equally by homeowners and the fire services.

Literature Cited

ALLXANDER, M.E., B.J. STOCKS, B.M. WOTTON, M.D. FLANNIGAN, J.B. TODD, B.W. BUTLER, and R.A. LANOV1LLE. 1998. The International Crown Fire Modelling Experiment: An overview and progress report. *In Proceedings of the Second Symposium on Fire and Forest Meteorology*, 20-23. Boston: American Meteorological Society.

COHEN, J.D. 1995. Structure ignition assessment model (SIAM). In *Proceedings of Biswell Symposium: Fire Issues and Solutions in Urban Interface and Wildland Ecosystems*, 85-92. General Technical Report PSW-158. Albany, CA: USDA Forest Service, Pacific Southwest Research Station.

COHEN, J.D., and B.W. BUTLER. In press. Modeling potential ignitions from flame radiation exposure with implications for wildland/urban interface fire management. In *Proceedings of the 13th Conference on Fire and Forest Meteorology*. Fairfield, WA: International Association of Wildland Fire.

COHEN, J., and J. SAVELAND. 1997. Structure ignition assessment can help reduce fire damages in the W-UI. *Fire Management Notes* 57(4):19-23.

DAVIS, J.B. 1990. The wildland-urban interface: Paradise or battleground? *Journal of Forestry* 88(1):26-31.

DRYSDALE, D. 1985. *An introduction to fire dynamics.* New York: John Wiley & Sons.

FOOTE, E.I.D. 1994. Structure survival on the 1990 Santa Barbara "Paint" fire: A retrospective study of urban-wildland interface fire hazard mitigation factors. MS thesis, University of California at Berkeley.

HOWARD, R.A., D.W. NORTH, F.L. OFFENSEND, and C.N. SMART. 1973. Decision analysis of fire protection strategy for the Santa Monica mountains: An initial assessment (on file). Menlo Park, CA: Stanford Research Institute.

LAUGHLIN, J., and C. PAGE, eds. 1987. *Wildfire strikes home! Report of the national wildland/urban fire protection conference.* NFPA SPP-86. Quincy, MA: National Fire Protection Association.

TRAN, H.C., J.D. COHEN, and R.A. CHASE. 1992. Modeling ignition of structures in wildland/urban interface fires. In *Proceedings of the First International Fire and Material Conference*, 253-62. London: Inter Science Communications Limited.

Jack D. Cohen (e-mail: jcohen/rmrs_missoula @fs.fed.us) is research physical scientist, USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laborator, PO Box 8089, Missoula, MT 59808.