Key Excerpts from The Latest Wildfire Science About Defensible Space

1. From ***A More Effective Approach for Preventing Wildland-Urban Fire Disasters*****,** by Jack Cohen, PhD; Research Physical Scientist; US Forest Service, retired
Full article is attached. **Jack Cohen is the "godfather" of all modern wildfire science.**

"...community wildfire risk is not directly determined by wildfire intensity and its location related to wildland. Burning embers, initially from the wildfire and then from burning structures within the community are a principal contributor to community fire spread. Thus, not having a flammable wood roof, removing flammable tree debris from the roof, in rain gutters, on decks, assuring nothing burns (flaming or smoldering) within 5 feet (1.5 m) of flammable walls and attachments, and vents covered with 1/8 inch (3 mm) mesh screen can significantly increase home ignition resistance. Reducing home exposure from flame radiation and convection may require reduced vegetation and trimming but not the necessary removal of most vegetation and large trees within the HIZ (as noted in Fig. 1). As indicated by the typical patterns of WU fire destruction, shrub and tree canopies are not spreading high intensity fires through communities."

2. From ***Cascadia Burning: The historic, but not historically unprecedented, 2020 wildfires in the Pacific Northwest, USA*****,** by Matthew J Reilly, Aaron Zuspan, Joshua S. Halofsky, et al., published in *Ecosphere, Volume 13, Issue 6, June 2022*.
Matthew Reilly and Aaron Zuspan are wildfire scientists at USDA Forest Service, Pacific Northwest Research Station, Western Wildland Environmental Threat Assessment Center, Corvallis, Oregon. Joshua Halofsky is a lead wildfire researcher at Washington State Department of Natural Resources, Olympia, Washington, USA and also teaches at the School of Environmental and Forest Sciences, University of Washington, Seattle.
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Our findings reinforce that the Labor Day fires were fundamentally a weather-driven event (Abatzoglou et al., 2021; Mass et al., 2021). The influence of forest management on fire severity was minimal and variation in forest structure or fuels played relatively little role. These results provide little evidence to support the use of fuel treatments to mitigate fire severity under extreme fire weather conditions on the westside. Hazardous fuel reduction, a prominent wildfire risk reduction strategy in dry forests of the western United States (Stephens et al., 2021), can mitigate fire effects and tree mortality in dry forests during low and moderate fire weather conditions, and even in some topographic positions during extreme conditions (Prichard et al., 2020; Prichard & Kennedy, 2014). However, our results suggest that manipulation of stand structure is unlikely to mitigate fire effects in wind-driven fires on the westside given the minimal differences in burn severity among stand structure classes.

3. From ***Wildland-Urban Fire Disasters are a Home Ignition Problem***, by Jack Cohen, PhD; Research Physical Scientist; US Forest Service, retired
Full article is attached. **Jack Cohen is the "godfather" of all modern wildfire science.**

Community wildfire risk analysis indicates structure ignition resistance, and collectively the community, as the most effective approach for preventing WU fire disasters (Finney and Cohen 2003; Calkin et al. 2014). ... Given the inevitability of extreme wildfires, a reactionary wildfire suppression and control approach fails and cannot reliably reduce community wildfire risk. ... Reducing structure ignition potential remains the principal factor for reducing community wildfire risk; thus, WU fire disasters must be defined and approached as a home-structure ignition problem, not as a problem of wildfire control.

A More Effective Approach for Preventing Wildland-Urban Fire Disasters

Jack Cohen, PhD; Research Physical Scientist; US Forest Service, retired

Introduction

Inevitable extreme wildfire conditions do not have to result in disastrous community fire destruction. Local conditions, the characteristics of a home and its immediate surroundings within 100 feet (30 meters) principally determine home-structure ignitions. This area, called the *home ignition zone* (HIZ), effectively defines wildland-urban (WU) fires as a structure ignition problem and not a problem of controlling wildfires. Alternatively, readily reducing structure ignitability within the HIZ and collectively communities, property owners can prevent WU fire disasters without depending on wildfire suppression that fails during extreme wildfire conditions.

Inevitable Wildfires and Extreme Burning Conditions

Wildfire suppression has successfully controlled 95 to 98 percent wildfires with initial attack for over one-hundred years (Stephens and Ruth 2005). Paradoxically, the high degree of successful fire suppression has ensured the inevitability and increased likelihood of uncontrollable, extreme wildfires (Arno and Allison-Bunnell 2002; Williams 2013). Importantly, WU fire disasters have only occurred during these extreme wildfire conditions when fire control fails (Cohen 2010; Calkin et al. 2014). Without seriously questioning this failure, Federal, state and local fire agencies continue wildfire suppression, along with pre-suppression fuel breaks and shrub and forest fuel treatments, as the principal approach for protecting communities (Finney and Cohen 2003; Cohen 2010; Calkin et al. 2014).

Community fire destruction will continue as long as wildfire suppression is the primary approach. The inevitability of uncontrolled extreme wildfires suggests inevitable disastrous home destruction; however, available science indicates practical opportunities for effectively creating ignition resistant homes and thereby preventing community fire disasters without necessarily controlling wildfires (Cohen 2000a; Cohen 2001; Cohen 2004; Cohen and Stratton 2008; Cohen 2010; Calkin et al. 2014; Cohen 2017; Cohen and Westhaver 2022). Readily observable patterns of unconsumed tree canopies and other vegetation surrounding totally destroyed homes indicates high intensity wildfire flames did not spread through communities.

Patterns of Home Destruction during Wildfires

Unconsumed vegetation post-fire, often remaining green, adjacent to and surrounding home destruction is the typical WU fire pattern associated with extreme wildfire conditions (Cohen 2000b; Cohen and Stratton 2003; Cohen 2003; Cohen and Stratton 2008; Graham et al. 2012; Cohen 2017; Cohen and Westhaver 2022). The three photos (Figure 1) of home destruction with adjacent unconsumed shrub and tree vegetation indicate the following:

- ***High intensity wildfire did not continuously spread through the residential area as a wave or flood of flame.***
- ***Unconsumed shrub and tree canopies adjacent to homes did not produce high intensity flames that ignited the homes.***
- ***Homes could have only ignited from lofted burning embers on the home, low intensity surface fire spreading to contact the home, and in high density development, structure-to-structure fire spread.***
- ***The 'big flames' of high intensity wildfires did not cause total home destruction.***

Paradise, CA; 2018 Camp Fire **Southwest CO; 2002 Missionary Ridge Fire** **S Cal; 2007 Grass Valley Fire**

Figure 1.

High intensity wildfires do not spread through communities that experience disastrous fire destruction. A community's streets, driveways, parking areas, building sites, etc. create gaps in the continuous tree and shrub canopies required to maintain high intensity wildfire spread (crown fires) (Cohen 2010). Figure 2 shows a crown fire that spread to but could not continue beyond the first residential street. Although the crown fire terminated at the street, burning embers showered downwind resulting in several blocks of total home destruction (Cohen 2010). Extreme wildfire conditions initiate ignitions within residential areas but the residential fuels, structures and vegetation, continue the residential burning resulting in total home destruction. The community fire spread continues hours after the wildfire ceases influence to the community (Cohen and Stratton 2008; Cohen 2010; Cohen and Westhaver 2022).

The typical WU fire patterns indicate that conditions local to a structure principally determine structure ignitions with burning embers the principal source of ignitions. The totally destroyed home in Figure 3 indicates burning embers as the only possible ignition source igniting the home directly, and from igniting flammable materials immediately adjacent to the home. Burning embers should be expected during extreme WU fire conditions; however, regardless of the distance burning embers travel, burning ember ignitions depend on the local conditions of the ignitable materials on and adjacent to a home.

Figure 2.

Figure 3.

An Effective Approach for Preventing WU Fire Disasters

Extensive research has identified local ignition conditions that determine home ignitions during extreme wildfire conditions (Cohen 2000a; Cohen 2000b; Cohen and Stratton 2003; Cohen 2003; Finney and Cohen 2003; Cohen and Stratton 2008; Graham et al. 2012; Cohen 2017; Cohen and Westhaver 2022). The "local ignition conditions" area has been quantified as a home's ignition characteristics in relation to burning materials in its immediate surroundings within 100 feet (30 meters) and burning embers for all sources (Cohen 1995; Cohen 2000a; Cohen 2004). This area is called the ***home ignition zone*** (HIZ; Cohen 2010; NFPA 2018). An ignition resistant HIZ is not necessarily a unique, specified home ("hardening") and surrounding area ("defensible space") coded list of factors. An ignition resistant HIZ is how a home performs in resisting ignitions related to burning materials within the HIZ and burning embers from all sources. For example, a home with a flammable wood roof can readily ignite during extreme wildfire conditions having no flammable materials within its HIZ. Or, an earth-berm house can be ignition resistant having intensely burning materials within its HIZ.

The relatively small area of the HIZ principally determines home ignitions during extreme wildfires and defines WU fire destruction as a *home ignition problem* that can be prevented by readily addressing home ignition vulnerabilities within the HIZ without necessarily controlling wildfires. Thus, community wildfire risk is not directly determined by wildfire intensity and its location related to wildland. Burning embers, initially from the wildfire and then from burning structures within the community are a principal contributor to community fire spread. Thus, not having a flammable wood roof, removing flammable tree debris from the roof, in rain gutters, on decks, assuring nothing burns (flaming or smoldering) within 5 feet (1.5 m) of flammable walls and attachments, and vents covered with 1/8 inch (3 mm) mesh screen can significantly increase home ignition resistance. Reducing home exposure from flame radiation and convection may require reduced vegetation and trimming but not the necessary removal of most vegetation and large trees within the HIZ (as noted in Fig. 1). As indicated by the typical patterns of WU fire destruction, shrub and tree canopies are not spreading high intensity fires through communities.

The inevitability of uncontrolled extreme wildfires spreading to communities does not mean WU fire disasters are inevitable. We can effectively prevent WU fire disasters by reducing home ignitability and collectively, the community. Ignition resistant communities will increase community fire protection effectiveness, life-safety options for residents and firefighters, and can decrease wildfire suppression costs by not ineffectively attempting control of extreme wildfires to prevent WU fire disasters. For more information on creating ignition resistant homes visit www.firewise.org (NFPA 2018).

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Wildland-Urban Fire Disasters are a Home Ignition Problem
Jack Cohen, PhD

A trend of increasing community destruction during wildfires is apparent. The United States (US) provides a prime example. In 1985, 1400 homes and structures burned during wildfires. This motivated the establishment of the US national "Wildland-Urban Interface (WUI) Initiative," a collaboration of Federal and state agencies directed by the National Fire Protection Association, a US private organization (Laughlin and Page 1987). Approximately 9000 homes burned during US wildfires from 1985 to 1994, the first decade of the WUI Initiative. The recent decade from 2012 to 2021 had over 45,000 US homes burn during wildfires. The US policy and funding response has predominantly focused on increasing firefighting capacity and fuel treatment to increase wildfire suppression effectiveness. However, community fire destruction will continue as long as reactive wildfire suppression is the primary approach.

Disastrous community destruction (100 homes and greater) has only occurred during extreme wildfire conditions when initial attack fails and control is not possible (Cohen 2010; Calkin et al. 2014). The inevitability of extreme wildfires, exacerbated by increasingly frequent, persistent hot-dry weather due to climate change, suggests inevitable disastrous home destruction. However, readily observable patterns of unconsumed tree canopies and other vegetation surrounding totally destroyed homes indicate high intensity wildfires did not spread through communities. Research results indicate practical opportunities for effectively creating ignition resistant homes and thereby preventing community fire disasters without necessarily controlling wildfires (Cohen 2000a; Cohen 2001; Cohen 2004; Cohen and Stratton 2008; Cohen 2010; Calkin et al. 2014; Cohen 2017; Cohen and Westhaver 2022).

Patterns of Home Destruction during Extreme Wildfires
Wildland-urban fire disaster examinations reveal the typical post-fire pattern is unconsumed vegetation, often remaining green, adjacent to and surrounding total home destruction during extreme wildfires (Cohen 2000b; Cohen and Stratton 2003a; Cohen 2003b; Cohen and Stratton 2008; Graham et al. 2012; Cohen 2017; Cohen and Westhaver 2022). Typical WU fire pattern, exemplified in Figure 1, indicate the following:

Figure 1. Patterns of destruction

a) b) c)

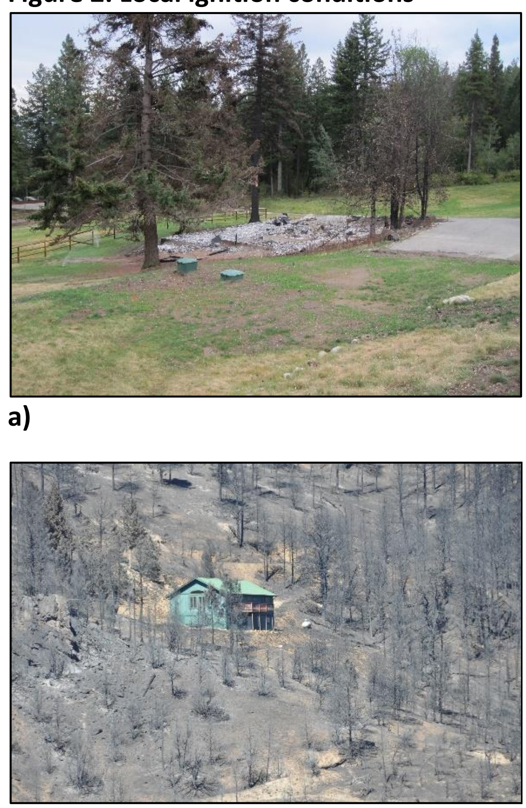
- **High intensity wildfires typically do not continuously spread through residential areas as a wave or flood of flame (fig. 1a).**
- **Unconsumed shrub and tree canopies adjacent to homes do not produce high intensity flames that ignite homes (fig. 1a,b).**
- **Homes typically ignite from lofted burning embers on the home, low intensity surface fire spreading to contact the home, or in high density development, structure-to-structure fire spread (fig. 1a,b,c).**
- **The "big flames" of high intensity wildfires do not necessarily cause total home destruction (fig. 1a,b,c).**

Disaster examinations have determined that intense wildfire flame fronts do not continuously spread within communities having moderate to high structure density (for example, fig. 1a; density greater than 3 homes per hectare). A community's streets, utility corridors, driveways, parking areas, building sites, etc. create gaps in the continuous tree and shrub canopies that cease high intensity wildfire spread (Cohen 2010). Extreme wildfire conditions initiate ignitions within residential areas but burning structures and vegetation continue fire spread within the community. Burning structures become the principal source of burning embers and flames continuing community fire spread hours after significant wildfire activity ceases adjacent to the community (Cohen and Stratton 2008; Cohen 2010; Cohen and Westhaver 2022).

Local Conditions Determine Ignitions

The converging agreement of WU fire research from disaster examinations, modeling and laboratory and field experiments has found that local conditions principally determine structure ignitions during extreme wildfires. Research (Cohen 2000; Cohen 2004) has quantified local ignition conditions to include a home and its immediate surroundings within 30 meters. Within that area, ignition potential depends on the degree of structure ignition vulnerability related to its burning ember and flame exposure. This area has been called the home ignition zone – HIZ (Cohen 2001; Cohen 2010; Cohen and Westhaver 2022).

Figure 2. Local ignition conditions



a)

b)

The typical WU fire patterns indicate a structure's local conditions principally determine its ignitions. The unburned area surrounding the destroyed home in Figure 2a indicates lofted burning embers as the principal source of ignition directly on the home or from ignited materials immediately adjacent to the home, or both. Regardless of the lofted distance, burning ember ignitions depend on a structure's materials and design that make it vulnerable to ignition. This home's ignition vulnerability determined the high HIZ ignition potential.

Equally, local ignition conditions determine low ignition potential. The home in Figure 2b survived without controlling the extreme wildfire (Graham et al. 2012). The relatively small surrounding area that did not burn with high intensity wildfire did not produce sufficient radiant heating or flame contact to ignite the house, and the house was sufficiently resistant to sustained burning ember ignitions – an ignition resistant HIZ.

Effective Reduction of Community Wildfire Risk

Community wildfire risk analysis indicates structure ignition resistance, and collectively the community, as the most effective approach for preventing WU fire disasters (Finney and Cohen 2003; Calkin et al. 2014). Community ignitions leading to WU fire disasters have only occurred when wildfire control fails during extreme wildfire conditions in all fuel types: grass, shrubs and forests (Cohen 2010). These wildfires typically burn during high wind speeds and low relative humidity producing high spread rates and intensities that overwhelm control. These are the "target conditions" of community wildfire risk (Calkin et al. 2014). Given significant potential for an extreme wildfire exposure, community fire risk factors are wildfire control, home and structure ignition potential, and structure protection effectiveness. Reducing community wildfire risk depends on the degree (probability) of controlling wildfire to critically limit community ignition exposure, reducing structure ignition potential, and increasing community fire protection to prevent and extinguish sustained structure ignitions. Given the inevitability of extreme wildfires, a reactionary wildfire suppression and control approach fails and cannot reliably reduce community wildfire risk. During extreme wildfire conditions, an ignition vulnerable community can simultaneously ignite multiple structures thereby overwhelming community structure protection. Thus, structure fire protection cannot reduce community wildfire risk without sufficient structure ignition resistance. Reducing structure ignition potential remains the principal factor for reducing community wildfire risk; thus, WU fire disasters must be defined and approached as a home-structure ignition problem, not as a problem of wildfire control.

We can effectively and practically reduce community wildfire risk and prevent WU fire disasters by creating ignition resistant homes-structures and collectively, the community. In high density community development, increasing structure-to-structure fire spread resistance is additionally essential. Without necessarily controlling extreme wildfires, ignition and structure fire-spread resistant communities can increase community fire protection effectiveness, provide options for increasing resident and firefighter life-safety, and increase options for more effective management of inevitable wildfires.

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