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Wildfire, Wildlands, and People: Understanding and Preparing for Wildfire in the Wildland-Urban Interface

A Forests on the Edge Report

ABSTRACT

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Fire has historically played a fundamental ecological role in many of America's wildland areas. However, the rising number of homes in the wildland-urban interface (WUI), associated impacts on lives and property from wildfire, and escalating costs of wildfire management have led to an urgent need for communities to become "fire-adapted." We present maps of the conterminous United States that illustrate historical natural fire regimes, the wildland-urban interface, and the number and location of structures burned since 1999. We outline a sampler of actions, programs, and community planning and development options to help decrease the risks of and damages from wildfire.

Key Words: wildfire, community planning, fire-adapted, wildland-urban interface, defensible space

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US Fish and Wildlife Service Southeast Region

Brett Van Paepeghem

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INTRODUCTION

Wildfire! It's been the subject of legends; the source and sustenance of many of America's forests, shrub lands, grasslands, and other wildlands; and a central theme in forest management in the United States during the 20th century (Agee 1998). Fire plays a vital role in the maintenance of the health of many ecosystems (Hutto 2008, Pollet and Omi 2002), in part by promoting a mosaic of vegetation and by stimulating the establishment and growth of particular trees and other plants (Brown 2000); indeed, many wildland species, such as the lodgepole pine found in the West, require fire to regenerate (Brown and Smith 2000). However, wildfire can also be the cause of economic and ecological losses and can pose threats to people, property, and communities.

As more and more people live in and around forests, grasslands, shrub lands, and other natural areas—places referred to the wildland-urban interface, or WUI—the fire-related challenges of managing wildlands are on the increase (Hammer and others 2009, NASF 2009). The number of wildfires exceeding 50,000 acres has increased over the past 30 years, with most of that change occurring over the past 10 years (NASF 2009); many of these large wildfires are more intense than they were in the past[1] (Hardy and others 2001, Schmidt and others 2002). As more people live or work in the WUI, fire management becomes more complex. In addition, the costs to reduce fire risk, fight wildfires, and protect homes and human lives have risen sharply in recent decades (Abt and others 2009, NASF 2009). Climate change, insect pests, and diseases, among other influences, are also contributing to vast changes in wildland vegetation that in many areas result in landscapes that are drier, less resilient, and more likely to burn once ignited (Keane and others 2008a, 2008b).

Some 32 percent of U.S. housing units[2] and one-tenth of all land with housing are situated in the wildland-urban interface (Radeloff and others 2005), and WUI growth is expected to continue (Hammer and others 2009). While the degree of risk may vary from one place to another, given the right conditions, wildfire can affect people and their homes in almost any location where wildland vegetation is found[3]. Even structures not immediately adjacent to wildland vegetation are at risk of damage from wildfire, because embers can be transported by wind and ignite vulnerable homes a mile or more away from the flame front (Cohen 2000).

Reducing the loss of lives, property, infrastructure, and natural resources from wildfires depends on long-term community action (NFPA 2006). Land use decisions, building codes and standards, and other planning and landscaping choices all influence a community's vulnerability to damage from wildfire (Blonski and others 2010). Communities can reduce the risk of such damage by becoming knowledgeable about and engaged in actions to plan and protect their homes and neighborhoods from wildfire. Such "fire-adapted" communities will be better prepared to safely accept wildfire as a part of their surrounding landscape (Leschak 2010, NASF 2009, NFPA 2006).

Terry DeWan and Associates

As houses are added to the landscape, fire-management challenges increase.

[1] The range of ecological processes and conditions that characterized various ecosystems in the United States prior to European settlement, referred to as "historical range of variability (HRV)," has been a subject of much research (Keane and others 2009). HRV is used by scientists and managers as a reference point to assess current conditions. For fire, HRV refers to the fire regimes that existed prior to European settlement.

[2] For the cited study, "housing units" were defined as homes, apartment buildings, and other human dwellings.

[3] Of course, vegetation outside of wildland areas can also burn.

This report by the Forests on the Edge project, sponsored by the U.S. Department of Agriculture, Forest Service (see box), is intended to heighten awareness of the ecological role and societal costs of wildfire, the causes and impacts of wildfire on human communities, and the relationship between increases in housing development and wildfire risk. While our target audience is planners and developers, many other entities—such as extension agencies, conservation districts, landscape designers, communities, and homeowners—can also benefit from the information and materials provided here. The report includes maps identifying areas in the conterminous United States where the wildland-urban interface is located and where structures have already been lost to wildfire. A sampler of resources and programs is provided to call attention to a few of the many options for reducing the risk of wildfire and its impacts, and to highlight the numerous organizations, Websites, and resources that can provide specific guidance relevant to individual regions, communities, and situations. Case studies focus on fire prevention and mitigation tools currently being used in a number of communities in the United States.

Key Terms

Wildlands—forests, shrub lands, grasslands, and other vegetation communities that have not been significantly modified by agriculture or human development*. A more specific meaning for fire managers, used by the National Wildfire Coordinating Group (which coordinates programs of participating wildfire management agencies nationwide), refers to an area in which development is essentially non-existent (except for roads, railroads, power lines, and similar transportation facilities); structures, if any, are widely scattered.

Wildfire—unplanned fire burning in natural (wildland) areas such as forests, shrub lands, grasslands, or prairies**.

Prescribed fire (or controlled burn)—the intentional application of fire by management under an approved plan to meet specific ("prescribed") objectives.

Mechanical treatments—the use of people or machines to thin or reduce the density of live and dead trees and plants.

* By "human development" is meant the construction of homes or other structures; we are not referring to forest management.

** The complete definition of wildfire from the National Wildfire Coordinating Group glossary is "an unplanned ignition caused by lightning, volcanoes, unauthorized, and accidental human-caused actions and escaped prescribed fires" (NWCG 2010).

Forests on the Edge

Forests on the Edge (FOTE) is a project developed by the U.S. Forest Service in conjunction with universities and other partners. The project aims to increase public understanding of the contributions of and pressures on America's forests, and to create new tools for strategic planning. This report, one of several FOTE reports to date, provides an overview of the relationship between housing in the wildland-urban interface and wildfire. Unlike other FOTE reports, which focus primarily on private forests, this one examines the relationship between wildfire and all wildlands, including public and private forests, as well as grasslands and shrub lands. It also emphasizes the impacts of wildfires on people and their homes, and presents a sampler of some preventative measures that can be taken to create fire-adapted homes and communities.

WILDFIRE—A FUNDAMENTAL, COMPLEX, AND COSTLY FORCE

The Ecological Role of Wildfire

While many people experience and interpret wildfire in terms of the damages caused to human lives, structures, and communities, it is important to recognize the ecological role that fire plays across landscapes. Wildfire is a fundamental ecological component for 94 percent of wildlands across the conterminous United States (USDA Forest Service 2012). Fire-adapted[4] ecosystems and species are found in every region of the United States, from the ponderosa pine forests of the Northwest and the Rocky Mountain West, to the Southwest's chaparral, the Midwest's tall grass prairies, the pine barrens of New Jersey, and the South's longleaf pine forests.

The relationship between wildlands and wildfire is complex, and it varies considerably depending on the location, size, and intensity of the fire; the season; the weather; the ecological characteristics of the land; and the type and amount of human influence (Anderson 2001, Greswell 1999, Martin and Sapsis 1992, Rieman and others 2005). Typical long-term patterns of fire size, intensity, frequency, and other characteristics occurring naturally over time and across the landscape are known as "natural fire regimes." Fire regimes have been assigned to wildlands based on fire severity (how damaging a fire is to vegetation and soils of a certain site), fire intensity (the rate of heat released by a fire and prominent immediate effects), and fire frequency (how often the site burns)(Morgan and

[4] "Adapted" in this sense means an ability to adjust to the intensity or quality of a disturbance; qualities that make an organism or its parts fit for existence under the conditions of its environment (Merriam-Webster 2011).

Table 1. Historical natural fire regimes, with examples

Fire regime group	Percent of wildland in this group[a]	Fire frequency[b] (years)	Fire severity[c]	Description/ definition	Examples
I	25	0–35	Low to mixed	Low-severity fires that leave most dominant overstoryd vegetation intact; can include mixed-severity fires replacing up to 75 percent of overstory	Lower elevation Ponderosa pine forests in the West; Pine and oak forests in the Southeast
II	19	0–35	High	High-severity fires that consume at least 75 percent of overstory vegetation	Grassland areas across the central United States; Chaparral stands throughout the West
III	22	35–200	Mixed to low	Generally mixed-severity fires; can also include low-severity fires	Mixed deciduous-conifer forests of the upper Midwest and Northeast; Western Douglas-fir forests
IV	12	35–200+	High	High-severity fires that consume or kill most of the aboveground vegetation	Lodgepole pine in the Northern Rockies; Isolated areas of the Great Lakes and New England regions
V	16	200+	Any severity	Infrequent fires that consume or kill most of the aboveground vegetation	Wetter forests in much of Maine, northern Pennsylvania, and parts of the West

[a] The column does not add up to 100 percent because 6 percent of all wildlands do not fall into any of these categories.
[b] Historical average number of years between fires (prior to European settlement).
[c] Historical effect on the trees and plants most commonly found in each wildland type (prior to European settlement).
[d] The term overstory refers to all above-ground vegetation.

Sources: Barrett and others 2010, Brown 2000, Hardy and others 2001, Rieman and others 2005, Schmidt and others 2002, USDA Forest Service 2012.

others 2001). Understanding these regimes can help to communicate the ecological role of fire in America's wildlands and can be used to identify significant changes resulting from management actions or possible shifts in climate (Brown 2000). Table 1 describes and provides examples of wildland fire regimes found in the United States[5]; see also the Historical Natural Fire Regimes box[6], and Figure 1.

Many plant and animal species depend or thrive on the structure and conditions resulting from the natural fire

Kelly Stover/US Forest Service

[5] The information displayed in Table 1 and Figure 1 is derived from an analysis (USDA Forest Service 2012) based on the following data sources: Fire Regime Group and Mean Fire Return Interval data come from LANDFIRE Refresh 2001 v1.0.5 (http://www.landfire.org). Developed and agricultural lands data come from LANDFIRE Refresh 2008 v.1.1.0 Existing Vegetation Type. State boundaries are from publicly available 1:2,000,000-scale polygon spatial data of U.S. States. All spatial data were converted to rasters with 270-meter (~82-feet) resolution for this summary.

[6] It is important to note that some U.S. wildlands no longer experience these fire regimes, owing to fire suppression, invasive species, and other factors.

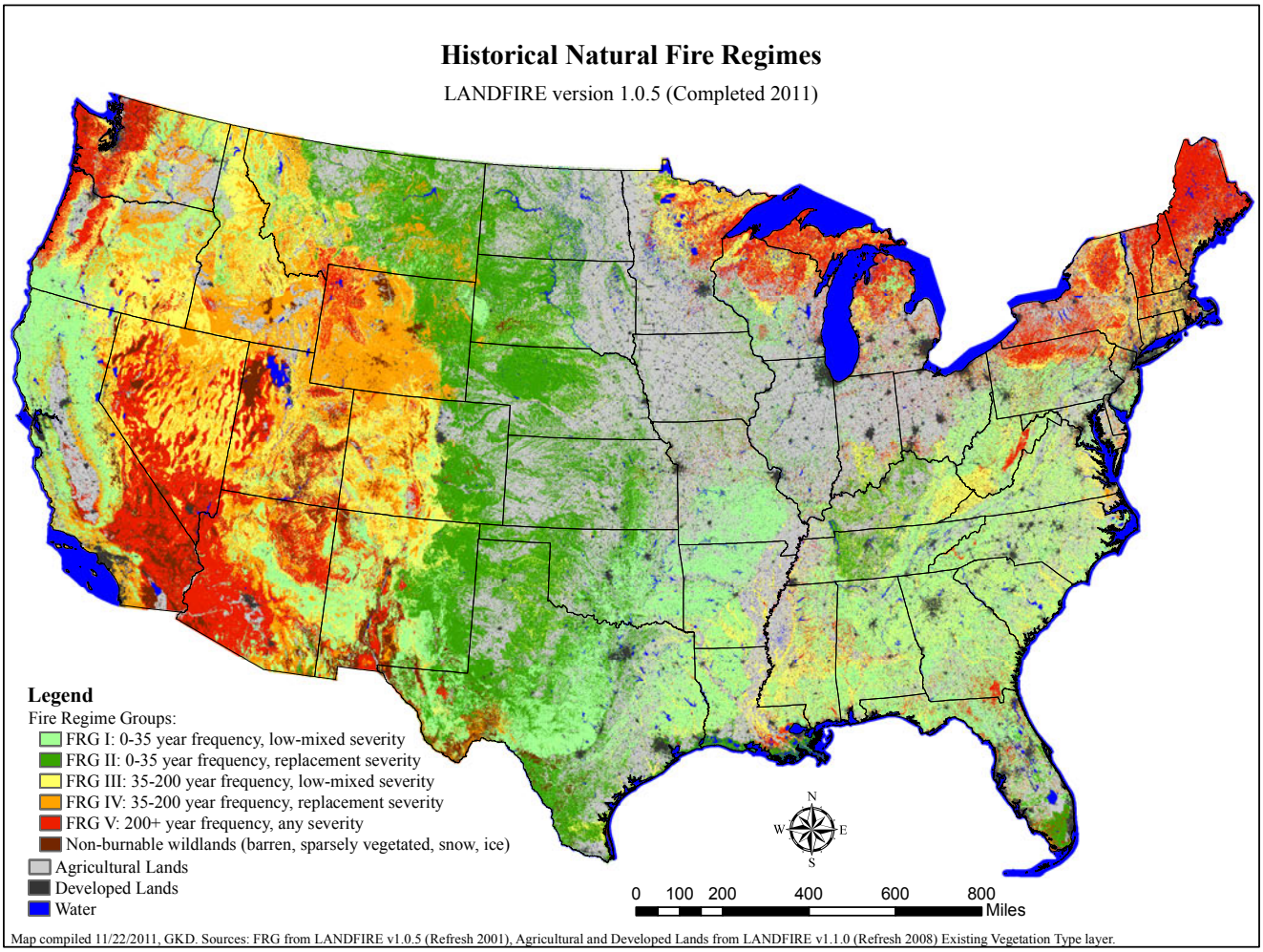


Figure 1. Historical natural fire regimes. Source: FRG from LANDFIRE v. 1.0/5 (Refresh 2001), Agricultural and Developed Lands from LANDFIRE v1.1.0 (Refresh 2008) Existing Vegetation layer.

Historical Fire Regimes: What's 'Natural' for Wildfire?

What determines whether a fire is unusual or just part of a typical fire pattern for a particular place? Fire specialists have looked at fires that occurred in various ecosystems prior to European settlement. In studying these fires, scientists categorized broad areas across the country that have similar patterns of fire frequency and severity (see Table 1 footnote for definitions) that have occurred over extended periods of time. Historical patterns of fire *frequencies* were typically caused by lightning and by burning by Native Americans; patterns of fire *severity* were mostly caused by climate, topography, and vegetation dynamics. The grouping of such patterns into categories (Table 1) is referred to as historical fire regimes, and provides a framework for what to expect in the way of fire in different locations based on historical conditions (Fig. 1).

In many areas, fire still plays a vital role and is key to maintaining those ecosystems; some fire-dependent forest types, such as the lodgepole pine in Yellowstone National Park, continue to function within their historical range (Hardy and others 2001, Schmidt and others 2002). However, in many areas, especially in lower elevation areas characterized by fire regimes I and II, current fire regimes are different than they were historically—in part because of fire exclusion, human disturbance, exotic species, and changes in climatic patterns. In some areas, fires that once burned often but with low severity may now burn less frequently, hotter, and larger; other places may now have numerous fires where once they had few (Martin and Sapsis 1992, Rieman and others 2005). Such "uncharacteristic" fires can challenge the ability of systems, wildland species, and people to respond to fire.

—Hardy and others (2001), Rieman and others (2005), Schmidt and others (2002)

Marc Barrison / Flickr

The gopher tortoise requires low-severity fires every 3 to 4 years.

regimes to which the species evolved or adapted (Kennedy and Fontaine 2009, Martin and Sapsis 1992). For example:

- The gopher tortoise (*Gopherus polyphemus*) and Bachman's sparrow (*Aimophila aestivalis*) found in longleaf pine forests require low-severity fires every 3 to 4 years to maintain bare ground and herbaceous habitat for nesting (Kennedy and Fontaine 2009).

- Black-backed and hairy woodpeckers make use of snags (standing dead trees) typically created by more intense fire (Kennedy and Fontaine 2009).

- Some fish and amphibians have complicated life cycles that benefit from fire because it can create the habitat diversity they require for long-term population stability (Rieman and others 2005, Skinner 2002). In some shallow wetlands and riparian areas, frequent fire can keep woody vegetation from being established, thus creating opportunities for amphibians that need sunny areas or open water (Pilliod and others 2003).

- Lodgepole pines in some areas of the Rocky Mountains require fire to open their sticky cones, and dense Douglas-fir forests in the Pacific Northwest benefit when fire creates sunny openings where shade-intolerant Douglas-fir seedlings can grow (Franklin and Van Pelt 2004, Rieman and others 2005).

- Whole suites of "fire-following" wildflowers produce profuse blooms of annuals or short-lived perennials, such as lupines and Indian paintbrush, with winter or spring rains following a wildfire; their seeds can lay dormant for decades until the right conditions trigger germination.

KevinCass / istockphoto.com

Many wildflowers germinate after fires.

Depending on the characteristics and scale of a particular fire, a patch of habitat or an entire watershed can undergo shifts in nutrients, energy cycles, and other ecological conditions that favor some species or communities while adversely affecting others (Agee 1998, Pickett and White 1985, Reeves and others 1995). Changes in characteristic fire patterns can have substantial consequences for ecosystems and the species they harbor, including wildlife and plant pollinators adapted to specific vegetation types. For example, the absence of typical fires from some vegetation types can lead to unusually large, intense wildfires that can extensively alter habitats or landscapes (Ice and others 2004, Smith 2000, Wilcove and others 1998), hasten soil erosion (Kocher and others 2001), increase stream temperature or sediments (Minshall and others 1989), and reduce the amount of carbon that is stored in the vegetation (Hurteau and others 2009).

Regardless of the fire regime, wildfires can kill individual plants, animals, fish, and aquatic organisms (Reiman and others 1997); degrade fish and wildlife habitat in the short term (Burton 2005); temporarily lower survival rates for larger animals and their young (Singer and others 1989); change the mix of birds and other species in an area (Tiedemann and Woodard 2002); and increase the susceptibility of trees to insect invasion (McCullough and others 1998). In many instances, such ecological impacts eventually disappear or create a net benefit for the ecosystem over time[7], but chronic damage can also occur (Gresswell 1999, Gruell 1983, Singer and others 1989, Neary and others 2005).

[7] Whether or when recovery occurs depends upon site conditions, fire severity, and species involved.

Complicating Factors: Climate Change, Insect Pests, and Diseases

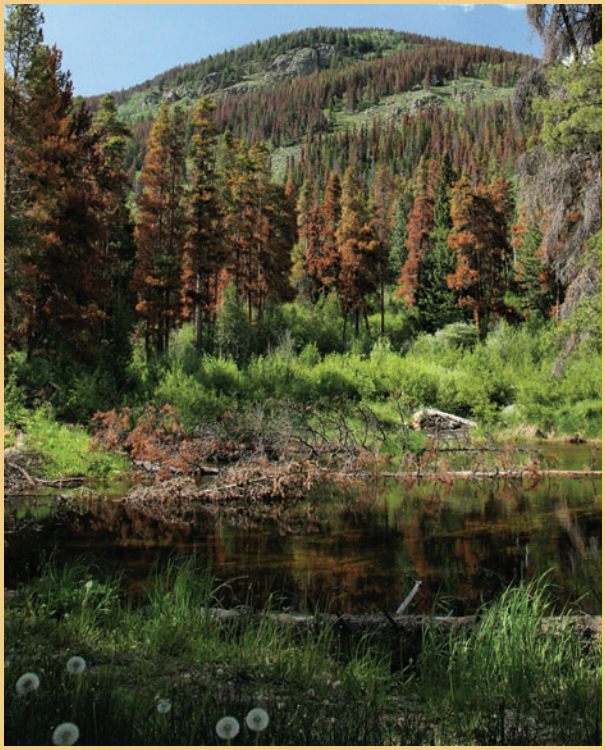
On many landscapes across the country, climate change as well as insect pests and diseases are increasing the potential for wildfires by influencing changes in vegetation.

Climate Change

Increases in the number, size, intensity, and duration of wildfires across large areas of the United States are being attributed in part to climate change (Fried and others 2004, Westerling and others 2006). Climate change is predicted to lead to warmer temperatures and changes in rainfall patterns, as well as increased periods of drought in many locations (Dale and others 2001). By 2070, the length of the fire season in some Western U.S. regions could increase by 2 to 3 weeks (Brown and others 2004). Projections for the Greater Yellowstone ecosystem foresee a dramatic increase in fire frequency, which will lead to the replacement of many plant and animal communities with a different mix of species (Westerling and others 2011). However, changes in acreage burned and other fire characteristics are not likely to be uniform because of variations in precipitation, winds, temperature, vegetation types, and landscape conditions (California Climate Change Center 2006). Furthermore, water shortages as a result of drought and changes in snowpack[8] could also affect the availability of water to fight fires once they start (Knutson and others 1998; Barnett and others 2005).

Insect Pests and Diseases

Insect and disease outbreaks are an integral part of the life cycle of many forests. However, insect and disease outbreaks are increasing across the country—linked in part to climate change; to human activities that introduce and spread forest pests (Koch and Smith 2010, Logan and others 2003); and, in some areas, to fire suppression (Romme and others 2006). Insects and diseases caused the mortality of 5.3 million acres of U.S. forests in 2006 and nearly 6.8 million acres in 2007 (USDA Forest Service 2009). The large number of trees being killed by extreme insect or disease outbreaks contributes to increasing the potential for wildfires (Konkin and Hopkins 2009, Man 2009, McCullough and others 1998, Parker and others 2006).



Curtis Lee Jones / Flickr

Pine bark beetle kill.

Chris Evans/Bugwood.org

Cheat grass is an invasive, highly flammable non-native species that increases the risk of wildfire.

Non-native invasive plants are an additional complicating factor for fire in forest and grassland areas. The replacement of native grasses, shrubs, and trees with non-native species, which are often more flammable, has increased the potential for future wildfires (D'Antonio and Vitousek 1992).

[8] Earlier winter/spring snowmelt reduces streamflow during the summer and autumn, thus increasing vulnerability to wildfire damage.

Societal Costs of Wildfire

While the presence of fire on the landscape is inescapable and often desirable from an ecological standpoint, wildfires can have considerable social and economic costs. These costs have risen substantially in recent years and can be particularly high in the wildland-urban interface (Kent and others 2003), where considerable resources are spent on the protection of homes and other structures. Recent studies have found a positive correlation between firefighting expenditures and the presence of housing and private lands (Gebert and others 2007, Liang and others 2008)[9].

The most publicized costs associated with wildfire are those to fight, or suppress, large wildfires. Average annual fire suppression expenditures by the U.S. Forest Service alone totaled $580 million from 1991 to 2000, and more than doubled to $1.2 billion annually from 2001 to 2010 (USDA Forest Service 2011c). State expenditures related to wildfire have also increased substantially in recent years. According to a biannual survey conducted by National Association of State Foresters (NASF), more than $1.6 billion annually is spent by State forestry agencies on wildfire protection, prevention, and suppression (including Federal funding expended by State agencies)—and that number has more than doubled in the past 10 years (NASF 2010).These figures do not include the cost to local fire departments across the country, which, according to a survey by the National Fire Protection Association (NFPA), responded to an average of 36,700 fires annually in forests, woodlands, or other wildlands from 2004 to 2008[10] (Ahrens 2010).

Kari Greer / US Forest Service

Application of fire retardant is one of the most costly aspects of fire suppression.

However, fire suppression expenses represent only a fraction of the monetary value spent on or lost in damages due to wildfires (see box). Numerous other costs include: the costs of restoring burned areas[11], lost tax and business revenues, property damage and/or devaluation, and costs to human health and lives (Donovan and others 2007, Kent and others 2003, USDA Forest Service 2011b, WFLC 2010). As an example, soil erosion and flash flooding following Colorado's 1996 Buffalo Creek fire resulted in more than $2 million in flood damage as well as more than $20 million in damage to the Denver water supply system (Lynch 2004).

Human lives lost or injured in the course of a wildfire are an incalculable societal cost. In the most extreme case to date in North America, the 1871 Pestigo Fire killed more than 1,200 people, destroyed numerous settlements, and burned 2,400 square miles across Wisconsin and Michigan (Pernin 1971). But the loss of even one person is an immense cost.

Wildfires can damage human health and take human lives even when people do not come into direct contact with the fire itself. People living near or downwind of a wildfire, for example, can be exposed to a host of pollutants that, depending on the person and the level of exposure to smoke, can trigger allergies, bronchitis, impaired judgment, and respiratory irritation (Chepesiuk 2001). Such health costs are generally accompanied by increased

[9] Recent analyses indicate that fire suppression expenditures by the U.S. Forest Service are greatly influenced by the presence of private lands (Liang and others 2008) and that per-acre suppression costs are greater in areas with higher total housing values (Gebert and others 2007).

[10] Figures are based on data provided by fire departments and State fire authorities who participated in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. Fires in forests, woodlands, or other wildlands accounted for about 10 percent of all fires to which local fire departments responded (estimated average of 356,800 brush, grass, and forest fires per year) during 2004–2008.

[11] The need for restoration after a wildfire varies considerably, depending upon the location and intensity of a fire. In some areas, such as remote areas, restoration may not be warranted.

Ric Francis / AP Photo

Bell Canyon area of southern Ventura County, CA.

How Much Money Does a Wildfire Cost?

Total monetary costs associated with any wildfire are difficult to estimate but even partial costs can be staggering, as shown in the following examples*:

Colorado's 2002 Hayman Fire, 138,000 acres (Kent and others 2003)*:*

- Total insured private property losses: $38.7 million
- Loans and grants from Small Business Administration and FEMA: $4.9 million
- Damage to transmission lines: $880 thousand
- Loss in recreation concessionaire revenue on two U.S. Forest Service ranger districts: $382 thousand
- Lost value of water storage capacity: $37 million
- Lost value from timber: $34 million

Total documented cost: $115.9 million

Six weeks of large wildfires (500,000 acres) occurring across 18 counties in northeastern Florida in 1998 (Butry and others 2001):

- Commercial timber (softwood) losses: $322 million to $509 million
- Suppression and disaster relief: $50 million to $100 million
- Property losses (including 340 homes): $10 million to $12 million
- Tourism and trade losses: $140 million
- Health care (asthma treatment): $325 thousand to $700 thousand

Total documented cost: $522 million to $762 million

* Not including suppression costs or costs to rehabilitate burned areas.

monetary expenses for medical treatment (Butry and others 2001).

Living in or near a wildland-urban interface area that is at high risk of wildfire also can reduce real estate values. A recent Colorado study showed that after the posting of fire risk maps and information on the Web, the values of homes located near areas of high wildfire risk experienced a temporary (2-year) decrease in value relative to homes farther away from high-risk areas (Donovan and others 2007). A Montana study concluded that sale prices of homes closer to areas previously burned by wildfires were lower than those for similar homes located farther away (Stettler and others 2010).

Over Time: Changes in U.S. Wildland Fire Management Policy

Fire and fire management have played a substantial role in the development and maintenance of America's wildlands. Long before European settlement, fire was used extensively by native inhabitants as an agricultural tool and to create hunting habitat (Pyne 1982), a practice that was continued by some European settlers. Until the early 1900s, fire also was used by settlers to reduce the amount of vegetation in order to decrease the potential "fuel" for future fires (Donovan and Brown 2007, Pyne 2010).

By the beginning of the 20th century, at a time when virtually every industry and convenience of life in America relied on wood (Williams 1989), America's professional foresters and others saw fire as a waste of valuable forest resources (Donovan and Brown 2007, Pyne 2010). Public support for fire suppression

F. E. Dunham / US Forest Service, National Archives and Records Administration

Malibu Fire, near Angeles National Forest, fall 1935.

Gary Chancey, Black Hills National Forest / forestphoto.com

increased after a series of large, intense fires burned vast stretches of U.S. wildlands (Pyne 2010), destroyed entire communities, and led to the loss of many lives. A tipping point came in 1910, when a wave of wildfires swept across the West, burning more than 3 million acres and leading to the loss of 78 firefighters (Pyne 2010).

In the years following the 1910 fires, Federal and State agencies strove to suppress all wildfires, but the lack of fire led to changes in the condition of some fire-dependent wildlands, and a build-up of flammable materials (Parsons 2000). Since the early 1900s, public wildfire management policy has evolved considerably. In the 1960s and 1970s, managers, scientists, and the public learned more about the fundamental role of fire in many forest and wildland ecosystems. Fire has been gradually reintroduced through carefully controlled and supervised burns referred to as prescribed burning (Parsons 2000, Pyne 2010, Stephens and Ruth 2005, vanWagtendonk 1995).

Larry Kohrnak / InterfaceSouthv

Close to 70 percent of the 9 million acres treated with prescribed fire from 2005 to 2010 were located in the Southeast (Gary Jarvis, U.S. Forest Service, Fire and Aviation Management, Fuels and Fire Ecology, personal communication).

A National Cohesive Wildland Fire Management Strategy

Under the guidance of the Wildland Fire Leadership Council, dozens of Federal, State, local, tribal, and non-governmental partners, as well as interested members of the public, are working on a strategy to guide the future of fire management across the United States. The council's vision is "to safely and effectively extinguish fire when needed; use fire where allowable; manage our natural resources; and as a nation, to live with wildland fire."

The strategy contains objectives and actions for each of three U.S. regions—Northeast, Southeast, and West. These include:

- efficiently reducing wildfire hazards on lands bordering communities;
- restoring and maintaining the structure, composition, and function of fire-dependent landscapes; and
- improving the overall effectiveness of the wildland fire management organization.

More information on this effort can be found at: http://www.forestsandrangelands.gov/strategy/.

Public wildfire policy continues to evolve, as managers advance their efforts to coordinate and improve wildfire response, prevention, and restoration of fire-adapted wildlands. Much work still remains to reduce fuels to those more closely matching the ecological fire loads of natural fire regimes depicted in Table 1, especially because biomass continues to accumulate (P. Langowski, personal communication).

WHERE WILDLANDS, HOUSING, AND FIRE CONVERGE

The Wildland-Urban Interface

The dynamic tension between the need for periodic fire to sustain wildland health in certain ecosystems and the need to minimize negative impacts to people and their homes from wildfire is most acute in the wildland-urban interface (WUI), where homes and wildlands meet or intermingle. Given that fire plays an ecological role in 94 percent of wildlands across the conterminous United States (USDA Forest Service 2012), we know that wildfire can and will eventually occur in most U.S.

Mark D. Roper / US Forest Service

Larry Kohrnak / InterfaceSouth

Kari Greer / US Forest Service

Examples of wildland-urban interface.

wildlands. Therefore, homes located anywhere in the WUI will eventually be exposed to wildfire, regardless of vegetation type or potential for large fires.

What is the WUI and where is it located? There are many ways to answer this question (Blonski and others 2010), depending in part on how specifically one defines WUI. One definition refers to the WUI as any area where "humans and their development meet or intermix with wildland fuel" (USDA Forest Service and others 2001). The map presented here (Fig. 2a) is based on a study (Radeloff and others 2005) that identified WUI more specifically as lands with more than one housing unit per 40 acres where wildlands dominate the landscape (referred to as intermix); and land with higher housing densities that are adjacent to natural areas (referred to as interface). In other words, homes in the intermix WUI are interspersed with vegetation, whereas homes in the interface WUI are grouped together and adjacent to areas with heavy vegetation (Fig. 2b). Figure 2a was built considering vegetation data, census data on housing[12], and updated land ownership data as initially described in Radeloff and others (2005)[13].

As depicted in Figure 2a, both intermix WUI (colored orange) and interface WUI (colored yellow), are found across the United States and are most prominent across much of the East, where most of the Nation's population is found. Under the right conditions, homes in any of these WUI areas could be exposed to wildfire. So too, could homes in more lightly settled rural areas with considerable wildland vegetation (colored lighter green on the map). Since housing in these lighter green areas is sparse and scattered, housing density is not yet high enough to be considered WUI. However, with additional housing growth and no change in vegetation, light green areas could become WUI communities. Because these isolated homes are near or within wildlands, their owners must also be ready to respond to the risk of wildfire.

According to the Radloff and others (2005) study, about one-tenth of the land area occupied by housing and about one-third of all housing units (homes, apartment houses, condominiums, etc.) in the conterminous United States are located in the WUI[14]; if past trends continue, the WUI will continue to increase. From 1990 to 2000 alone, the total WUI area in the United States increased by 18 percent, with the addition of more than 6 million

[12] Public lands are excluded from census blocks before housing and vegetation are assessed, to ensure that WUI classification captures even small human communities surrounded by public lands.

[13] We used the same methods as described in the Radeloff and others 2005 publication to produce Figure 2, but we updated the analysis based on the 2010 census data.

[14] The remaining nine-tenths of land area occupied by housing, and two-thirds of housing units, are located in areas that are urban, or are too sparsely populated to be identified as WUI.

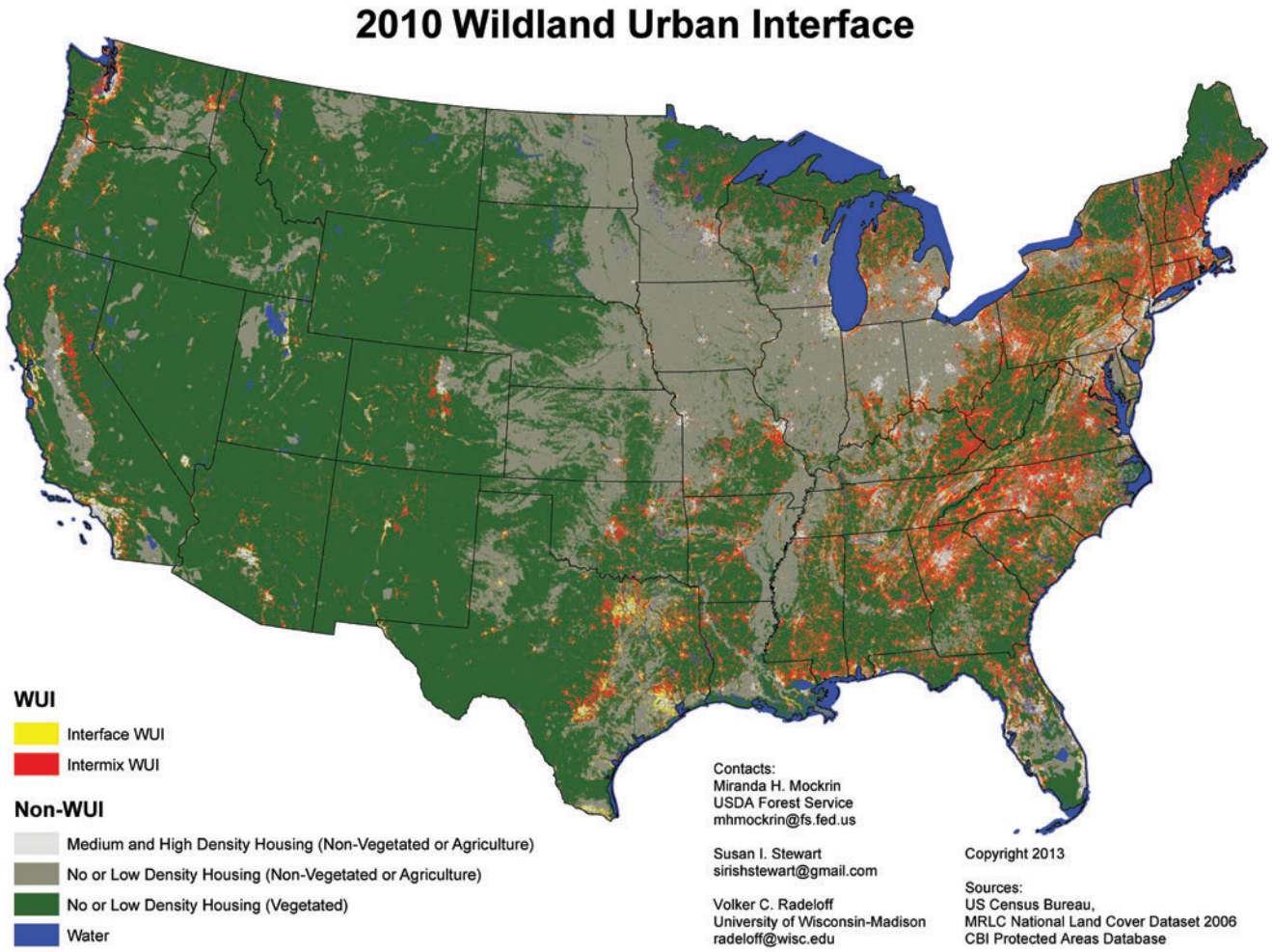


Figure 2a. Distribution of wildland-urban interface across the conterminous United States, 2010. Source: compiled by S.I. Stewart and V.C. Radeloff based on the 2010 census, the 2006 National Land Cover Dataset (NLCD), and the Protected Area Database v.1.1

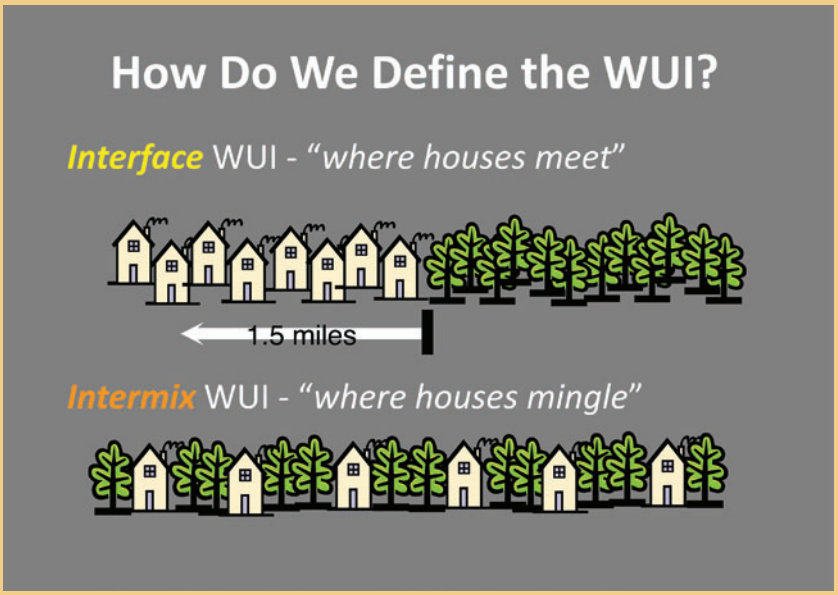


Figure 2b. How Do We Define the WUI? In *interface* WUI wildlands are adjacent to housing developments, while in *intermix* WUI, houses and wildlands intermingle. Source: Dr. Volker Radeloff, University of Wisconsin, used with permission.

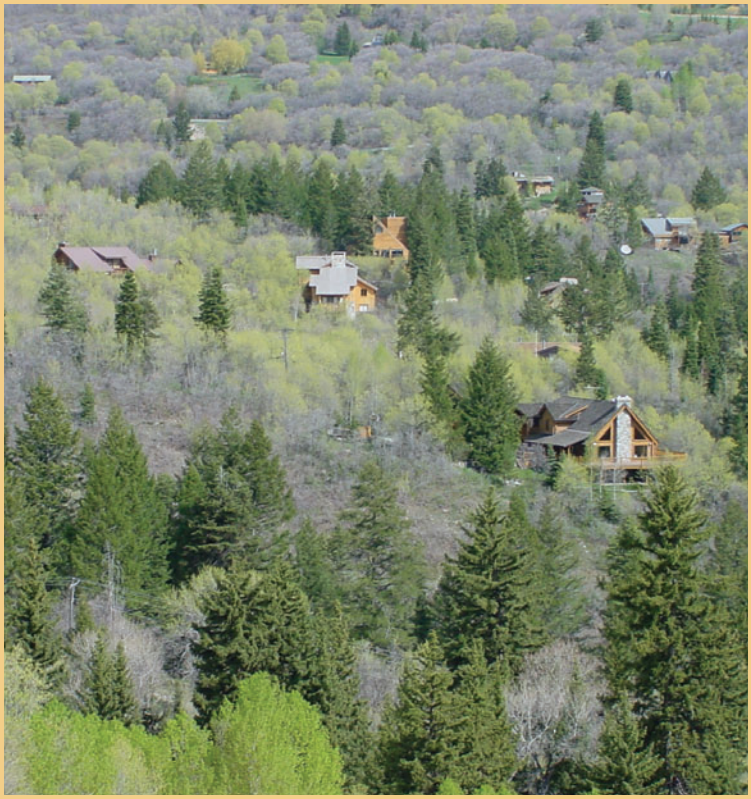
Paul Ryan/US Fish and Wildlife Service

Smoke from approaching fire, JN 'Ding' Darling National Wildlife Refuge, Florida.

Kari Greer/US Forest Service

Waldo Canyon Fire, Colorado Springs, CO, 2012, where wildfire caused extensive damage in and near WUI neighborhoods.

homes (Radeloff and others 2005). There are many factors behind WUI growth, including population growth; housing growth in areas with abundant natural amenities (such as forests, scenery, and wildlife); and population shifts from the long-developed Eastern United States to the still-growing West and South, where cities are expanding into their surrounding wildlands (Hammer and others 2009). "Baby-boom" retirement is just beginning and will likely reinforce the so-called amenity migration, as some retirees move to smaller, more rural communities close to scenic natural resources (Hammer and others 2009). Many Federal, State, and local agencies responsible for suppressing wildfires are concerned about such increases in the WUI because fire management and firefighting in these areas can be complicated and expensive, and resources for fire management are limited (NASF 2009).



NFPA Firewise Communities Program

WUI Facts and Figures

- In 2000, nearly a third of U.S. homes* (37 million) were located in the WUI (Radeloff and others 2005).
- More than two-thirds of all land in Connecticut is identified as WUI (Radeloff and others 2005).
- California has more homes in WUI than any other State—3.8 million (Radeloff and others 2005).
- Between 1990 and 2000, more than 1 million homes were added to WUI in California, Oregon, and Washington combined (Hammer and others 2007).
- WUI is especially prevalent in areas with natural amenities, such as the northern Great Lakes, the Missouri Ozarks, and northern Georgia (Stewart and others 2001).
- In the Rocky Mountains and the Southwest, virtually every urban area has a large ring of WUI, as a result of persistent population growth in the region that has generated medium and low-density housing in low-elevation forested areas (Hammer and others 2009).

* The research conducted for this and the other bullets in this box actually focused on "housing units," which include homes, apartment buildings, and other human dwellings.

Variations in Wildfire Risk Across the Wildland-Urban Interface

Many homes in the wildland-urban interface are at risk of wildfire. However, the potential for economic damage from wildfires is higher in some areas than in others. As described in previous sections, wildland areas with certain climates, seasonal weather patterns, and vegetation types are more susceptible to wildfires than others. Similarly, wildfires occurring in certain vegetation types are likely to be more intense than others. Lastly, the pattern and density of housing in a WUI area can influence the level of economic damage resulting from a wildfire.

Karl Anderson, The Courier/AP photo

Identifying areas where total wildfire damages to structures may be highest can help Federal, State, and local government agencies identify priorities for hazardous fuel treatments and wildfire mitigation. The Calkin (Calkin and others 2010, 2011) and Haas (Haas and others, in review) analyses identified areas across the country where wildfire poses the greatest risk to people, their homes, and other valuable resources (including energy and recreation infrastructure, fire-susceptible species, and municipal watersheds). Estimates of risk were based on the probability that large wildfires would occur, the estimated intensity of future wildfires, and the likelihood that future wildfires would cause damage to residential homes (based on population density, proximity to roads, and other factors (Haas and others, in review).

The approach by Haas and others (in review) is illustrated in Figure 3. As depicted in this example, wildfire risk to structures and populations can vary considerably across

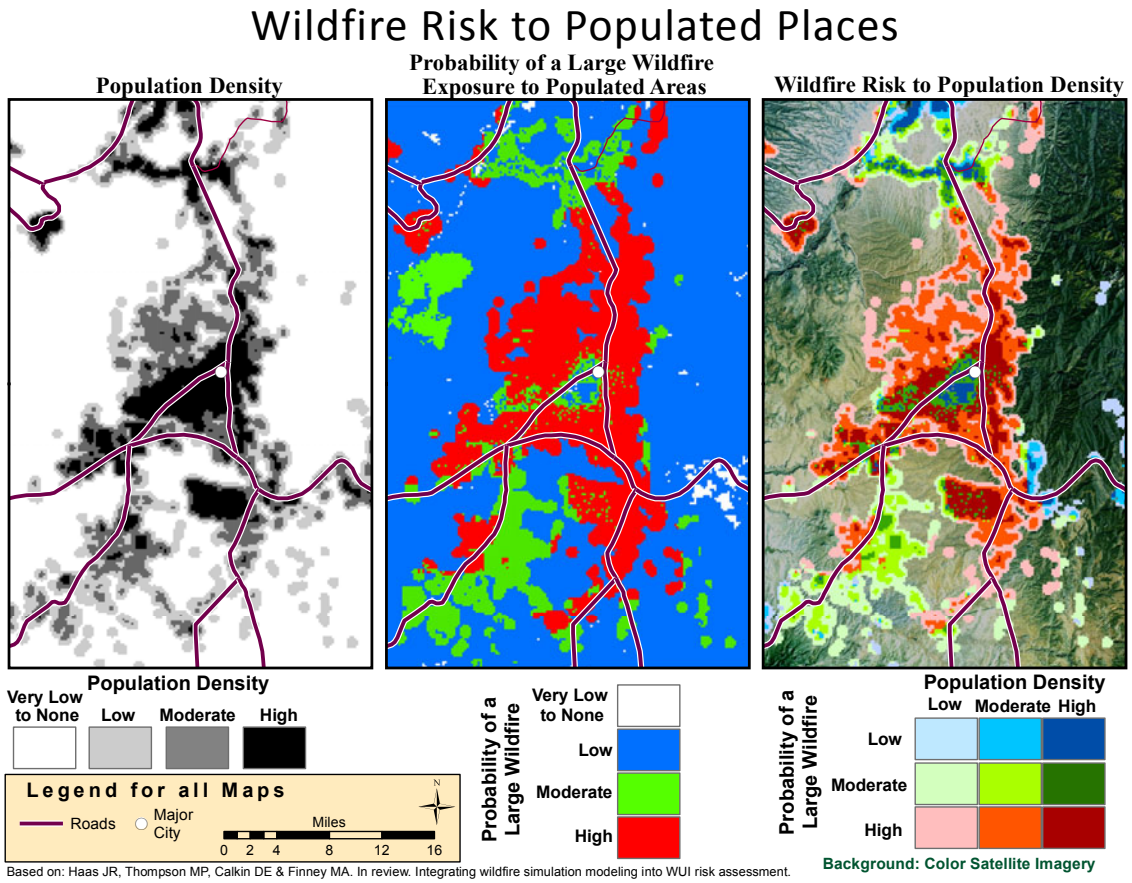


Figure 3. Example of how wildfire risk can be estimated for a wildland-urban interface area. One approach is to map an area's population density (left) and the probability of large wildfire exposure (center), and then overlay the two layers (right). Source: Based on Haas and others (in review).

a region and tends to be highest in areas where moderate population levels overlap with, or are close to, areas of wildland vegetation, and high potential wildfire exposure.

As will be discussed later in this report, potential wildfire damage to homes and other structures can be decreased by reducing wildland vegetation in and around high-risk areas, removing flammable vegetation directly around homes, and reducing the flammability of homes.

Structures Already Lost to Wildfire

Where in the WUI have homes and other structures already been destroyed? In order to answer this question, we analyzed data on structures burned that had been collected from 1999 to 2006 by an interagency group of Federal and State land management agencies for the purpose of emergency response management[15].

As depicted in Figure 4, during 1999–2011, wildfires destroyed homes and other structures across the conterminous United States. Structures destroyed were located in or near a range of wildland vegetation types, from chaparral shrub lands of southern California, to grasslands of central Oklahoma, to the forests of Pennsylvania and Georgia, and the scrub lands of central Florida[16].

15 The data were collected by the Geographic Area Coordination Centers (GACC), an interagency group of Federal and State land management agencies created for the purpose of management and mobilization of resources to respond to emergency incidents such as wildfires, earthquakes, floods, hurricanes, and tornadoes (http://gacc.nifc.gov/admin/about_us/about_us.htm). Data on structures burned and on latitude and longitude of the fire start are among the many types of information collected by GACC. The map itself was created by the U.S. Forest Service Fire Modeling Institute, in the Fire, Fuels, and Smoke Program of the Rocky Mountain Research Station.

16 The map depicted here only includes data collected by the GACC and does not include areas outside of the conterminous United States. Although wildfires do occur in U.S. States and territories outside the continental United States, few structures are lost compared to the conterminous United States.

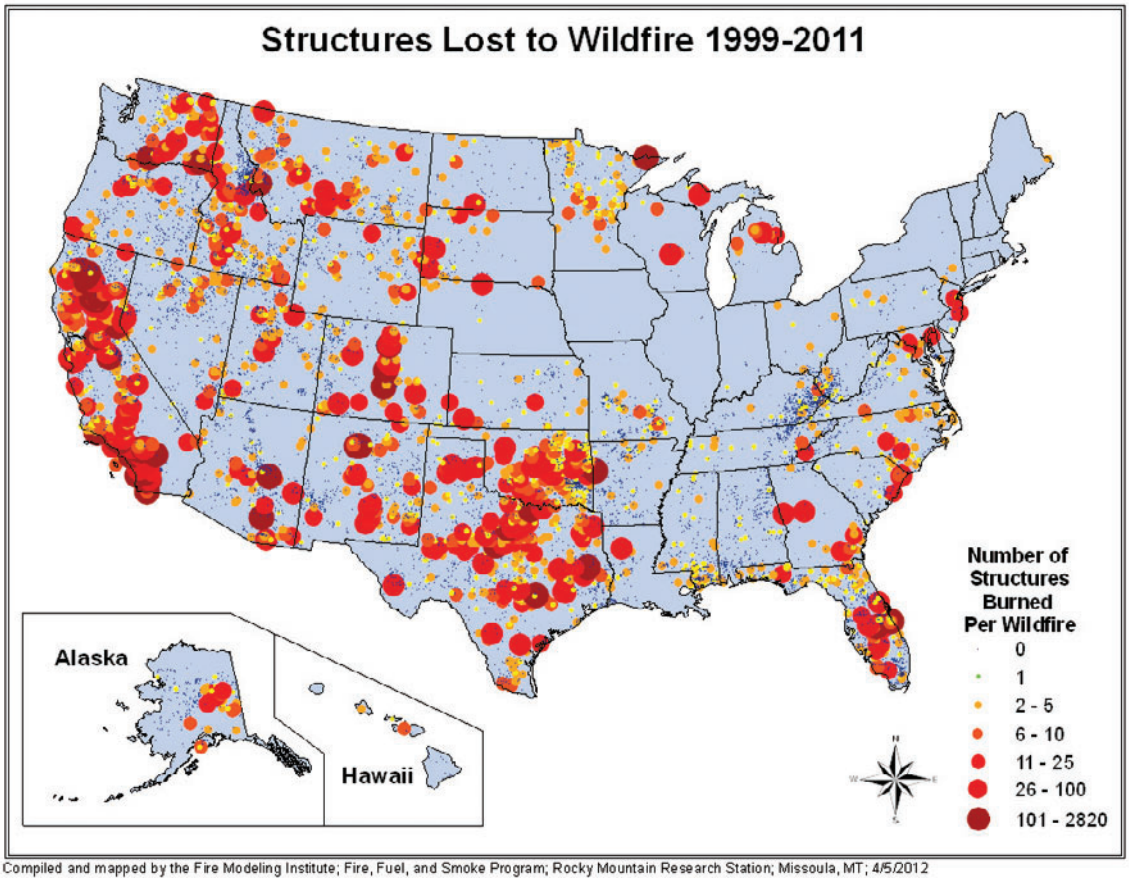


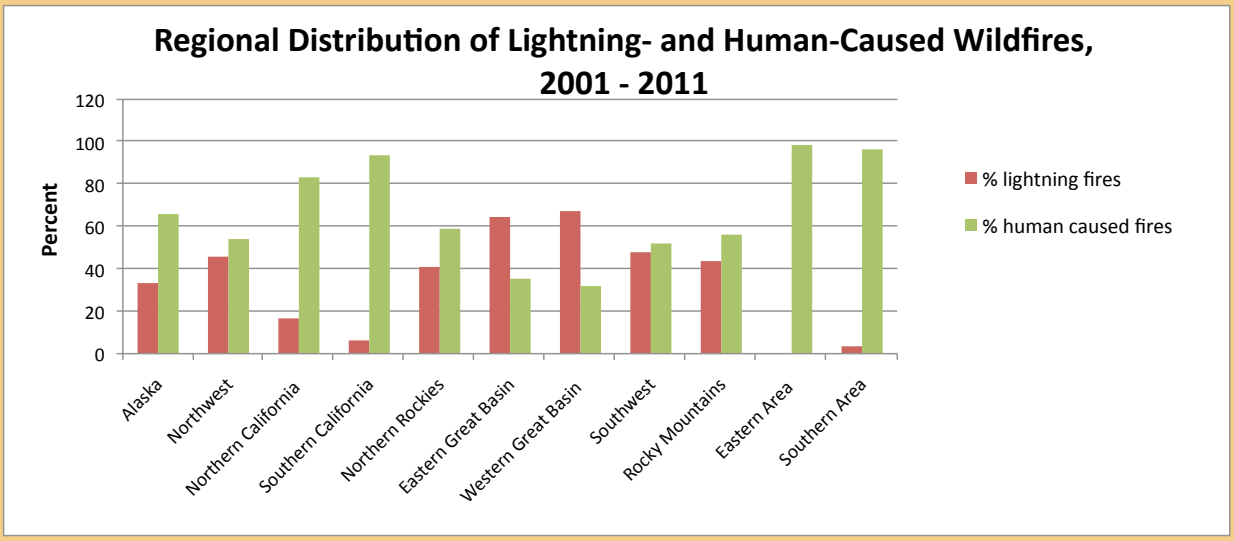
Figure 4: Structures lost to wildfire 1999–2011. Data are limited to burned structures reported through the National Interagency Coordination Center database. Data source(s): Situation Report (SIT/209) (http://famtest.nwcg.gov/fam-web/help/famweb_data_warehouse/fdw_topic_areas/situation_report_incident_status_summary_(sit_209).htm). Compiled and mapped by the Fire Modeling Institute, Fire, Fuel, and Smoke Program, U.S. Forest Service, Rocky Mountain Research Station, Missoula, MT, April 2012.

Connecting the Dots: How Housing Can Influence Wildfire Activity

Although vegetation type, climate, and other ecological factors have a strong influence over wildfire potential, people and their homes can also affect wildfire frequency, distribution, and suppression (Syphard and others 2007).

In general, the more houses and people, the more human-caused fire ignitions occur (Blonski and others 2010, Hammer and others 2007). From 2001 through 2011, an average of 85 percent of wildfires in the United States as recorded by the National Interagency Fire Center (NIFC) were caused by people (121,849 lightning-caused and 717,527 human-caused) (Fig. 5). The two areas with the highest percentage of wildfires caused by humans are the Eastern (99 percent) and Southern (96 percent) areas. However, in terms of average annual number of acres burned by human-caused wildfires in 2001–2011, the Southern area is highest nationwide, with more than

Karl Greer / US Forest Service



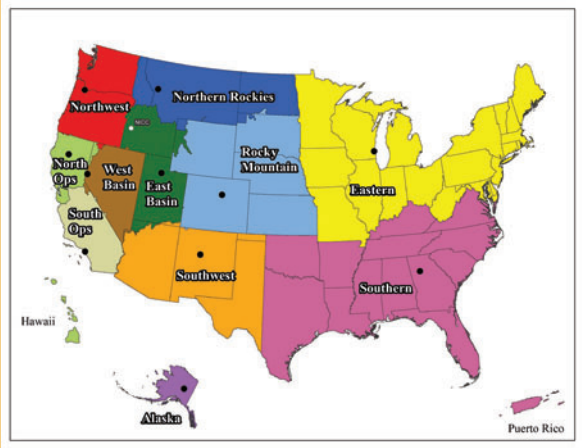


Figure 5. Regional distribution of lightning- and human-caused wildfires, 2001–2011. In every region of the United States except the Eastern Great Basin and Western Great Basin, most wildfires are started by people. Source: National Interagency Coordination Center <http://www.nifc.gov/nicc/>

1 million acres, followed by the Southwest region, with about 380,000 acres of human-caused wildfires annually. Such findings are consistent with a recent report linking high population growth with the prevalence of human-caused fires in the South (Andreu and Hermansen-Baez 2008).

The presence of homes can also increase the spread of a wildfire once it has started, in part because housing materials, such as wood shakes, can be highly flammable (Cohen 1999). A burning home is a major source for hot embers, which can travel through the air and help spread wildfires. The pattern of housing development also influences the spread and intensity of fire (Blonski and others 2010, ISO 1997).

NFPA Firewise Communities Program

CREATING FIRE-ADAPTED COMMUNITIES

Given that wildfires can occur in any wildland area; that the number of acres burned has been increasing; that the number of houses in the WUI is increasing; and that Federal, State, and local government fire suppression budgets are already strained—agencies are focusing more and more on promoting the concept of "fire-adapted" communities (NASF 2009). A fire-adapted community is "a knowledgeable and engaged community in which the awareness and actions of residents regarding infrastructure, buildings, landscaping, and the surrounding ecosystem lessen the need for extensive protection actions and enables the community to safely accept fire as a part of the surrounding landscape"[17]. Fire-adapted communities can also be thought of as those that are relatively "safer from the risk of brush, grass, and forest fires" (NFPA 2006).

The creation of a fire-adapted community is a proactive process that produces a community-wide pre-fire strategy, as well as actions, to reduce risks and thus costs (Leschak 2010). In this way, communities do not rely solely on suppression activities for protection after a wildfire starts, but rather become less at-risk for damage to property and lives in the first place. To be successful, efforts to create and maintain a fire-adapted community must involve the entire community—including residents, government agencies, emergency responders, businesses, land managers, and others. Participants work together to remove fuels, reduce ignition sources, modify structures, prepare the larger landscape for fire, and build strong local response capability. Communities use codes and ordinances where possible, develop internal safety zones, build external fuel buffers, use prevention education, and form partnerships to address hurdles that can deter some people from participating in fire-risk reduction activities (Leschak 2010). This section explores some of these options in more detail. For additional information on fire-adapted communities, visit the National Fire Protection Association Websites: http://www.nfpa.org, and www.fireadapted.org.

Reducing the Risk—Prevention and Mitigation

One of the most effective ways to reduce the risk of damage to homes or property from a wildfire is to prevent an ignition in the first place. Communities with robust wildfire prevention programs are likely to have fewer human-caused ignitions, which occur most often unintentionally when kids play with matches or when people burn leaves or trash, toss cigarettes, leave campfires unattended, or drive through dry grass, for example. (See case study 1).

In addition to reducing human-caused ignitions, community wildfire prevention includes taking actions to protect homes and property from future wildfires. Such actions focus on modifying the vegetation in and around structures (Finney and Cohen 2003) and ensuring that all structures are constructed with fire-resistant materials.

Trees, shrubs, and other vegetation are removed or reduced from within and around a community to reduce the intensity and growth of future fires, and to create a

[17] This is the definition used by Fire Adapted Communities Program of the U.S. Forest Service's Fire and Aviation Management staff.

CASE STUDY 1: COST-EFFECTIVE WILDFIRE PREVENTION EDUCATION IN FLORIDA

Wildfire prevention education efforts can be a particularly cost-effective way to limit damages from wildfires, in conjunction with prescribed fire and other actions to reduce fire risk. Between 2002 and 2007, the State of Florida spent an average of $500,000 annually on wildfire prevention education, including such activities as media efforts, homeowner visits, informational brochures and flyers, and presentations. During this time, the number of fires started accidently by people was reduced, thereby reducing costs for firefighting and damage compensation. The study's authors suggested that for every dollar of increased spending on wildfire prevention education, some $35 in wildfire-related losses and suppression costs could be saved, a 35:1 benefit-to-cost ratio. While specific to Florida, the study strongly implies that educating the public about the dangers of accidentally igniting fires can lead to fewer wildfires and lower costs.

—Source: USDA Forest Service and others (2011).

Jenn Viane Riese

relatively safe place for firefighters to control and contain wildfires. Vegetation is removed or reduced by using prescribed fires to burn the vegetation and/or by reducing the number of trees and other vegetation (mechanical or manual treatments). In a recent assessment, 90 percent of fuel treatment efforts conducted on national forests were found to be effective in reducing the intensity of wildfires (see Fuel Treatment Effectiveness box). Because vegetation continues to grow, mechanical and prescribed fire treatments must be repeated over time to keep fuels from accumulating. (See case study 2.)

Wildfire damage to most homes and structures is due to wind-borne embers igniting after landing on a roof or wooden deck, or blowing in through vents (Cohen 1999, 2000). Ignitability of structures can be reduced if homeowners adopt actions collectively described as Firewise (www.firewise.org; see Community Education and Involvement Programs section later in this report); such actions promote the reduction of flammable vegetation and other wildfire hazards in the "ignition zone" around individual structures (also known as "defensible space") and the use of fire-resistant building

Beth Stein hauer/Black Hills National Forest

University of Nevada Cooperative Extension

One spark from a flying ember on a wood-shake roof could spell disaster. Homes with non-flammable roofing materials (such as metal or tile)—and those where debris is kept from collecting on the roof or in gutters—are likely to suffer less damage from a wildfire.

CASE STUDY 2: FIRE 'PRESCRIPTION' FOR WILDLIFE AND LONGLEAF PINE IN GEORGIA

In recent years, visitors at many Georgia State parks, wildlife management areas, and other natural areas have had the opportunity to observe habitat restoration in progress as prescribed fires have been intentionally set in the forest understory. Conducted outside most plants' active growing seasons, the burns are done to reduce fuel loads and to improve habitat for dozens of native plant and animal species by opening up overgrown areas. Each prescribed burn is planned, ignited, and monitored by a team of trained wildland fire specialists. In 2010, prescribed burns were conducted on more than 25,660 acres in Georgia.

Georgia Governor Nathan Deal signed a proclamation in 2011 to kick off Prescribed Fire Awareness Week, which recognizes prescribed fire as a safe way to apply a natural process that can be helpful for wildlife and people. Prescribed fire as a habitat management tool also is emphasized in Georgia's Wildlife Action Plan, a comprehensive strategy that guides State efforts to conserve biological diversity.

One major tree species that has benefitted from the prescribed fires is the longleaf pine, which today is found in a fraction of its historical range in the southeastern United States. A longleaf pine forest benefits a diversity of native animal species, including some threatened or endangered species in Georgia, such as the red-cockaded woodpecker, gopher tortoise, and eastern indigo snake.

—Potts (2011)

Longleaf pine forest in the Okefenokee Swamp, Georgia, provides habitat for the endangered red-cockaded woodpecker.

Jim McCormac

materials (including roofing, decks, and vents) (Nader and others 2007, NFPA 2006, Quarles and others 2010, BOF 2006). Such proactive action on the part of homeowners is critical because when a wildfire occurs, it might be impossible for firefighters to reach and protect all individual properties, depending on the fire's size and intensity and the availability of firefighting resources.

Homeowners in the Wildland-Urban Interface

In recent years a wealth of research on attitudes and behaviors of homeowners in the WUI, based on surveys of individual communities, provides useful insights to their varying levels of participation in and commitment to actions to reduce the risk of damage from wildfire, which can be due to a number of reasons related to motivation, means, and opportunity (Kent and others 2003, Reams and others 2005, Kocher 2011). Some findings include:

Fuel Treatment Effectiveness

Between 2006 and 2011, about 600 assessments were completed by the Forest Service on wildfires that burned into areas where hazardous fuels reduction treatments had previously been conducted (USDA Forest Service 2011a). These assessments evaluated the effects of prescribed fire as well as mechanical and chemical treatments on fire behavior and fire suppression actions. The data indicate that 90 percent of treatments reported in the database have helped to reduce wildfire intensity, allowing better control by firefighters. In most of these cases, as fires moved from untreated locations to areas treated by thinning, mowing, or prescribed burning, the fire behavior changed from active crown fires (burning an entire upper story of the forest) to passive crown fires (where only a single tree or small group of trees burned), or from passive crown fires to surface fires (burning only dry grass, shrubs, pine needles, and other flammable materials on the ground). Although proven effective for fire control in certain situations, fuel treatments must be carefully planned, with consideration of local ecological conditions, forest types, and wildfire conditions (DellaSalla and others 2004, USDA Forest Service 2011a).

Kari Greer / US Forest Service

Fuel treatments can slow the spread of wildfire and diminish wildfire intensity. The speed and intensity of the wildfire spreading downslope through the untreated forest along the top of this ridge were reduced dramatically when the wildfire entered the treated area (center of photo). This helped to save the 40 homes located at the bottom of the ridge.

- Homeowner involvement varies. Awareness of wildfire risk has been an important factor in the decision of many homeowners to reduce wildfire risk on their properties (McCaffrey and others 2011), and most homeowners in areas of high wildfire risk have undertaken some type of defensible space activity (McCaffrey 2009). However, the level and nature of effort ranges widely, from small-scale actions to fire-proof homes, to extensive fuels treatment actions (Brenkert and others 2006). Ninety-one percent of WUI residents interviewed in California, where defensible space ordinances are in place, have lowered fire risk by removing flammable vegetation from their property, while less than 50 percent of residents in Florida and Michigan had done this action (Vogt and others 2005).

NFPA Firewise Communities Program

NFPA Firewise Communities Program

"Defensible space" or reduced-hazard "home ignition zone" refers to the area around a house or other structure where vegetation has been significantly modified or removed to reduce the risk of damage from wildfire (see, for example, NFPA 2006, BOF 2006). For fire-resistant landscaping ideas and lists of desirable plant attributes see Doran et al. 2004, NFPA 2006, White and Zipperer 2010, and www.interfacesouth.org.

- Individual motivations vary. According to one survey, motivating factors for some individuals included friends and family, regulation, and the desire to clear property for building; for others, these factors were less important than agency outreach, influence of community leaders and homeowner associations, and government programs (McCaffrey and others 2011). Most homeowners do think that managing vegetation on their property to create defensible space is their

personal responsibility (McCaffrey and others 2011, Winter and others 2009). The presence of social networks within communities as well as between communities and various government agencies seems to increase the likelihood that a community will adopt wildfire mitigation actions (Jakes and others 2007, as cited in McCaffrey 2011).

- Perceptions of risk vary. Some homeowners tend to estimate the risk of wildfire damage to their own homes and property as being lower than the estimated wildfire risk elsewhere in their immediate area, in part because they may have taken at least some mitigation actions (McCaffrey 2008). A survey of WUI residents in Colorado, for example, indicated that although wildfire risk was acknowledged as an important issue and some safety measures had been adopted, most people had not engaged in fuels treatment activities in part because they saw no need to take that level of action until actually faced with a wildfire (Brenkert and others 2006).

- Time, resources, and knowledge can be limited. Some of the greatest barriers to action include the lack of time, money, assistance, and technical knowledge, as well as homeowner perceptions of costs and labor requirements (Hodgson 1995). Additionally, many homeowners have difficulty disposing of vegetation cleared to create defensible space (Winter and others 2009). To address such limitations, some communities provide free home inspections and free or cost-shared clearing, chipping, and disposal of debris (Reams and others 2005). (See case study 3.)

- Feelings towards regulations are mixed. Most homeowners prefer not to have mandatory regulations, although some see a role for government and insurance companies in requiring vegetation management to reduce the risk of wildfire damage, particularly when other policies and approaches have not been successful (Winter and others 2009). Homeowners are most likely to comply with risk-reduction guidelines and other rules if they see the guidelines as fair, if they trust the sources (Vogt and others 2005), and if they see their actions as part of a larger efforts involving fire-safe building codes and zoning/planning practices that discourage development in high-risk areas (Winter and others 2009, Monroe and others 2004).

- Aesthetic preferences can help or hinder. Although some homeowners enjoy the look of wildfire-resistant landscaping (such as minimal trees or selection of certain types of shrubs and other vegetation) (Winter and others 2009), others reject such actions for aesthetic and privacy reasons (Daniel and others 2003, Kent and others 2003, Nelson and others 2003, Brenkert and others 2006, Winter and others 2009). Studies have noted that some homeowners would rather make structural changes to their homes than make landscape changes they find unattractive (Brenkert and others 2006).

- Conflicts with best management practices. In areas where vegetation removal can lead to increased erosion, creating safer home ignition zones can be problematic because they sometimes conflict with local "best management practices" (BMPs) for soil and water protection. For example, residents of one community indicated that their State department of environmental quality guidelines prohibited the removal of vegetation over a certain size (Winter and others 2009).

- Conflicts with homeowner association restrictions. In the past, some homeowner associations restricted tree removal, dictated that roofs have wood shingles, or mandated certain kinds of vegetation for aesthetics, despite the potential fire hazard. Much progress has been made in this area, however, and most homeowner associations no longer have such clauses; some now require vegetation management to reduce fire risk (S. McCaffrey, personal communication). In one case, the State of Colorado passed a law to forbid homeowner associations from interfering with the rights of homeowners to create defensible space or install non-flammable roofing (General Assembly of the State of Colorado 2005).

Preparing Homes and Neighborhoods: Examples and Resources for Planners and Homeowners

Whether planning new developments, working to make existing developments and homes safer, or sharing information about what to do before, during, and after a wildfire, many resources are available for homeowners and community decision makers. Such resources typically fall into two general categories: community education and involvement programs, and community planning

CASE STUDY 3: FROM SOUP TO NUTS: MAINE FOREST SERVICE TAKES A COMPREHENSIVE APPROACH

The Maine Forest Service (MFS) offers a full meal deal when it comes to reducing the risk that a wildland fire might damage or destroy homes in its rapidly growing wildland-urban interface. Its WUI program includes everything a homeowner might need to be safer from wildfire: from conducting assessments of individual or community risk, to making recommendations for creating defensible space around a home, to providing DVDs and other educational materials online and in schools and communities; they even offer a free chipping service for getting rid of the branches and brush removed to reduce potential fuels. It's not a small undertaking in the Nation's most forested state, one that experiences upward of 700 wildfires annually. A third of those fires threaten structures—including those associated with dense housing development in forested areas, and those located on its coastal islands, where additional challenges of response time, road access, and limited resources complicate firefighting. The program got started in 2003, with a statewide assessment strategy and more than a dozen community risk assessments conducted by AmeriCorps employees. Today Maine's forest rangers collaborate with a non-governmental organization, the Island Institute, to conduct assessments, which then feed into the development of a community wildfire protection plan (CWPP). New in recent years is a "LakeSmart and FireWise" program to help educate lake and shorefront property owners on how they, too, can create defensible space while complying with zoning laws related to shoreline vegetation protection. See the details at http://www.maine.gov/doc/mfs/ , or read a summary of the program at http://www.wildfireprograms.usda.gov/index.html.

Maine Forest Service

and development options. A few specific examples are presented below to give a flavor of the wealth of detailed information that is available. In addition to resources and Websites noted here, see also: Blonski and others 2010, NACo (2010), Schwab and Meck (2005), and Southern Group of State Foresters (no date); or visit the American Planning Association Website at http://www.planning.org/resources/, and Interface South at www.interfacesouth.org.

Community Education/Involvement Programs

Involving communities in educational programs about fire safety is preferred by many homeowners over regulatory programs (Ryan and others 2006) and can also increase support for fuels treatments on nearby wildlands (Winter and Fried 2000). Successful public education programs are designed to reflect local values, foster neighbor contact (Sturtevant and McCaffrey 2006), and clearly state who is responsible for specific actions: land management agencies, other community entities, and/or landowners. In this way, fire mitigation becomes a true community effort (Kent and others 2003).

Key Ingredients for Education Programs

- Publications on hazard reduction, fire protection and safety, landscaping, fire-resistant plants (White and Zipperer 2010), and defensible space are geared to specific geographical areas (Reams and others 2005); they not only provide "how to" information but also explain why a particular intervention is important, as well as the likely impacts of the recommended action (Monroe and others 2004).

- Varied educational approaches and information pathways meet differing learning styles (Monroe and others 2004)—including the Internet, printed brochures, local community meetings, and materials

Larry Kohrnak / InterfaceSouth

US Fish and Wildlife Service Southeast Region

Larry Kohrnak / InterfaceSouth

for local schools; as well as a variety of information distributers such as extension agents, stores, landscape architects, and real estate agents (Monroe and others 2004). For example, homeowners in one survey expressed a preference for receiving information about WUI policies via written communication sent through the mail, rather than advertisements, Internet, or signage (Winter and others 2009); participants in a different survey indicated that their best source of information on current wildfire risk was from roadside signs (McCaffrey 2008).

- Media attention helps to heighten understanding of the need for wildfire protection and planning (Reams and others 2005).
- Targeted materials are created specifically for local school teachers and students, including computer interactive materials (Reams and others 2005).
- Personal interaction includes conversations with agency employees, elementary school programs, guided field trips, and public meetings that truly engage all participants (Toman and Shindler 2006).
- Hands-on, practical assistance is offered to homeowners, appropriate for their individual properties (Brenkert and others 2006), including one-on-one consultation by trained personnel (Winter and others 2009).
- Materials and approaches reflect the attitudes, beliefs, and perceptions of homeowners. For example, landowners who value wildlife viewing might be more likely to adopt wildfire mitigation measures if materials explain the benefits of defensible space to wildlife viewing (Monroe and others 2004).

What do homeowners need to know?

In addition to information on reducing hazards in home ignition zones, homeowners also need to know that:

- Once an area is ordered to evacuate from a wildfire, there is no time for homeowners to conduct last-minute mitigation efforts, such as emergency fuels treatments (Brenkert and others 2006).
- Wildfire mitigation is not an-all-or-nothing task; a series of small and large-scale treatments can be implemented over time (Brenkert and others 2006).
- Vegetation management (such as prescribed burning or tree removal) must be a continuous effort and not a one-time activity (McCaffrey and others 2011).

Firewise Communities Program

Firewise Communities is a program of the National Fire Protection Association (NFPA) and is supported by the U.S. Forest Service, the Department of the Interior, and the National Association of State Foresters. The goal of the Firewise Communities Program is to encourage local solutions for wildfire safety by involving homeowners, community leaders, planners, developers, firefighters, and others in creating fire-adapted communities. A cornerstone of Firewise is the development of wildfire hazard mitigation plans; formal, national recognition as a Firewise/USA community; and creation of defensible space.

Communities benefit from national recognition in a number of ways: they get organizational help, connect with experts to learn about fire risk and mitigation, attain peace of mind from knowing what to do and how to do it, foster community-building as neighbors meet and work together, gain pride in achieving national recognition for their efforts, engender publicity that brings attention to the community's achievement and spreads the word to others, and receive access to funding and assistance (http://www.firewise.org). Since starting with 12 pilot communities in 2002, more than 700 communities now participate in 40 States.

The NFPA Firewise Communities Program also provides a wealth of educational tools through its Website (http://www.firewise.org) and a free online catalogue of print and audiovisual materials. Sections of the Website include publications, interactive models, research reports, courses and training, Firewise discussion templates, presentations, and videos. One publication of particular interest to developers is Safer from the Start: A Guide to Firewise-Friendly Developments (NFPA 2009). The Firewise goal for its educational outreach: "to teach people how to adapt to living with wildfire and encourage neighbors to work together and take action now to prevent losses."

NFPA Firewise Communities Program

Ready, Set, Go!

The Ready, Set, Go! Program is sponsored by the International Association of Fire Chiefs and the U.S. Forest Service. This collaborative process is intended to help fire departments encourage local citizens to create fire-adapted communities, through wildfire safety messages and training for emergency response preparedness.

Career and volunteer fire departments use the term "ready" to teach the defensible space message promoted by Firewise; "set" to educate the public about situational awareness during a fire; and "go" to prepare people for a safe and speedy evacuation. Designed to improve coordination and communication between emergency response agencies and communities, Ready, Set, Go! builds partnerships and helps communities clarify and refine priorities to protect life, property, infrastructure, and other valued resources. This program is unique in that it focuses on life safety aspects and preparedness to evacuate homes and neighborhoods. The program began in 2009 with 9 pilot fire departments; by 2011 nearly 400 fire departments across the country were participating. Visit: http://www.wildlandfirersg.org/.

A Sampler of Other Educational Resources

Numerous Western States have developed local programs and resources that would be useful in promoting fire-adapted communities elsewhere in the country as well. Here are a few examples:

Fire Safe Council—This California-based organization provides resources for establishing and maintaining local fire safe councils (FSC), including a media handbook, a communications manual, and a newsletter, as well as grant-writing workshops and brochures for homeowners. Visit http://www.firesafecouncil.org .

Living with Fire—This program from Nevada focuses on living more safely in high fire hazard locations. It offers a consistent set of guidelines for homeowners, teaching how to safely coexist with wildfire before, during, and after it occurs. Visit http://www.livingwithfire.info/.

Take Responsibility—This campaign was created by the California Fire Alliance to encourage homeowners in the WUI to create and maintain 100 feet of defensible space around structures. Download resources at http://takeresponsibility.cafirealliance.com .

Community Planning and Development Resources

Key Ingredients for Effective Planning

While individual homeowner actions are essential to reduce the potential for wildfire damage to property, it is also critical that entire communities work together at the broader planning and development scale. A study of 15 communities across the United States at high risk for wildfires revealed the following four factors to consider when planning for development and when designing community wildfire preparedness efforts (Jakes and others 2007):

- Landscape. Level of fire risk, location of a community, and the attachment of community members to the land, can all influence community members to take on wildfire preparedness measures.
- Government. In each community surveyed, government leadership and involvement (in the provision of funds, equipment, and expertise) were critical to community wildfire preparedness.
- Citizens. The ability of citizens to apply their knowledge and skills of local conditions and practices was also an important factor.
- Community. The existence of community and regional groups, such as neighborhood associations and collaborative groups working across a watershed or region, can strengthen wildfire preparedness efforts.

Community Wildfire Protection Plans

Community wildfire protection plans (CWPPs), encouraged by the Healthy Forests Restoration Act of 2003 (HFRA), provide a framework to identify and reduce wildfire risk and promote healthier forests (Jakes and others 2011). Such plans can be as simple or complex as a community desires (provided they contain the key features listed below) and are meant to reflect local social and ecological contexts (Jakes and others 2011, Schwab 2005). In some cases local citizens organize to take responsibility; in others, a homeowners association or a community Fire Safe Council takes the lead; in still others, particularly those with limited resources, State or Federal agencies can play a critical role in initiating the CWPP process (Jakes and others 2011). (See case study 4.)

The National Association of State Foresters (NASF) estimates that nearly 6,000 communities nationwide had developed and implemented CWPPs by 2009, but these accounted for less than 10 percent of the nearly 70,000 communities identified by NASF as being at-risk (Jakes and others 2011). Although communities often face shortages of financial, social, or political resources that can deter proactive actions such as developing CWPPs, some have reported that the CWPP process itself actually helped communities build their capacity to leverage resources and relationships, enabling them to tackle other projects (Jakes and others 2011). In a study of 13 communities that had developed CWPPs, some reported that the CWPP process helped reinforce public attitudes supporting fire planning efforts that were already in place before the planning process, while others noted that the planning process changed attitudes and built support for fire management (Jakes and others 2011).

Key features of a community wildfire protection plan (SAF 2004) include:

(1) Collaboration,

(2) Identification and prioritization of areas for fuel reduction activities, and

(3) Taking steps to treat ignitability of structures.

For more information, download a handbook at: http://www.stateforesters.org/files/cwpphandbook.pdf .

CASE STUDY 4: COMMUNITY PLANNING AND WILDFIRE PROTECTION PLANS IN OREGON

Located in southwestern Oregon, Douglas County includes more than 5,000 square miles of land at high risk of wildfire, stretching from the Pacific Coast to the Cascade Mountains. More than half the land in the county is managed by the U.S. Forest Service or Bureau of Land Management.

In 2004 and 2005, the Douglas County Board of Commissioners directed the county planning department to develop community wildfire protection plans (CWPPs) for its at-risk communities. The resulting plans—which include an overall plan for the county and smaller plans for each of the 30 identified at-risk communities—provide a model of how a large county with multiple at-risk communities can structure a cohesive plan.

The CWPPs were developed according to Healthy Forest Restoration Act (HFRA) guidelines. The core team included wildfire specialists from the Douglas Forest Protective Association, Bureau of Land Management, Umpqua National Forest, Douglas County Sheriff, Office of Emergency Management, and Douglas County Planning Department. The team's risk assessment identified fuel reduction areas for each community, prioritized fuel reduction strategies, and developed plans to reduce wildfire hazards around each at-risk community. Each community then identified the specific areas where it wanted fuel reduction treatment to occur.

A key feature of the project was the development of action items to reduce structure ignitability and to help people protect themselves and their homes. These included:

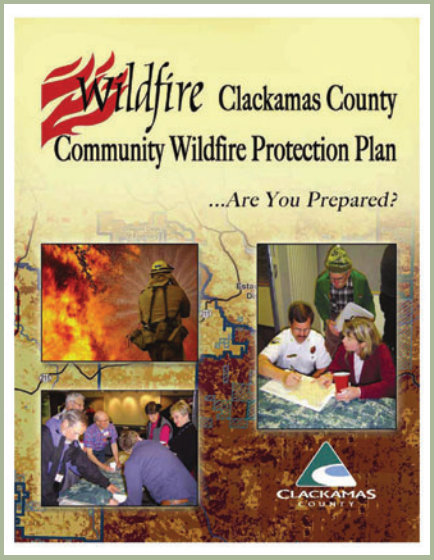
√ Educating homeowners about defensible space and fire-resistant materials;

√ Seeking assistance for homeowners to implement defensible space activities;

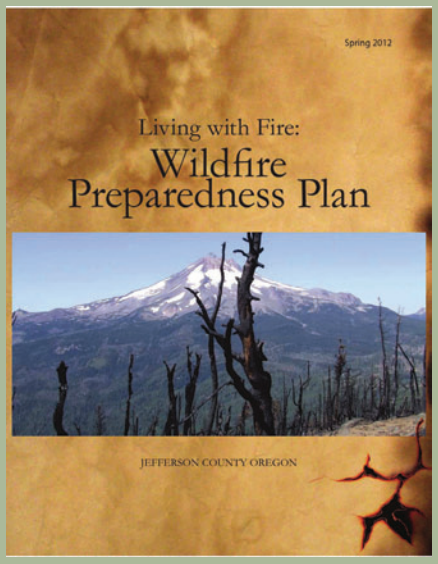
√ Promoting existing education and outreach programs such as Firewise, and developing other community education programs; and

√ Training volunteer firefighters to assist paid firefighters.

—Source: National Database of State and Local Wildfire Hazard Mitigation Programs, http://www.wildfireprograms.usda.gov/index.html.



Clakamas County, Oregon



Jefferson County, Oregon

Zoning Ordinances and Codes

Local ordinances and codes can be an important element of community preparedness and protection in fire-prone areas (Dombeck and others 2004, Schwab and Meck 2005). These can include mandatory defensible space standards, wildfire review processes for planned developments, subdivision regulations, development plan standards, real-estate disclosure of wildfire hazard zones, and insurance incentives for reducing risks in home ignition zones (Blonski and others 2010, Reams and others 2005, Schwab and Meck 2005). (See case study 5.) Typically, a hazard or risk is identified before zonings and codes are put in place. Blonski and others (2010) provides a helpful overview of accepted threat assessment methods.

A suite of codes and standards from the National Fire Protection Association can help a community address wildland fire. These include NFPA 1141, Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas, which provides recommendations for planning fire protection infrastructure for new developments in a community; and NFPA 1144, Standard for Reducing Structure Ignition Hazards from Wildland Fire, which covers minimum design, construction, and landscaping elements for structures in the WUI (http://www.nfpa.org/catalog/). Additionally, the International Code Council has developed international codes, or I-Codes, providing minimum safeguards in a number of areas. The International Wildland Urban Interface Code (ICC 2008) contains provisions addressing fire spread, accessibility, defensible space, water supply, and other considerations for buildings constructed near wildland areas (http://www.iccsafe.org/).

CASE STUDY 5: FIREWISE-FRIENDLY DEVELOPMENT: RIVER BLUFF RANCH, WASHINGTON

River Bluff Ranch, a community developed in Spokane, WA, built Firewise-friendly elements into its infrastructure and guiding documents or covenants. The covenants include access requirements for firefighting and evacuation, including paved two-lane roads, secondary evacuation roads, and a network of forest roads. Also required are underground utilities; a series of non-potable-water storage tanks with dry hydrants (non-pressurized pipe systems); and fire-resistant roofing, double-paned windows, deep side yard setbacks, defensible space, and vegetation maintenance. The covenants further require that the community's homeowners' association enforce the covenants, educate the residents, maintain the roads and water storage facilities, manage an ongoing forest stewardship program, and implement the recommended Firewise Communities budget (in 2009, $2 per person) to be used for future Firewise efforts.

—excerpted from NFPA (2009)

Steve Wallin / Windermere Real Estate

It's the Code!

Many rural counties throughout the Western United States are adopting what they call the "Code of the West"—an advisory letter informing people about what it takes to live in the country. In the category called Mother Nature, the Code as adopted recently by commissioners in Stevens County, MT, advises:

"The physical characteristics of your property can be positive and negative. Trees are a wonderful environmental amenity, but can also involve your home in a forest fire. Building at the top of a forested draw should be considered as dangerous as building in a flash flood area. 'Defensible perimeters' are very helpful in protecting buildings from forest fire and inversely can protect the forest from igniting if your house catches on fire. If you start a forest fire, you are responsible for paying for the cost of extinguishing that fire" (Henneman 2011).

While these "codes" are neither universal nor enforceable, they indicate that some Western residents are concerned about growth in their communities and aware of the challenges from wildfire that accompany life in the wildland-urban interface.

SUMMARY AND CONCLUSIONS

Although wildfire has been and will continue to be fundamental to the ecological health of many wildland areas, wildfires can harm people and their homes, especially when weather, vegetation, and terrain create extreme conditions, and when communities are unprepared. People who live in the wildland-urban interface or WUI in particular may face increasing risk and property damage from wildfires of all sizes in coming decades. From 1990 to 2000 alone, the WUI increased by 18 percent and is expected to increase further in the years ahead. Homes and other structures across the United States, in a wide range of vegetation types from forests to shrub lands and grasslands, have already been lost to wildfire. Numerous opportunities are available for planners, developers, and others to help WUI communities adapt to wildfire through education, planning, and mitigation activities that can help limit the number of ignitions, reduce flammable vegetation, create Firewise homes, and thereby establish fire-adapted communities.

As with previous Forests on the Edge reports and other national assessments, the findings of this report derive from data available at a national level and may not precisely describe projections for all individual locations. Nonetheless, our findings can provide a useful tool for decreasing the potential for wildfire damage to homes, and for increasing the number of fire-adapted communities across the country.

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Wildfire smoke, seen from space.

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US Fish and Wildlife Service Pacific Southwest Region

FORESTS ON THE EDGE

Forests on the Edge is a project of the U.S. Department of Agriculture, Forest Service, State and Private Forestry, Cooperative Forestry staff, in conjunction with Forest Service Research and Development, National Forest System staff, universities, and other partners. The project aims to increase public understanding of the contributions of and pressures on America's forests, and to create new tools for strategic planning. The first report (Stein and others 2005) identified private forested watersheds in the conterminous United States most likely to experience increased housing density. Subsequent reports have provided more in-depth discussion and data on: the development pressures on America's national forests and grasslands (Stein and others 2007), the impacts of increased housing density and other pressures on private forest benefits (Stein and others 2009), threats to at-risk species (Stein and others 2010), and sustaining America's urban trees and forests (Nowak and others 2010), among others. This report presents an overview of the relationship between housing in the wildland-urban interface and wildfire, including preventative measures that can help to create fire-adapted homes and communities.

Future Forests on the Edge work will include impacts of increased housing density in Hawaii, Puerto Rico, the U.S. Virgin Islands, and U.S.-affiliated Pacific Islands; impacts of forestland development on water resources; a report on America's private forest landowners; assessments of additional private forest benefits and risks; and construction of an Internet-based system that permits users to view, combine, and depict results for selected contribution and threat layers.

For further information on Forests on the Edge, contact:

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