Local Fire Department Responses to Wildfires in the US: National Estimates Based on 2004–08 Data

MARTY AHRENS
Fire Analysis and Research Division
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169 USA

ABSTRACT

While large wildfires make news, many are unaware that local US fire departments responded to an estimated average of 356,800 brush, grass, or forest fires (collectively called wildfires) per year during 2004–08. Wildfires accounted for 23 % of fires handled by local fire departments. Three-quarters (74 %) of these fires burned less than one acre (0.4 ha). Using data from the National Fire Protection Association's (NFPA) annual fire department survey and the US Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS), this paper examines the causes and circumstances of these fires. Wildfires handled solely be federal agencies are not included in these estimates. Local fire departments handled almost five times as many wildfires the number of wildfires reported by wildland fire agencies to the National Interagency Fire Center.

Nine percent of the locally handled wildfires occurred at one- or two-family homes. During this period 4,800 buildings, on average, were involved annually in wildfires handled by local fire departments. The leading causes of wildfires were intentional (20 %), hot embers or ashes (17 %), outside fires for debris or waste disposal (15 %), high wind (13 %), smoking materials (12 %), playing with heat source (6 %), fireworks (5 %), and lightning (4 %). The cause profile varies by type of fire and type of material first ignited. Lightning caused 15 % of the forest fires but only 4 % of wildfires overall.

Landscaping choices can influence the probability of both ignition and fire spread. Mulch fires have become a concern.

KEYWORDS: statistics, wildfires, fire department responses, brush fires, forest fires.

INTRODUCTION

Nine of the 25 costliest fires in the US were described as either wildland or wildland/urban interface fires. Eight of the nine were in the last two decades [1]. In this analysis, the term 'wildfire' is used to describe any hostile fire involving natural vegetation, such as grass, brush, or forests. The term 'wildland/urban interface' is used to describe locations where the natural vegetation is close to places where people live or work.

The National Interagency Fire Center (NIFC), a group of eight agencies and organizations with wildland firefighting as part of their mission, is the US center of wildland firefighting support. NIFC collects data about fires handled by these federal agencies, such as the US Forest Service, Park Service, Bureau of Land Management, Fish and Wildlife Service, and Bureau of Indian Affairs, as well as state agencies that have their own firefighting organizations.

In the United States, local fire departments handle fires in their communities. Around the country, these local fire departments document their responses using the US Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS). NFIRS participation is voluntary at the federal level. The states set their own reporting requirements, ranging from mandatory for all incidents to completely voluntary. The states actually collect the NFIRS data and then forward it to the USFA.

Some fires, particularly those handled by state agencies or incidents in which state or national agencies assisted a local department, may be captured by both NFIRS and the NIFC data collection system. Unfortunately, the amount of overlap is unknown. Also, differences between the two data collection systems and the definitions used make it challenging to compare the two.

FIRE SAFETY SCIENCE-PROCEEDINGS OF THE TENTH INTERNATIONAL SYMPOSIUM, pp. 1389-1400
 / DOI: 10.3801/IAFSS.FSS.10-1389

NIFC data show that the number of wildfires handled by wildland fire agencies has been fairly stable over time since the late 1980s. Rolling five-year averages ranged from a low of 67,000 per year in 1987–91 to a high of 86,000 in 1996–2000. However, the severity of these fires has generally been increasing in terms of both the total number of acres burned and average number of acres burned per fire. Although the amount of land burned varies greatly from year to year, the number of total hectares burned in fires handled by federal and state wildland fire agencies increased from an average of roughly one million hectares (three million acres) per year in the late 1980s through the mid 1990s to roughly three million hectares (eight million acres) annually in recent years. The average number of hectares burned per fire doubled over the same period [2].

With these trends, it is no surprise that national fire agencies and laboratories are devoting more resources to preventing and mitigating fires in the wildland/urban interface. While these larger fires have been the impetus for increased attention, they should not be the sole focus. Wildfire agencies reported an average of 78,700 fires per year to NIFC during 2004–08. The vast majority of wildfires are handled by local fire departments.

During 2004–08, local fire departments in the US responded to an estimated average of 356,800 wildfires per year, almost five times the number reported to NIFC. Local responses to these incidents, ranged from a low of 310,200 in 2004 to a high of 401,200 in 2006. Wildfires accounted for almost one-quarter (23 %) of all fires handled by local fire departments in 2004–08. While most wildfires stayed small, they can tax local fire department resources and pose a threat to structures and vehicles. These fires are often overlooked by researchers focusing on the wildland/urban interface. People living outside areas where large wildfires are common, particularly those in cities and suburbs, are often unaware that wildfires can occur in their backyard and threaten their home.

In this analysis, data from the National Fire Protection Association's (NFPA) annual fire department survey and the US Fire Administration's (USFA) National Fire Incident Reporting System (NFIRS) were used to estimate the size of the wildfire problem handled by local fire departments and to gain a better understanding of where and how these fires occur. The findings suggest some prevention and mitigation strategies that should be considered for use throughout the country, not just in areas designated as wildland/urban interfaces.

METHODOLOGY

NFIRS provides a standard data classification or coding system that fire departments around the country use to document where, when and how fires occurred. Data elements include alarm and arrival times, incident type, property use, cause of ignition, factor contributing to ignition, heat source, item first ignited, type of material first ignited, area of origin, equipment involved in ignition, number of acres burned, and more. For most data elements, a standard list of code choices is provided. In some cases, NFIRS definitions may differ from those used by other organizations. NFIRS terminology is generally used in this analysis because it is what the firefighters who provided the data used to complete the reports.

Participating fire departments typically submit their incident reports through state agencies. The USFA compiles the data nationally.

The terminology used by the current version of NFIRS (Version 5.0) has four incident type codes that address wildfires:

> 141. Forest, woods or wildland fire. This includes fires involving vegetative fuels, other than prescribed fires, that occur in an area in which development is essentially nonexistent, except for roads, railroads, power lines, etc. It also includes forests managed for lumber production and fires involving elevated fuels such as tree branches and crowns.
>
> 142. Fire involving brush or brush and grass mixture, including ground fuels such as duff, roots, dead leaves, fine dead wood, and downed logs.
>
> 143. Grass fire with little or no involvement of other ground fuels.
>
> 140. Unclassified natural vegetation fire.

These incident types exclude prescribed fires and fires involving crops, orchards, or nursery stock [3].

Separate analyses were done for: a) fires involving brush or brush and grass mixtures; b) grass fires; c) forest, woods, or wildland fires; and d) total wildfires, including unclassified natural vegetation fires. NFIRS uses the term 'natural vegetation fires' to describe wildfires regardless of their causes. Unclassified natural vegetation fires are included in the totals, but no further analysis was done of these incidents.

Although NFIRS incident type 141 captures forest, woods, or wildland fires, it does not capture all the losses associated with wildfires in the same way that the media, land management organizations and the National Interagency Fire Center (NIFC) do. If a wildfire spreads to structures or vehicles, these structures and vehicle fires would be captured in NFIRS as structure or vehicle fires, not as wildfires.

Fire departments around the country participate in NFIRS but different states have different reporting requirements. Over the five-year period of 2004–08, a total of 993,171 fires were reported to NFIRS 5.0 with one of the four incident types listed above. Using the basic approach described by Hall and Harwood [4] with estimates of total outdoor fires from Karter's series of annual reports on US fire losses [5], multipliers were obtained by dividing Karter's estimates of all outside (non-structure, non-vehicle) and unclassified hostile fires by the number of such incidents reported in NFIRS each year. Fires in NFIRS 5.0 with the four incident types above were multiplied by the scaling ratio to calculate national estimates.

The statistics in this analysis are national estimates of fires reported to US municipal or county fire departments and so exclude fires reported only to federal or state agencies or industrial fire brigades. For most fields (data elements), fires with unknown or missing data were allocated proportionally. Results are generally presented as multi-year averages.

Defining and Handling Unknown or Partially Unknown Data in Specific Data Elements

For the NFIRS field "cause of ignition," the data element used to identify intentional fires, fires coded as "under investigation" or "undetermined" after investigation were treated as unknown. The cause of ignition was known in 62 % of the reported wildfires.

Playing with fire, heat source, outside or open fires for debris or waste disposal, and high winds are among the choices in the field "factor contributing to ignition." Multiple entries are allowed in this field, resulting in sums greater than the total number of fires. Code choices include the word "none", indicating that nothing played a role in how the heat source and fuel combined to ignite. This seems unlikely. When the code "none" is the only entry, it is treated as an unknown and allocated proportionally. The factor contributing to ignition was coded as none, undetermined or left blank in 70 % of the total wildfires

Hot embers or ashes, smoking materials, matches, lighters, lightning, and fireworks are some of the heat sources captured in NFIRS 5.0. One grouping of codes (heat source 60–69) encompasses various types of open flames, such as matches, lighters, and candles, as well as smoking materials including cigarettes, pipes, cigars, and undetermined smoking materials. In addition to the conventional allocation of missing and undetermined fires, code 60 – "heat from open flame or smoking material, other" – was treated as a partial unknown and allocated proportionally among the fires with heat sources in 61–69 range. In total wildfires, code 60: "heat from open flame or smoking material, other" was entered for 3 % of the fires. The heat source was undetermined in 58 % of total wildfires.

The field "equipment involved in ignition" is used to identify equipment that provided the heat of ignition. By itself, this field does not distinguish between equipment that was operating properly or improperly. In some cases, fires were coded as having no equipment involved in ignition but a heat source indicating operating equipment. Fires in which the equipment involved in ignition was coded as no equipment involved in ignition (NNN) and heat source was not in the code range of 40–99, indicating something other than operating equipment, were treated as unknown. The equipment involved in ignition was undetermined, not reported, or coded as no equipment with a heat source code outside the range of 40–99 (non-equipment related heat sources) in 91 % of total wildfires. In addition, the partially unclassified codes for broad equipment groupings (e.g., code 100 – heating, ventilation, and air conditioning, other; code 200 – electrical distribution, lighting and power transfer, other; etc.) were allocated proportionally across the individual code choices in their respective broad groupings (heating, ventilation, and air conditioning; electrical distribution, lighting and power transfer, other etc.).

The type of material first ignited is not required when the item first ignited in an organic material such as vegetation or crop; or a general material such as electrical wire; dust, fiber or lint; rubbish, trash or waste;

railroad ties; or multiple items. It is sometimes completed anyway and was analyzed when present. The type of material first ignited was undetermined or unreported but required in 52 % of total wildfires. The field was not required and left blank in 31 % of the fires. Fires in which the type of material first ignited was blank because it was not required were excluded from the calculation to allocate unknown data.

RESULTS

During 2004–08, local US fire departments responded to an estimated average of 356,800 wildfires per year. Figure 1 shows that two out of five (41 %) of these wildfires involved brush or mixtures of brush and grass; more than one third (37 %) were grass fires; 10 % were forest, woods or wildland fires; and 12 % were unclassified natural vegetation fires. During this period, 4,800 buildings, on average, were involved annually in wildfires handled by local departments. While the peak months for these fires were March and April, Independence Day (July 4th) was the peak day for these incidents. Fireworks are a major part of Independence Day celebrations.

Unlike the wildfires that make the news, 57 % of forest, woods, or wildland fires and 72–77 % of the remaining types of fires consumed less than 0.4 ha (less than one acre). Nine percent of the forest, wildland, or wood fires consumed more than four hectares (ten acres) compared to 3–4 % of the remaining types of fires.

One reason that forest, woods, or wildland fires were likely to grow larger than other vegetation fires is that the response time tended to be longer. It took local fire departments 15 min or more to reach 21 % of the forest, woods, or wildland fires. For the other types of wildfires, only 11–12 % of the responses took that long. Also, only 28 % of forest, woods, or wildland fires were reached within five minutes, compared to 38–40 % of other types of wildfires.

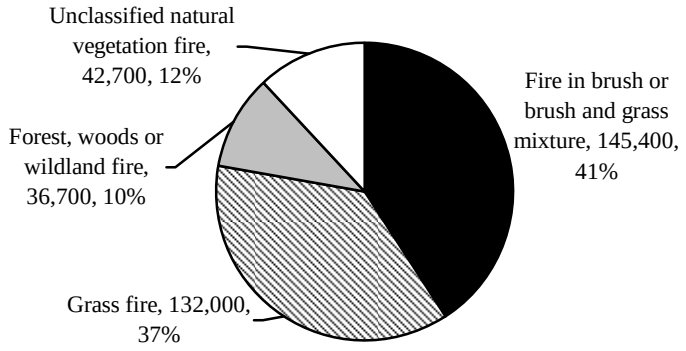

Fig. 1. Local fire department responses to wildfires by incident type: 2004-08 annual averages.

Figure 2 shows that more than one third of wildfires occurred on properties described as open land or fields. For fires involving brush or mixtures of brush and grass, and for grass fires, the second most common property use mentioned was highway, street, or parking area; one- or two-family homes ranked third. Forests, timberland, or woodland ranked second among the forest, woods, or wildland fires. Although these incidents were outside fires, in many cases, the property use data element was used to record the structure on the property rather than the land itself.

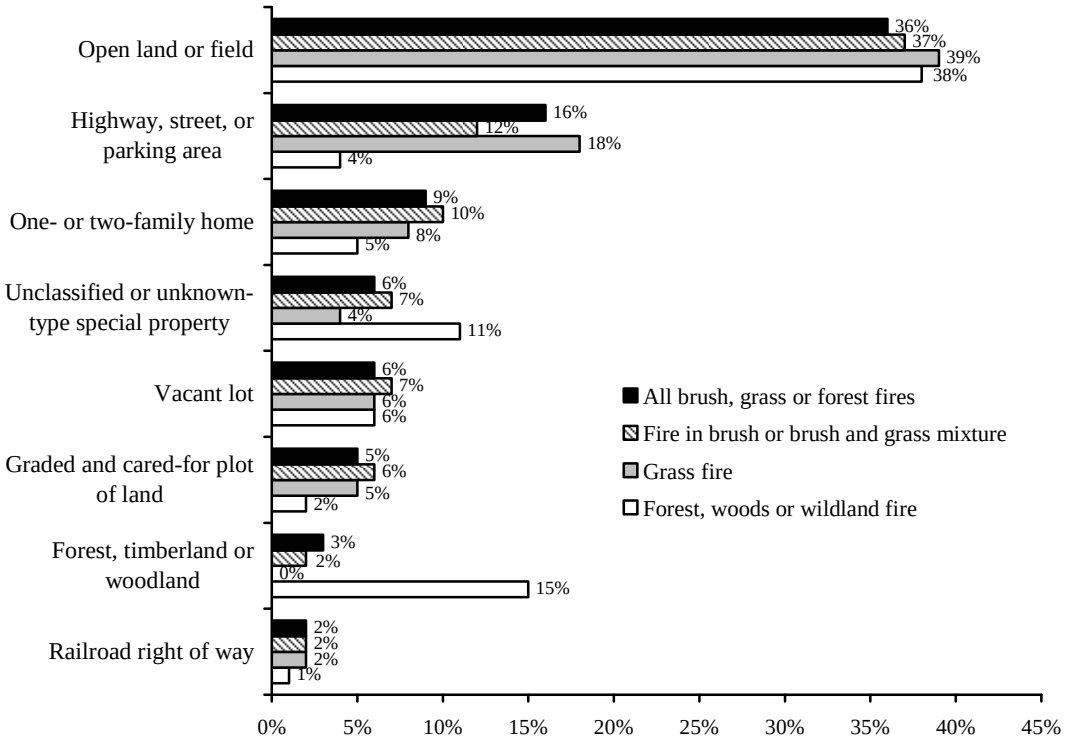

Fig. 2. Local fire department responses to wildfires by property use and incident type: 2004–08.

Fires by US Census Region

The US Census Bureau divides the 50 states and Washington, DC into four census regions. Figure 3 shows the states that are in each census region. In 2008, the Northeast, with only 5 % of the area and 18 % of the population, was the most densely populated. The South covers 24 % of the area and had the largest share (37 %) of the population. The Midwest had 22 % of the area and the same share of the population. The West had 49 % of the area, but only 22 % of the population [6].

Fig. 3. US Census regions.

While most of the wildfires in the news occur in the West, Fig. 4 shows that fire departments in the South made 54 % of all local fire department responses to wildfires. The Midwest ranked second.

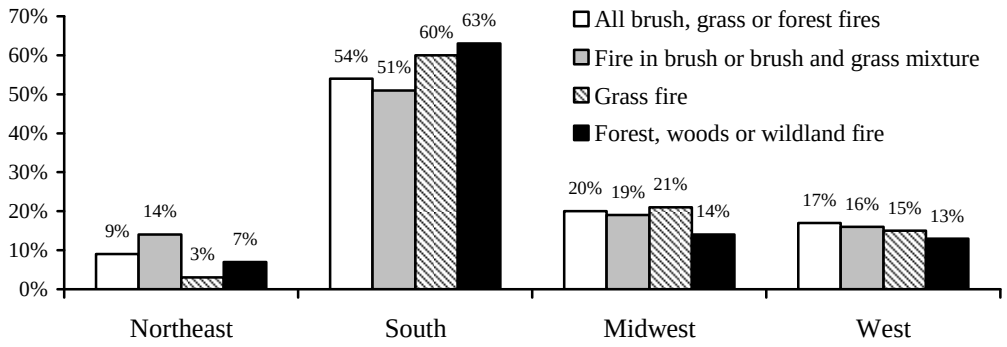

Fig. 4. Local fire department responses to wildfires by census region and incident type: 2004-08.

Local fire departments in the Northeast had the smallest percentages of all types of reported wildfires. The distribution of fires in the Northeast was also different. Fires involving brush or brush and grass mixtures accounted for almost two-thirds (64 %) of the brush, grass or forest fire responses in the region, compared to 38 % in the South, Midwest, and West. Fires involving grass only accounted for only 12 % of these fires in the Northeast compared to 33 % to 41 % in the other three regions. One percent of total reported wildfires were reported in territories or other US areas outside the four census regions. These are not shown here.

Figure 5 shows that the South also had the highest rate of total wildfires per 1,000 square miles overall as well as the highest rate for grass and forest fires specifically. The Northeast ranked second overall but led the country in the rate of fires involving brush or brush and grass mixtures. Local fire departments in the West had the lowest rate for all types of wildfires studied. This may seem counterintuitive. However, large parts of the West are not protected by local fire departments.

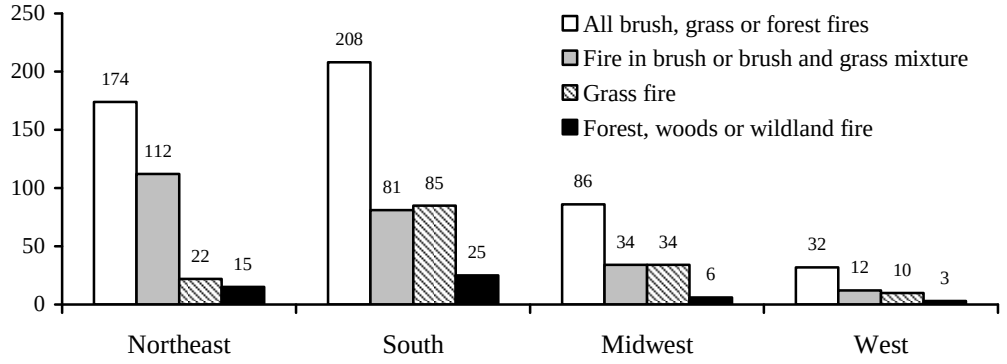

Fig. 5. Local fire department responses to wildfires per 1,000 square miles by census region and incident type: 2004-08.

The National Atlas of the United States reports that the various parts of the US federal government own almost 30 % of the land area in the country [7]. Most federally owned lands are in the Western region. Table 1 shows that 80 % of the forested land owned by federal or state government is located in the West [8]. State data were summed to obtain totals for each census region as the report uses a different regional grouping. Properties owned by Indian tribes are considered private property. Federal agencies such as the US Bureau of Land Management, the Bureau of Indian Affairs, the Fish and Wildlife Service, the National Park Service, and the Forest Service handle fires on their own properties. State forest services also maintain firefighting crews. In many cases, homes or communities abut these lands. Fire in one jurisdiction can spread to other jurisdictions. Federal and state agencies may also provide assistance when local fire departments need help fighting larger wildfires in their jurisdictions.

Local fire departments are less likely to be involved in firefighting on federal properties and state parks and more likely to be fighting fires on private property or land owned by the municipality or county. Table 1 shows that 46 % of the forested land owned privately or by county or municipal governments were in the South. The Northeast had the smallest amount of forested land in all categories of ownership.

Table 1. Forest land area in the US in 2007 by census region and ownership expressed in million hectares.

Region	**Federal and state**		**County and municipal**		**Private**		**Total forested hectares**		***Private plus county and municipal***	
Northeast	5.1	(4 %)	0.8	(17 %)	22.4	(13 %)	28.2	(9 %)	23.2	(13 %)
South	11.6	(9 %)	0.9	(21 %)	80.4	(47 %)	92.9	(31 %)	81.3	(46 %)
Midwest	9.5	(7 %)	2.3	(51 %)	25.9	(15 %)	37.6	(12 %)	28.2	(16 %)
West	102.3	(80 %)	0.4	(10 %)	42.5	(25 %)	145.2	(48 %)	42.9	(24 %)
Total	128.4	(100 %)	4.5	(100 %)	171.2	(100 %)	304.0	(100 %)	175.6	(100 %)

How These Fires Start

Figure 6 shows the leading causes of wildfires with data summarized from several NFIRS fields. Because the causes are pulled from different NFIRS fields, they are not mutually exclusive. The leading causes of all reported wildfires were: intentional (20 %), hot embers or ashes (17 %), outside fires for debris or waste disposal (15 %), high wind (13 %), smoking materials (12 %), playing with heat source (6 %), fireworks (5 %), electrical power or utility lines (4 %), and lightning (4 %). The cause profile varies by type of fire and type of material first ignited. Lightning caused 15 % of the forest fires but only 4 % of these fires overall. While high wind is not itself a heat source, wind can cause non-hostile fires, such as campfires or fires for open burning, to spread out of control.

Prevention strategies depend on the level of intent and human involvement. Communities that investigate and prosecute brush, grass and forest arson can deter potential arsonists. Supervising children can reduce fires started by playing with heat source.

Anyone who uses outside fire for recreation or waste disposal needs to be sure that the fire is fully extinguished and that the ashes are disposed of properly. NFPA's Educational Messages Advisory Committee advises that such fires should not be used on windy days and that all outdoor fires be closely supervised [9]. Cigarette butts should be placed into non-flammable containers, not tossed onto the ground. NFPA also advises that fireworks should be left to the professionals [10].

Lightning is a natural occurrence. The prevention goal for fires started by lightning is to minimize the potential for damage by reducing the amount of easily burnable material. This approach also provides protection when other ignition prevention methods fail. NFPA advises that people create a "fire break" around the home that excludes highly resinous plants and is kept free of dead leaves, pine needles, etc. [11]. Efforts should also be made to reduce the risks posed by sparks or hot surfaces from operating equipment. These may include design changes to the equipment, barriers to protect the vegetation, and education about the risks.

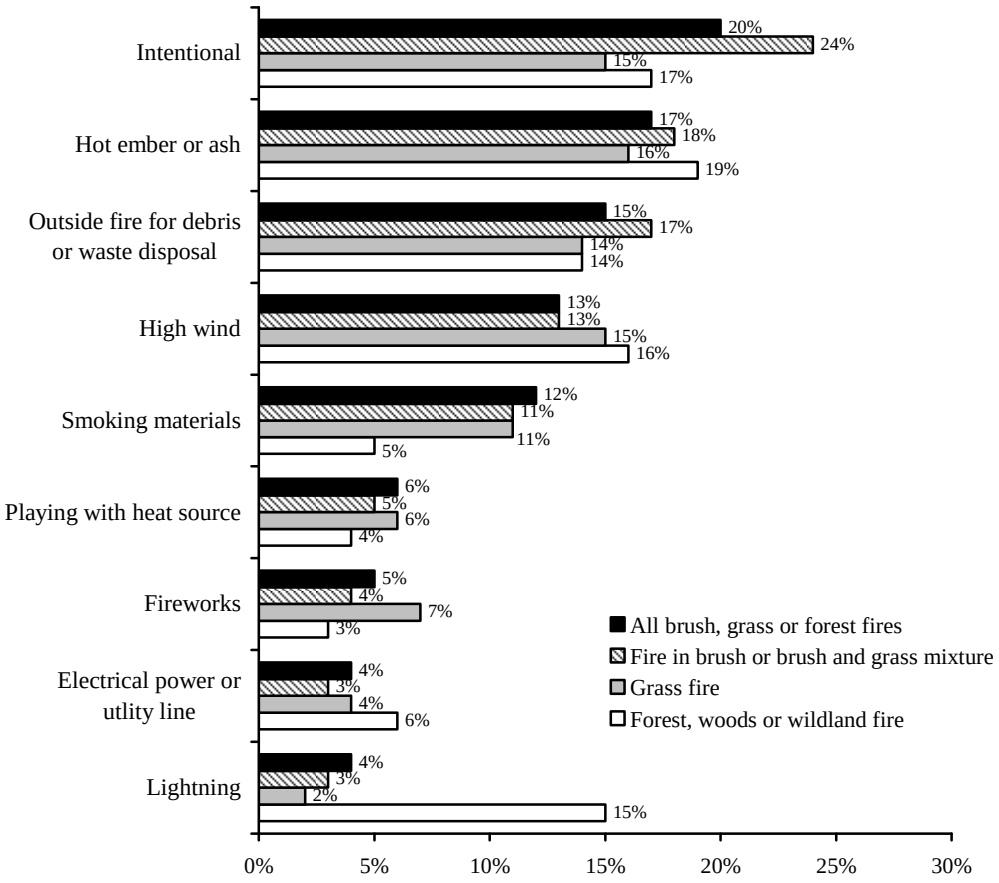

Fig. 6. Local fire department responses to wildfires by major cause and incident type: 2004–08.

Different fuels are likely to be ignited by different heat sources and burn differently once ignited. Figure 7 shows that an unclassified natural product was first ignited in one-quarter to one-third of these fires. Hay or straw was first ignited in 19 % of the grass fires and 8–12 % of the other wildfire types. Wood chips, sawdust, or shavings were first ignited in 8 % of the fires involving brush or brush and grass mixtures and of total wildfires.

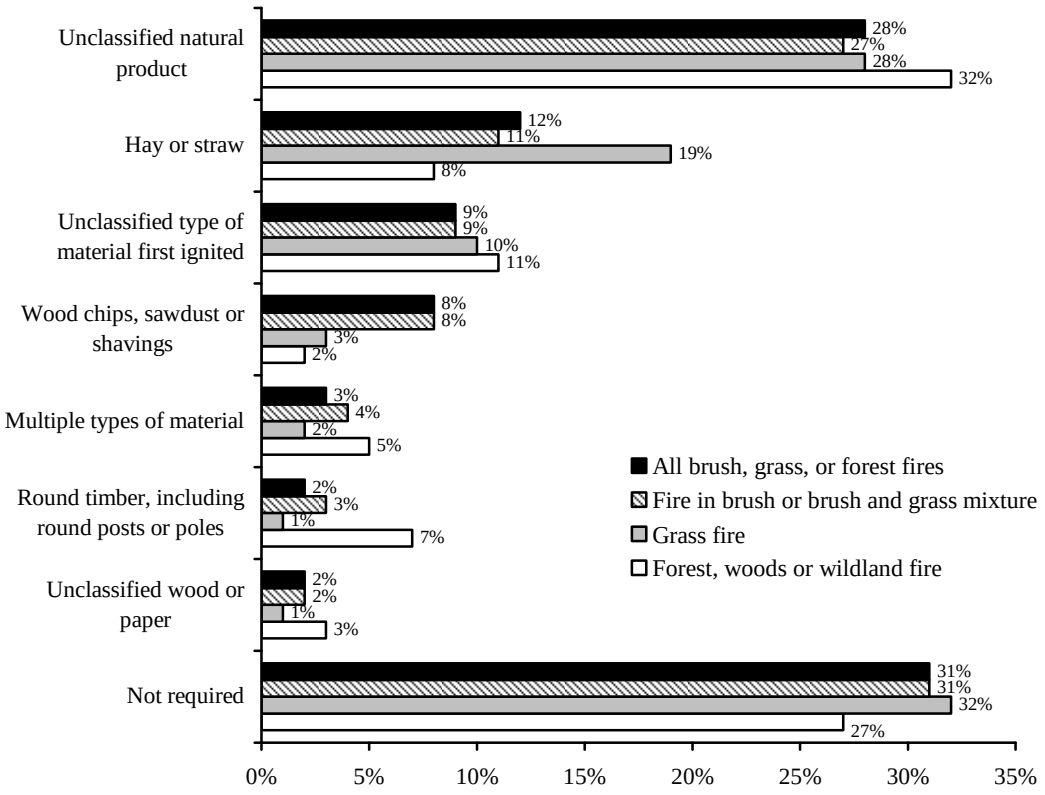

Fig. 7. Local fire department responses to wildfires by type of material first ignited and incident type: 2004–08.

Mulch Fires

As more homes and businesses ban indoor smoking, a larger share of smoking is done outside. As a strategy to prevent smoking-related fire fatalities, moving smokers outdoors is a good idea. However, it increases the frequency of lit cigarette contact with outdoor combustibles, including landscaping mulch, leaves, and other vegetation. In a 2008 article, Finucane wrote that the Johnston City, Tennessee Fire Department responds to an average of 100 mulch fires per year. He noted that the burning mulch was sometimes right next to a commercial or residential building. The burning mulch can ignite the underside of the structure's siding and spread into the structure. Large piles of mulch can spontaneously ignite [12].

On May 26, 2010, the Massachusetts Department of Fire Services issued a press release encouraging people to keep smoking materials out of bark mulch. They noted that in the past five years, Massachusetts had 184 fires that began with mulch but spread to buildings. A 2008 Massachusetts fire caused $5 million in damage to a sprinklered apartment building. Thirty-six residents were permanently displaced [13].

In a 2003 article, Steward, Sydnor, and Bishop reported on their findings about how easily 13 landscape mulches were ignited by cigarettes, matches, and a propane torch [14]. Ground recycled pallets, composted yard waste, and shredded pine bark were most easily ignited by cigarettes. Decorative ground rubber, pine straw, and oat straw were the most easily ignited by the propane torch. They did not find statistically significant differences in tests with matches. The authors also noted that weathering increased the ignitability of some mulches and decreased others.

In their 2007 paper on mulch flammability, Zipperer and his colleagues noted that other factors, such as how long the item burns, how much heat is produced, and how much of the fuel is consumed, are also important [15]. They studied four different mulches: pine straw; shredded cypress wood and bark; small pine bark chunks; and large pine bark chunks under laboratory and field conditions. They found the pine

straw was easiest to ignite. The large pine bark and pine straw produced large amounts of heat and had high rates of consumption. However, the pine straw burned for the shortest length of time. The authors note:

> "Each one of the tested mulches burned and none are 100 % safe. Mulch should not be used next to flammable material or vinyl surfaces on buildings…Only decorative gravel or stones or some other non-flammable material should be used immediately adjacent to the home…"

NFIRS does not specifically identify mulch. In some cases, the mulch is probably coded as unclassified natural product, the leading type of material first ignited in wildfires. Unfortunately, that category is not specific enough to provide much useful information. An analysis of heat sources in wildfires beginning with two types of material that could be mulch – a) wood chips, sawdust, and shavings; and b) hay or straw – found that the first group was more likely to have been ignited by smoking materials.

Figure 8 shows that smoking materials were the heat source in 48 % of the wildfires that began specifically with wood chips, sawdust, or shavings. This is four times the 12 % of all wildfires started by smoking materials. Hot embers or ashes were common sources for both hay or straw and wood chips. Matches were more common sources of fires beginning with hay or straw. In general, fires starting with hay or straw were more likely than wood chips, sawdust or shavings to have had a flaming ignition source such as matches (16 % vs. 3 %), lighters, (6 % vs. 3 %), and fireworks (6 % vs. 1 %). Arcing was also a more frequent heat source in hay or straw fires (5 % vs. 1 %). Smoking materials have already been discussed. An unclassified hot or smoldering object was the heat source in only 5 % of the hay or straw fires compared to 13 % of the wood chips, sawdust or shavings fires.

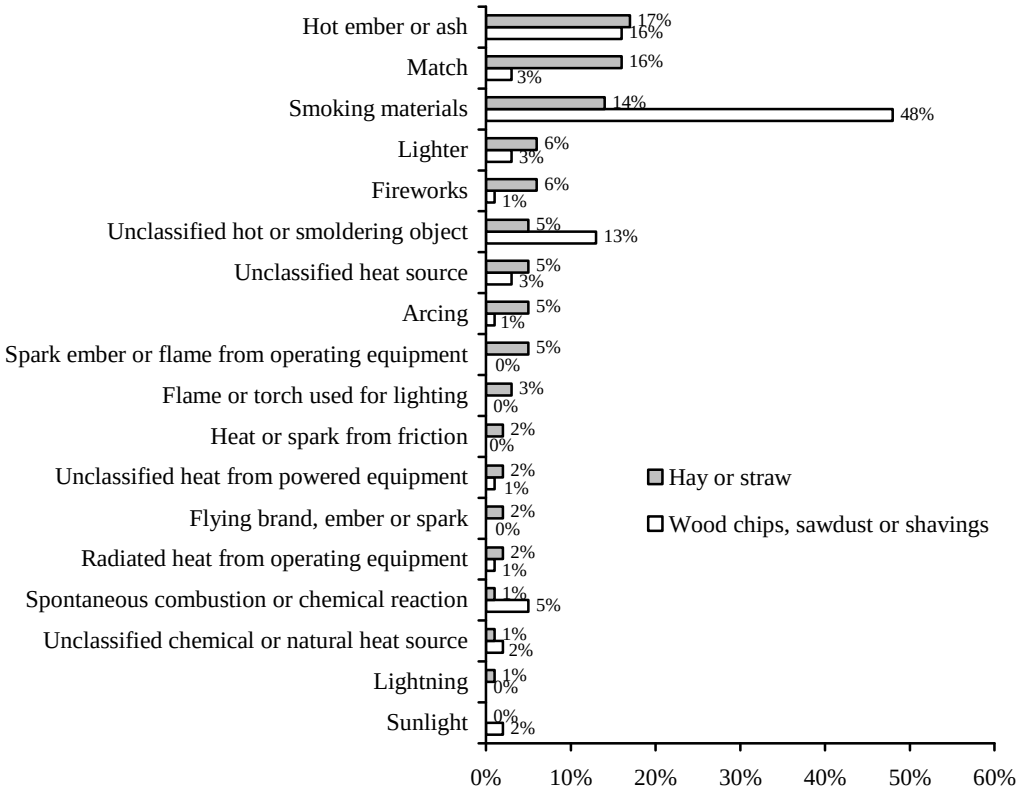

Fig. 8. Local fire department responses to wildfires that began with wood chips, sawdust, or shavings compared to wildfires that began with hay or straw: 2004–08.

DISCUSSION

While large wildfires are widely recognized as a major issue, wildfires are an underappreciated part of the fire problem faced by communities all over the US. Local fire departments respond to an average of almost 1,000 wildfires every day. Although most of the largest wildfires have been in the West, the South had the largest number and highest percentage of overall wildfires. The Northeast had the smallest number of incidents but it had the highest rate of fires involving brush or brush and grass mixtures per square mile.

These fires often occur on properties where people live, work, or travel. Nine percent occurred at one-or two-family homes. A wildfire can spread to buildings or vehicles on the property. A fire that starts outside a building can get into the concealed spaces between the exterior and interior. A fire inside the wall or attic space can spread undetected until it gets into the living space [16].

Many of the same wildfire safety strategies employed by property owners and residents in high-risk areas can reduce the likelihood of structural ignition or fire spread from wildfires outside the wildland/urban interface. Cigarettes butts should be placed in non-flammable containers, not on the ground. Recreational and open burning fires should not be allowed on windy days or when conditions are too dry. All recreational or open burning must be supervised until it is fully extinguished.

Landscaping practices can increase or decrease the risk of spread should a fire start. Some vegetation is more easily ignited and burns more intensely than others. Unfortunately, many landscapers and home gardeners, particularly those outside of areas prone to devastating wildfires, have never heard how their choices of vegetation can increase or decrease safety. Landscaping that uses gravel or other non-combustible material instead of organic mulch, eliminates dead branches, leaves and overhanging tree limbs, and keeps plants that release large amounts of heat if ignited away from the structure can reduce the risk that a wildfire will harm a building.

Structures built with fire-resistive siding, decks, porches, roofing, and screened or ember-resistant vents are safer from wildfires.

There is more we need to know. The percentages of unknown data in NFIRS are high. The very large number of incidents compensates for this somewhat. Several NFIRS fields have code choices that combine several items of interest. When these are all captured in one code such as “light vegetation, including grass, leaves, needles, chaff, mulch, and compost,” they cannot be separated. It is difficult to quantify the losses from these fires. When losses occur as a result of a structure or vehicle fire, they are counted with that structure or vehicle fire, even if the cause of the fire was exposure to a wildfire. We have no estimates of indirect costs due to traffic delays and added smoke in the air. It would also be helpful if the fire experience data from NIFC and NFIRS could be better integrated and if both used the same definitions.

While the vast majority of wildfires burn less than 0.4 ha (one acre), some grow larger and can consume considerable amounts of fire department time and resources. The overall discussion may be hampered by terminology. People who live in cities and suburbs can feel that wildfires happen only in remote areas. Likewise, urban and suburban fire departments may not see the need for training or equipment specific to wildfires. This paper shows that wildfires can happen anywhere this type of fuel is found.

CONCLUSIONS

Wildland fire agencies reported an annual average of 78,700 wildfires to NIFC during 2004–08, roughly one-fifth the 356,800 wildfires handled by local fire departments. Almost one-quarter of the fires handled by local fire departments were wildfires. People who live outside of the high-risk areas may not realize that such fires can and do happen everywhere.

Many of these fires can be prevented by following basic safety rules such as discarding cigarette butts into metal containers rather than on the ground, supervising any campfires or open burning carefully, avoiding such activity on windy days, etc. Even so, some ignitions will occur. Landscaping decisions can increase or decrease the risk of wildfires starting or spreading. Stones, gravel, or other nonflammable material should be used instead of mulch in landscaping that is right next to a building. Trees, shrubs, or plants that ignite easily and burn intensely should not be planted near a structure.

REFERENCES

[1] National Fire Protection Association. (2009) "25 Largest Fire Losses in U.S. History".

[2] National Interagency Fire Center. (n.d) "Fire Information -- Wildland Fire Statistics," sourced to National Interagency Coordination Center. Retrieved from http://www.nifc.gov/fire_info/fires_acres.htm on February 15, 2011.

[3] U.S. Fire Administration. (2008) National Fire Incident Reporting System 5.0 Complete Reference Guide, Section 3, p. 22. Retrieved from http://nfirs.fema.gov/documentation/reference/NFIRS_Complete_Reference_Guide_2008.pdf on February 15, 2011.

[4] Hall, J.R, and Harwood B., (1989) The National Estimates Approach to U.S. Fire Statistics. Fire Technology, 25(2): 99-113. http://dx.doi.org/10.1007/BF01041420

[5] Karter, M.J., Fire Loss in the U.S (during 2004-2008). (2005-2009) series of annual reports, Quincy, MA: National Fire Protection Association.

[6] U.S. Census Bureau. (2009) Statistical Abstract of the United States: 2010 (129th Edition), Washington, DC, Tables 12 and 346.

[7] U.S. Department of the Interior and U.S. Geological Survey. (2005) "Federal Lands and Indian Reservations" National Atlas of the United States of America.® Retrieved from http://www.nationalatlas.gov/printable/fedlands.html on February 15, 2011.

[8] Smith, W.B., Miles, P.D., Perry, C.H., and Pugh, S.A., (2009) Table 2. "Forest Land Area in the United States by Ownership, Region, Subregion, and State" in Forest Resources of the United States, 2007, Gen. Tech. Rep. WO-78, Washington, DC: U.S. Department of Agriculture, Forest Service, 2009. Retrieved from http://nrs.fs.fed.us/pubs/gtr/gtr_wo78.pdf on February 15, 2011.

[9] National Fire Protection Association (2010) NFPA Educational Messages, 2010 Edition Desk Reference, Quincy, MA: National Fire Protection Association.

[10] National Fire Protection Association. Fireworks Safety, Retrieved from http://www.nfpa.org/assets/files//PDF/Public%20Education/FireworksSafetyTips.pdf on February 11, 2011.

[11] National Fire Protection Association. Wildland Fire Safety Tips, Retrieved from http://www.nfpa.org/itemDetail.asp?categoryID=1912&itemID=44851&URL=Safety%20Information/For%20consumers/Outdoors/Wildland%20fires/Safety%20tips on February 11, 2011.

[12] Finucane, M.J., (2008) Combating and Preventing Mulch Fires. Fire Engineering, 161 (3) 139-140+.

[13] Mieth, J., (2010) Commonwealth of Massachusetts Department of Fire Services, "Keep Smoking Material out of Bark Mulch," Retrieved from http://www.mass.gov/Eeops/docs/dfs/news/press/20100526_mulch_fires.pdf on February 15, 2011.

[14] Steward, L.G., Sydnor, T.D., and Bishop, B., (2003) The Ease of Ignition of 13 Landscape Mulches. Journal of Arborculture 26 (6): 317-320.

[15] Zipperer, W., Long, A., Hinton, B., Maranghides, A., and Mell, W., (2007) "Mulch Flammability," Proceedings of Emerging Issues along Urban-Rural Interfaces II: Linking Land-Use Science and Society: 192-195.

[16] Davoodi, H., (2008) "Confinement of Fire in Buildings," Fire Protection Handbook (20th ed), Cote, A.E. (ed), National Fire Protection Association, Quincy, MA 02169, p. 18/11.