A Publication of the
National Wildfire Coordinating Group

Wildland Firefighter Fatalities in the United States: 1990–2006

PMS 841

August 2007

Cover photos—
Fridley Fire, 2001, Emigrant, MT
Inset: Markers commemorating fatalities during the South Canyon Fire, July 6, 1994, Glenwood Springs, CO

A publication of the
NWCG
Safety and Health Working Team

PMS 841 August 2007

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Sponsored for NWCG publication by the NWCG Safety and Health Working Team, August 2007, in cooperation with the USDA Forest Service Technology and Development Center, Missoula, MT. This document was produced under Missoula Technology and Development Center contract with Richard Mangan, retired Fire, Aviation, and Residues Program Leader for MTDC and owner of Blackbull Wildfire Services, Missoula, MT. E-mail: *blackbull@bigsky.net*

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Acknowledgments

The author of this publication, Richard Mangan, would like to acknowledge Heather Matusiak and Sunni Bradshaw, who worked hard to make sure the fatalities recorded in 17 years of "Safety Grams" were tallied accurately.

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Introduction

Wildland firefighting is a high-risk occupation, evidenced each year by deaths or injuries in the line of duty. One way to help reduce wildland firefighter deaths is to identify factors responsible for past fatalities so we can mitigate those factors in future fire seasons.

My interest in firefighter fatalities was fueled by my work on entrapment and fatality investigation teams, beginning with the Dude Fire in 1990 and continuing to the Sawtooth Prescribed Burn fatality in 2003. In 1999, while serving as the Fire, Aviation, and Residues Program Leader at the Forest Service, U.S. Department of Agriculture, Missoula Technology and Development Center (MTDC), I wrote a report on firefighter fatalities, "Wildland Fire Fatalities in the United States: 1990–1998" (figure 1). That report was based on data from the National Wildfire Coordinating Group's (NWCG) Safety and Health Working Team "Safety Gram," issued annually to document firefighter fatalities and entrapment events across the United States. "Wildland Fire Fatalities in the United States: 1990–1998" underreported aircraft accidents by three fatalities and heart attacks by one fatality.

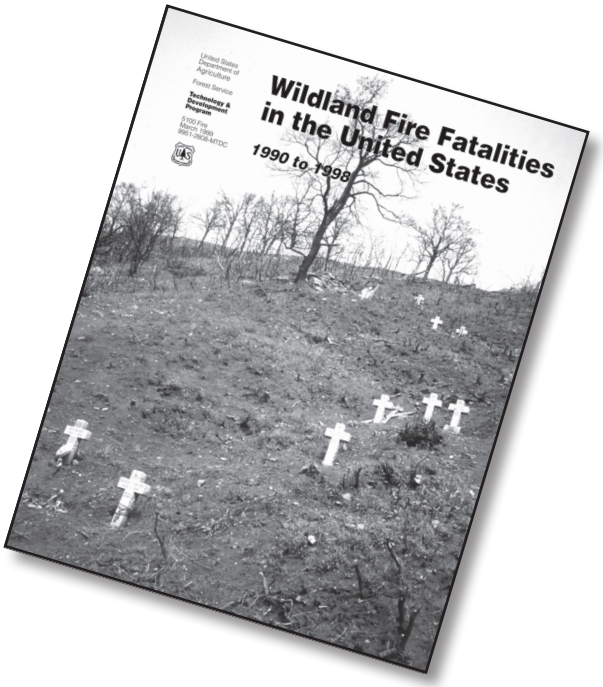


Figure 1—The 1999 report showed that from 1990 to 1998 burnovers killed more wildland firefighters than any other cause.

Highlights...

- From 1990 to 2006, 310 persons died during wildland fire operations.
- The number of wildland fire-related fatalities increased 26 percent from the initial period (1990 to 1998) to the most recent period (1999 to 2006).
- The leading causes of death are now aircraft accidents and vehicle accidents, closely followed by heart attacks.

This report, "Wildland Firefighter Fatalities in the United States: 1990–2006," continues to rely on the "Safety Gram," comparing data from the original 9-year period (1990 to 1998, called the initial period) to data from the following 8 years (1999 to 2006, called the most recent period). Fatality data (figure 2) is summarized for the entire 17-year period (1990 to 2006, called the entire period). Because the most recent period is 1 year shorter than the initial period, the basis for comparison between the two periods will be the annual average during each period.

This report is sponsored by the NWCG Safety and Health Working Team and the MTDC Fire and Aviation Program. The Safety and Health Working Team collects and analyzes data to validate and prioritize safety issues and works to improve firefighter health, safety, and effectiveness.

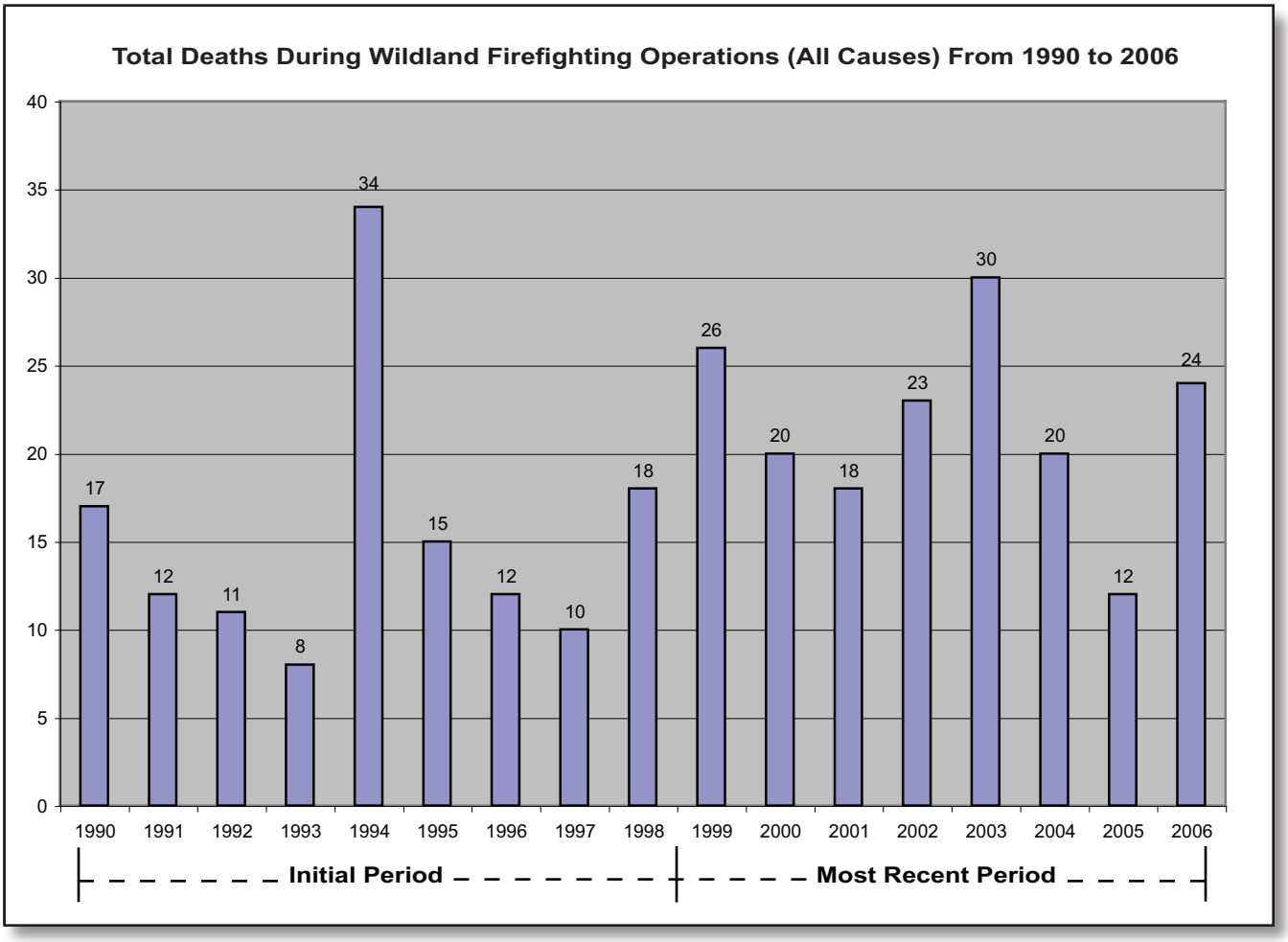


Figure 2—The annual death toll for persons who died during wildland fire operations from 1990 to 2006 (310 total deaths).

Other Wildland Firefighter Fatality Reports

Although wildland fires have burned the American landscape since long before the arrival of Europeans, they received little national attention before the 20th century. Even the Peshtigo Fire that burned more than 1.5 million acres in Wisconsin, killing more than 1,200 people, was overshadowed by the Great Chicago Fire that began the same day in 1871.

When the Big Burn of 1910 killed at least 78 firefighters and burned millions of acres in northern Idaho and western Montana, the public and politicians became aware of the tremendous loss of life and property associated with wildland fires.

The NWCG report "Historical Wildland Firefighter Fatalities 1910–1996" (1997) records numerous wildland firefighter fatalities from 1910 to 1948. On August 6, 1949, 13 firefighters died in a sudden blowup in Montana's Mann Gulch. A thorough investigation was conducted. The events were popularized in the 1952 movie, "Red Skies of Montana," and documented in Norman Maclean's best-selling book, "Young Men and Fire."

In the 1950s, 15 firefighters were killed at the Rattlesnake Fire in northern California (1953) and another 11 died at the Inaja Fire in southern California (1956). After those fires, the Chief of the Forest Service commissioned a task force that prepared a "Report of Task Force to Recommend Action to Reduce the Chances of Firefighters Being Killed by Burning While Fighting Fire" (1957). That study resulted in development of the "10 Standard Fire Orders" and the "13 Situations That Shout Watch Out" (now "18 Situations That Shout Watch Out").

A Forest Service fire safety review team issued a 1967 report: "A Plan to Further Reduce the Chances of Men Being Burned While Fighting Fires." After more fire fatalities in the late 1960s and throughout the 1970s, the Forest Service issued the "Preliminary Report of Task Force on Study of Fatal/Near-Fatal Wildland Fire Accidents" (1980). The report documented Forest Service firefighter fatalities from 1926 to 1979, firefighter fatalities for other agencies from 1933 to 1979 (including firefighter fatalities in Canada), and near misses for all agencies from 1949 to 1979.

The National Fire Protection Association (NFPA) has also looked at wildland firefighter fatalities, sometimes at the request of Federal agencies. An NFPA report in August 1988 summarized all firefighter fatalities in the United States, including those involving wildland firefighters. Two NFPA studies looked specifically at wildland firefighter fatalities: an August 1991 report covered fatalities from 1981 to 1990 and a special analysis in 1997 covered wildland firefighter fatalities from 1987 to 1996.

Study Protocol

This study is based on the annual "Safety Gram" (figure 3) produced by the NWCG's Safety and Health Working Team, allowing data from the initial period to be compared with that from the most recent period. The "Safety Gram" reports fatalities that meet the Safety and Health Working Team's criteria, as well as any fire entrapments and significant vehicle accidents that occur, even if they do not result in fatalities.

The main data in the "Safety Gram" include:

- The cause of death
- The agency for which the deceased worked
- The State where the fatality(ies) occurred

Safety and Health Working Team

SAFETY GRAM

Fatalities, Entrapments and Serious Accident Summary for 2006

The following data indicate the fatalities, entrapments and burnovers and other serious accidents associated with wildfire, wildland fire use and prescribed fire operations in calendar year 2006. The information was collected by the NWCG Safety & Health Working Team, with confirmation of the fatalities from the National Fire Protection Association (NFPA).

Date	Fire Location Jurisdiction	Activity and Type of Accident	Agency / Entity of Personnel Involved	Type of Accident	Number of People	# Shelters Deployed	Fatalities	Injuries
2/9	Hildreth Pool Road Fire Montague, Texas Texas Forest Service	Firefighting	Federal / USFS	Dozer Accident	1			Neck & pelvis injuries
2/18	Chisholm Fire Clinch County, Georgia	Firefighting	State/GA	Entrapment	1	1		1st & 2nd degree burns
3/1	Stephens County Duncan, Oklahoma	Firefighting	Volunteer	Burnover	2	0	1	1st & 2nd degree burns
3/2	Carroll County Sylvatus, Virginia	Firefighting	Volunteer	Burnover	3	0		1st degree burns, smoke inhalation and heat exhaustion
3/2	Yuma County Eckley, Colorado	Firefighting	Volunteer	Burnover	4	Unknown		2nd & 3rd degree burns, minor injuries
3/5	Waynesville, North Carolina	Firefighting	Volunteer	Heart Attack	1		1	
3/12	Gray County Groom, Texas	Firefighting	Volunteer	Engine Rollover	3		1	Broken back, neck, leg and burns
3/12	Shamrock, Texas	Firefighting	Volunteer	Burnover	1	0		

Figure 3—The "Safety Gram" published annually by the National Wildfire Coordinating Group's Safety and Health Working Team was the source of the data used in this report.

Other factors used in fatality analyses prepared by other groups and agencies were not used in this report. They include:

- **Month**: While the month of a fatality may be an important factor in structural firefighting where there is a year-round fire workload, it has little relevance in wildland firefighting. The occurrence of wildland fire is generally seasonal across the United States, driven by highly variable weather conditions.
- **Ages of Deceased**: This information is not reported in the "Safety Gram."
- **Time of Death**: This information is not reported in the "Safety Gram."

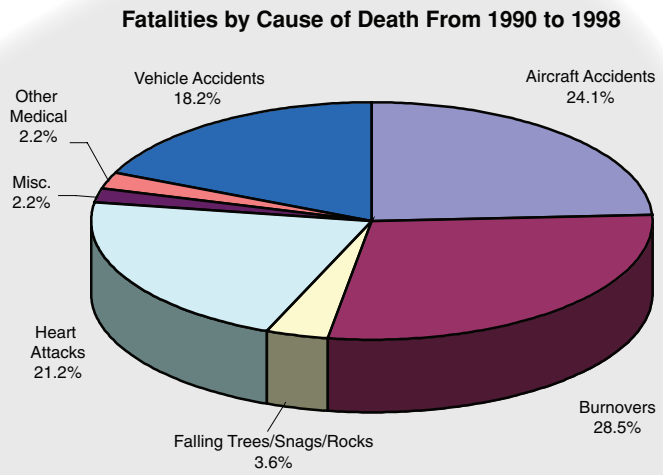
The 1999 report, "Wildland Fire Fatalities in the United States: 1990 to 1998," lumped all contractors into a single class. In recent years, the contracted workforce has increased significantly. To distinguish trends, this report breaks ground contractors into a separate category from aviation contractors, such as pilots and flight crews.

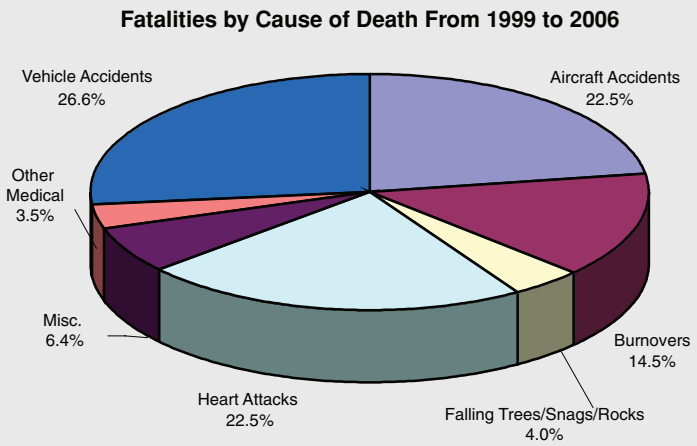
During the entire period, 7 events with 3 to 14 fatalities each have the potential to distort the findings and mask some trends. This report shows the analysis and trends with and without these events. Percentages may not add up due to rounding.

Causes of Death

From 1990 to 2006, 310 individuals died during wildland fire operations. Four major causes of death were responsible for 275 (about 89 percent) of the fatalities (figure 4). These causes of death include:

- Aircraft accidents—72 deaths, 23 percent
- Vehicle accidents—71 deaths, 23 percent
- Heart attacks—68 deaths, 22 percent
- Burnovers—64 deaths, 21 percent





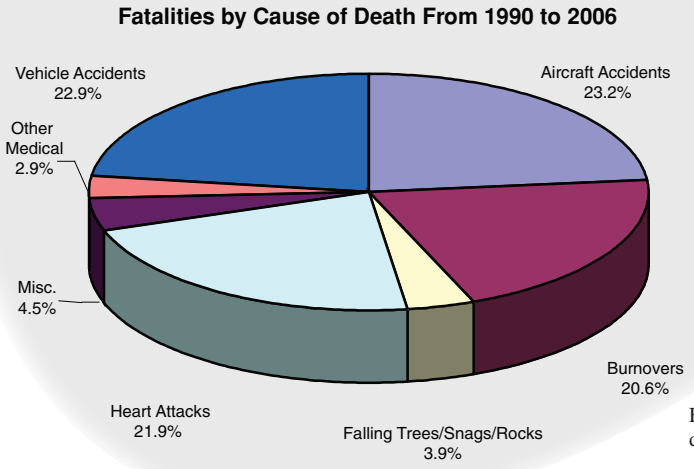


Figure 4—The causes of death for 310 persons who died during wildland fire operations from 1990 to 2006.

Burnovers

Burnovers were the only cause of death in which fatalities decreased. Burnover fatalities dropped from 39 (4.3 fatalities per year) during the initial period to 25 (3.1 fatalities per year) during the most recent period, a 28-percent decrease in the annual average. The number of fires reported to the National Interagency Fire Center in Boise, ID, (table 1) decreased from an average of 83,296 during the initial period to 79,313 per year during the most recent period. Despite fewer fires during the most recent period, the acres burned each year increased 107 percent from an average of 3.27 to 6.79 million acres.

The fires with the most burnover fatalities during the initial period were the South Canyon Fire (1994, 14 fatalities) and the Dude Fire (1990, 6 fatalities). During the most recent period, the wildland fires with the most fatalities were the Esperanza Fire (2006, five fatalities) and the Thirtymile Fire (2001, four fatalities).

Table 1—Number of fires, acres burned by wildland fires, and fatalities from 1990 to 2006.

- The source for annual fires and acreage is the National Interagency Fire Center Web site: *http://www.nifc.gov/fire_info/fires_acres.htm*.
- The Alaska acreage is available at: *http://www.nifc.gov/fire_info/lightning_human_fires.html*.
- The fatality figures are taken from the "Safety Gram" (1990 to 2006).

Year	Fires	Acres	Acres (Alaska only)	Fatalities (All causes)	Fatalities (Burnovers)
			Initial Period		
1990	122,763	5,452,874	Not available	17	10
1991	75,754	2,953,578	Not available	12	3
1992	87,394	2,069,929	Not available	11	0
1993	58,810	1,797,574	Not available	8	3
1994	79,107	4,073,579	Not available	34	17
1995	82,234	1,840,546	Not available	15	2
1996	96,363	6,065,998	Not available	12	2
1997	66,196	2,856,959	Not available	10	1
1998	81,043	2,329,704	Not available	18	1
Subtotal	**749,664**	**29,440,741**	**N/A**	**137**	**39**
			Most Recent Period		
1999	92,487	5,626,093	Not available	26	2
2000	92,250	7,393,493	Not available	20	4
2001	84,079	3,570,911	216,883	18	5
2002	73,457	7,184,712	2,176,665	23	1
2003	63,629	3,960,842	559,332	30	4
2004	65,461	8,097,880	6,523,817	20	1
2005	66,753	8,689,389	4,440,149	12	1
2006	96,385	9,873,745	266,266	24	7
Subtotal	**634,501**	**54,397,065**	**14,183,112**	**173**	**25**
Total	**1,384,165**	**83,837,806**	**14,183,112**	**310**	**64**

Vehicle Accidents

Vehicle accident fatalities increased more than any other cause of death, from 25 (2.8 fatalities per year) during the initial period to 46 (5.8 fatalities per year) during the most recent period, a 107-percent increase in the annual average. The spike in vehicle accidents (figure 5) can be attributed to: the Forest Service rollover on the Stanza Fire (2002, three fatalities), the Grayback Forestry, Inc. rollover (2002, five fatalities) and the First Strike Environmental vehicle accident (2003, eight fatalities). These three accidents killed 16 firefighters. No similar multifatality accidents occurred during the initial period.

Figure 5—Vehicle accidents are now the second most common cause of death during wildland fire operations.

Heart Attacks

Heart attacks caused 29 deaths during the initial period (3.2 fatalities per year), and 39 (4.9 fatalities per year) during the most recent period, a 51-percent increase in the annual average. Volunteer firefighters were the most likely to die from heart attacks (44 deaths, 65 percent of all heart attack fatalities). The number of volunteer firefighters dying from heart attacks probably can be explained by a couple of factors: many more volunteer firefighters are involved in wildland fires on the local level than are agency firefighters, and many volunteer departments have no physical fitness testing or health screening requirements. The National Fire Protection Association said that there were more than 823,350 volunteer firefighters nationwide in 2005.

Since 1998, 11 fire personnel have died while taking or preparing for the Work Capacity Test. In 2000, Federal agencies began implementing a wildland firefighter medical standards program. During 2005 and 2006, there were no reports of firefighters dying while taking or training for the Work Capacity Test.

Aircraft Accidents

Aircraft accident fatalities increased from 33 during the initial period (3.7 fatalities per year) to 39 during the most recent period (4.9 fatalities per year), a 33-percent increase in the annual average.

Aircraft accidents involving both fixed-wing (figure 6) and rotary-wing aircraft (figure 7) continue to be a significant cause of death. In recent years, the use of single-engine airtankers (SEATs) for wildland fire operations has dramatically increased. During the most recent period, four fatalities involved SEATs.

Two catastrophic fixed-wing, multiengine airtanker failures resulted in the entire Federal fixed-wing, multiengine airtanker fleet being grounded temporarily. The use of Type 1 and Type 2 helicopters to drop water, foam, and retardant increased dramatically during that period.

Figure 6—Aircraft accidents were the most common cause of fatalities for persons who died during wildland fire operations from 1990 to 2006.

Figure 7—Helicopters are being used more frequently during wildland fire operations.

Falling Trees/Snags and Rolling Rocks

Falling trees/snags (figure 8) and rolling rocks claimed the lives of five firefighters during the initial period (0.6 fatalities per year) and seven during the most recent period (0.9 fatalities per year). Given the large number of acres burned during the most recent period and increasing concerns about forest health, it's possible that increased emphasis on snag safety by firefighting agencies and teams may have helped prevent some fatalities. For the entire period, falling trees/snags and rolling rocks caused 12 deaths (4 percent of the total).

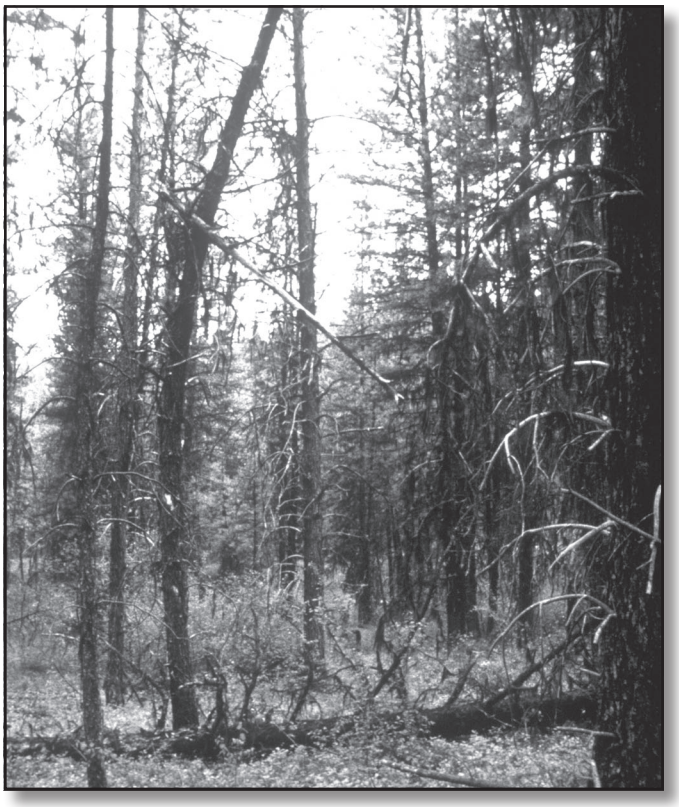


Figure 8—Firefighters must stay alert to the dangers of falling trees/snags and rolling rocks.

Medical Causes Other Than Heart Attacks

Medical causes other than heart attacks (heat stress, aneurysms, general illnesses) were responsible for three fatalities during the initial period (0.3 fatalities per year) and six during the most recent period (0.8 fatalities per year). These fatalities were distributed evenly between State, county, and volunteer firefighters. The nine deaths accounted for 3 percent of the total fatalities.

Miscellaneous Causes of Death

Miscellaneous causes of death that do not fit into any of the above categories claimed the lives of 3 firefighters during the initial period (0.3 fatalities per year) and 11 firefighters during the most recent period (1.4 fatalities per year). Some of the causes of death in this category include electrocution, lightning, falls, smokejumper training, and murder. The miscellaneous causes classification accounted for 5 percent of all fatalities during the entire period.

Incidents With Multiple Fatalities

Seven events with 3 to 14 fatalities each occurred during the study period, contributing 45 of the 310 total fatalities. Burnover events included:

- Dude Fire (1990)—6 deaths
- South Canyon Fire (1994)—14 deaths
- Thirtymile Fire (2001)—4 deaths
- Esperanza Fire (2006)—5 deaths

Vehicle accidents included:

- Stanza rollover (2002)—3 deaths
- Grayback Forestry rollover (2002)—5 deaths
- First Strike Environmental accident (2003)—8 deaths

If these events are removed because of their disproportionate impact, the causes of the remaining 265 fatalities are: aircraft accidents, 27 percent; heart attacks, 26 percent; vehicle accidents, 21 percent; burnover fatalities, 13 percent; miscellaneous causes, 5 percent; and other medical causes, 3 percent.

Organizations

The "Safety Gram" breaks firefighters into seven categories based on the fire organization (figure 9): volunteer, Federal, State, contractor, county/rural, private, and military. This report identifies contractors as aviation contractors or ground contractors.

Volunteer Firefighters

Volunteers died more often on wildland fires than did firefighters in any of the other groups. The fatalities for volunteers increased from 42 during the initial period (4.7 fatalities per year) to 64 during the most recent period (8 fatalities per year), a 71-percent increase in the annual average. Volunteers accounted for 34 percent of all fatalities during the entire period.

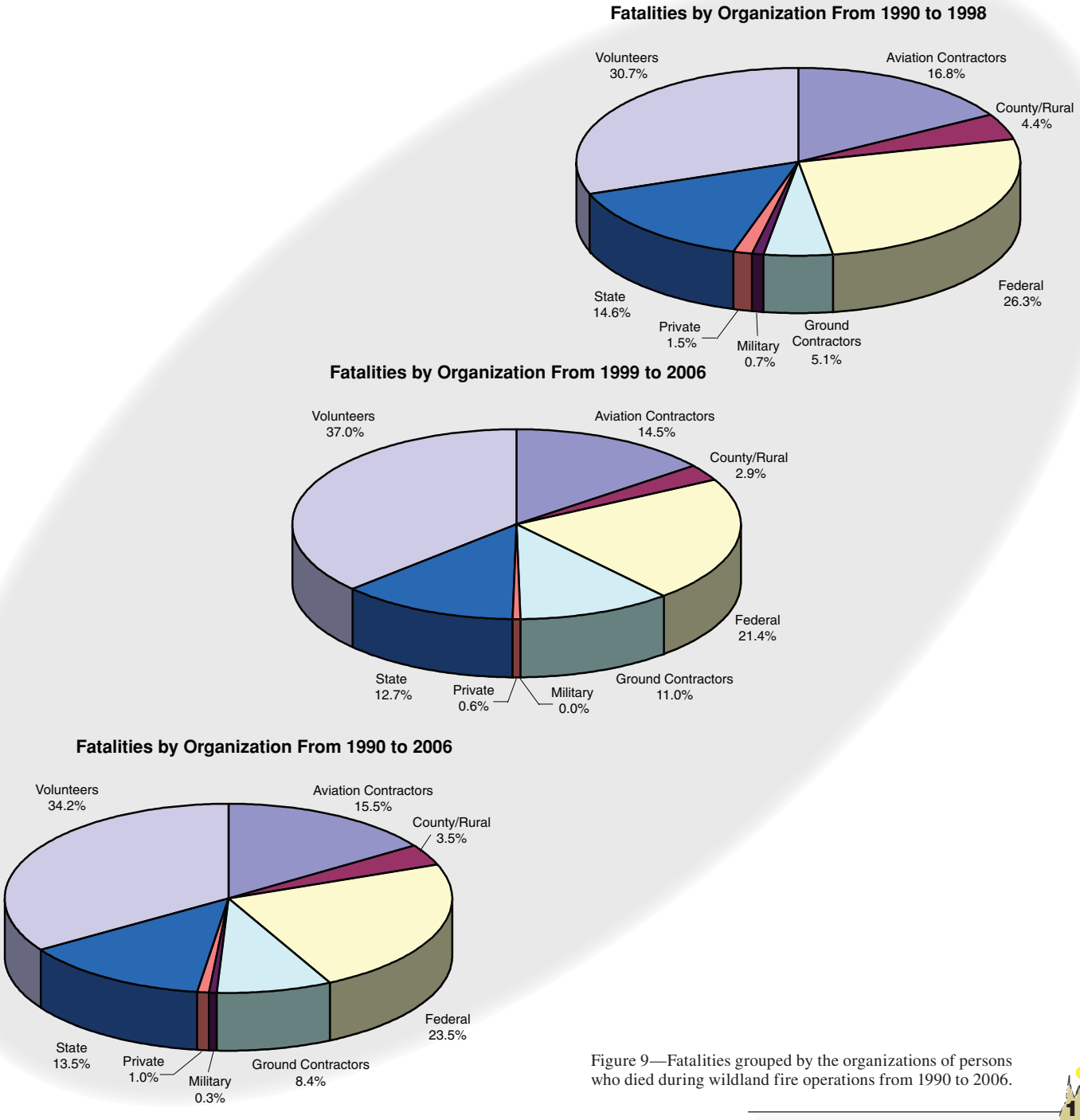
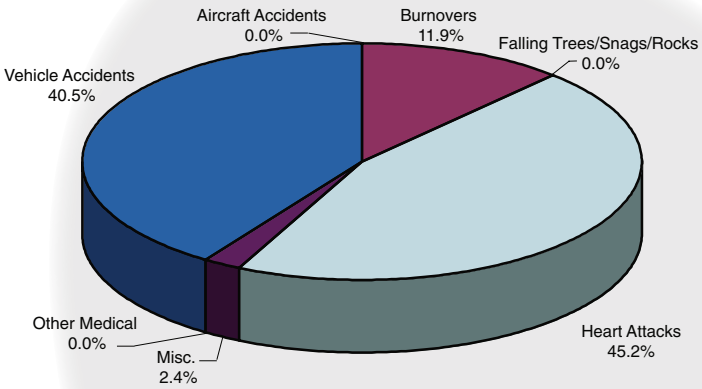


Figure 9—Fatalities grouped by the organizations of persons who died during wildland fire operations from 1990 to 2006.

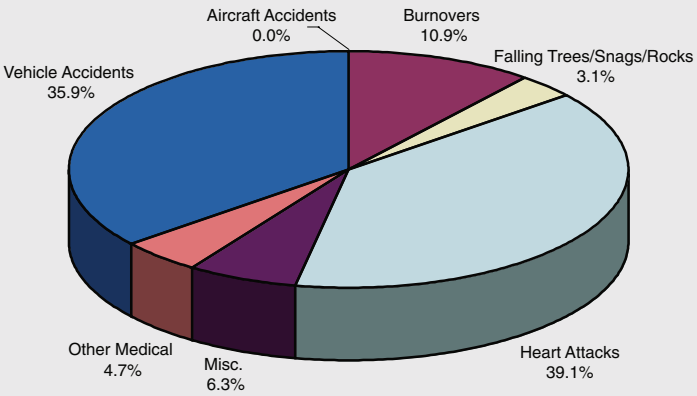
Fatalities for volunteers increased in all categories during the most recent period (figure 10). The largest percentage increase was in heart attack fatalities, which increased from 19 during the initial period (2.1 fatalities per year) to 25 during the most recent period (3.1 fatalities per year), an increase of 48 percent in the annual average.

Heart attacks were the leading cause of death for volunteers (44 fatalities, 42 percent of all fatalities for volunteers), with vehicle accidents a close second (40 fatalities, 38 percent of all fatalities for volunteers). Burnovers accounted for 11 fatalities (10 percent of all fatalities for volunteers), or less than 1 per year. Other causes of deaths among volunteers include miscellaneous causes (five fatalities), other medical causes (three fatalities), and falling trees/snags and rolling rocks (two fatalities).

Fatalities of Volunteers by Cause of Death From 1990 to 1998



Fatalities of Volunteers by Cause of Death From 1999 to 2006



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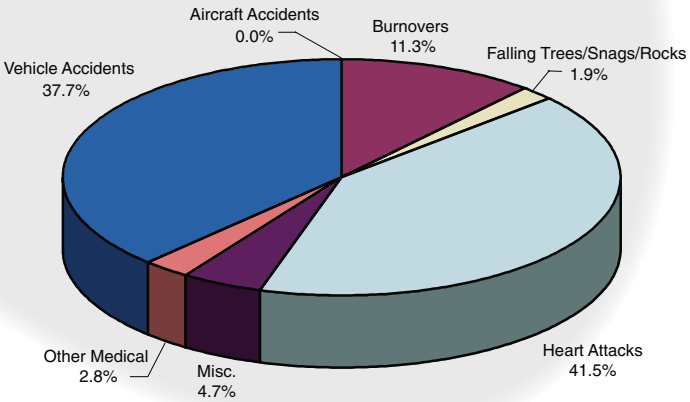


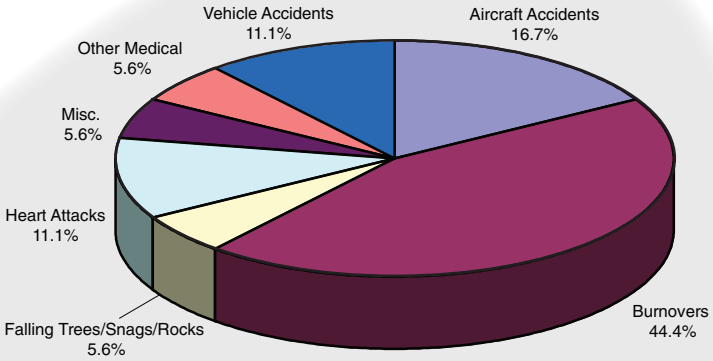
Figure 10—The causes of death for the volunteers who died during wildland fire operations from 1990 to 2006.

Federal Firefighters

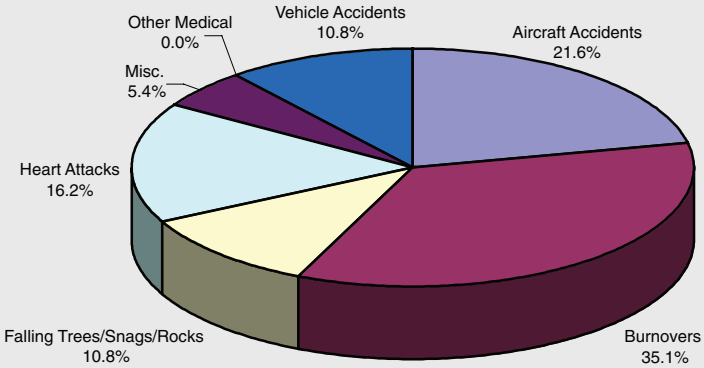
Federal firefighters suffered 73 fatalities (23 percent of the total) over the entire study period, 36 during the initial period (4 fatalities per year), and 37 during the most recent period (4.6 fatalities per year). Burnovers during 3 fires killed 23 Federal firefighters: South Canyon (14), Esperanza (5), and Thirtymile (4). Two burnover fatalities occurred during prescribed burning operations.

Heart attack fatalities among Federal firefighters (figure 11) increased slightly, from four during the initial period (0.7 fatalities per year) to six during the most recent period (0.8 fatalities per year). Four heart attack fatalities have occurred while firefighters were participating in or training for the Work Capacity Tests since the "Safety Gram" began reporting these fatalities in 1998.

Fatalities of Federal Employees by Cause of Death From 1990 to 1998



Fatalities of Federal Employees by Cause of Death From 1999 to 2006



Fatalities of Federal Employees by Cause of Death From 1990 to 2006

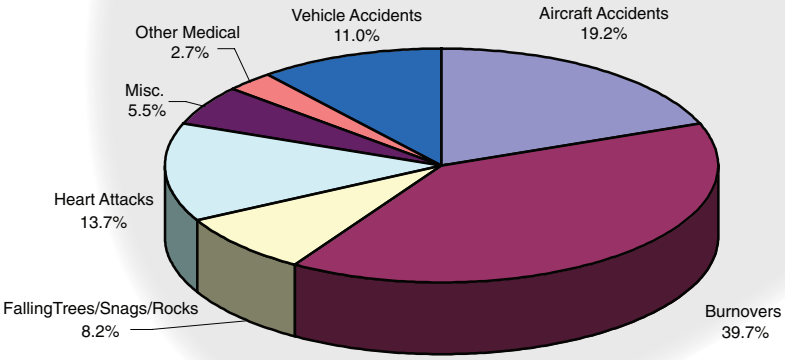


Figure 11— The causes of death for the 73 Federal employees who died during wildland fire operations from 1990 to 2006.

Deaths from aircraft accidents increased from six during the initial period (0.7 fatalities per year) to eight during the most recent period (1 fatality per year), a 50-percent increase in the annual average. All but one of the fatalities involved helicopter crashes. Deaths from falling trees/snags and rolling rocks increased from two during the initial period (0.2 fatalities per year) to three during the most recent period (0.4 fatalities per year).

Vehicle accident fatalities remained low for Federal employees (four fatalities in each period). Deaths from miscellaneous causes remained the same (two) during both periods.

State Firefighters

State firefighters suffered 42 fatalities (14 percent of the total): 20 during the initial period (2.2 fatalities per year) and 22 during the most recent period (2.8 fatalities per year). Burnover fatalities decreased from 11 during the initial period (including 6 on the Dude Fire, an average of 1.2 fatalities per year) to 4 during the most recent period (0.5 fatalities per year).

Fatalities in aircraft crashes increased from three during the initial period (0.3 fatalities per year) to six during the most recent period (0.8 fatalities per year). Accidents involving State-owned and operated fixed-wing aircraft in California accounted for six of those fatalities. State firefighter fatalities from heart attacks increased from three during the initial period (0.3 fatalities per year) to six during the most recent period (0.8 fatalities per year).

Ground Contractors

Ground contractors suffered seven fatalities during the initial period (0.8 fatalities per year): three from vehicle accidents, two from burnovers, one from a heart attack, and one from a falling snag. Ground contractors suffered 19 fatalities during the most recent period (2.4 fatalities per year), when significantly more contractors were in the firefighting workforce. Fourteen of the fatalities were from vehicle accidents, with two accidents accounting for all but one of the fatalities. The remaining fatalities were caused by heart attacks (two) or miscellaneous causes (three). For the entire period, 26 ground contractors died, or 8 percent of the total.

Aviation Contractors

Aviation contractors suffered 23 fatalities during the initial period (2.6 fatalities per year) and 25 fatalities during the most recent period (3.1 fatalities per year). The total of 48 deaths constituted 16 percent of all fatalities during the entire period. Four fatalities during the most recent period involved crashes of SEATs, a relatively new tool in air operations.

County Firefighters

County firefighters suffered a total of 11 fatalities, 6 in the initial period and 5 in the most recent period. Half of the fatalities during the initial period (three) were from burnovers. Causes of death during the most recent period included one fatality from a heart attack, one from other medical causes, one from a vehicle accident, and one from miscellaneous causes. County firefighter fatalities accounted for 4 percent of all fatalities.

Private Individuals

Two private individuals acting on their own behalf were killed by a burnover during the initial period. During the most recent period, one private individual was killed in a vehicle mishap while rushing to a fire. These three fatalities comprised 1 percent of the total fatalities. On February 2, 2005, the “Safety Gram” criteria were updated. The “Safety Gram” no longer includes fatalities of private individuals acting on their own behalf.

Military Personnel

One member of the military was killed in an aircraft fatality during 1994. That military fatality represents less than 1 percent of the total fatalities. The military generally is asked to help only during severe fire seasons after all other resources have been committed.

Locations of Fatalities

During the period covered by this study, all but 7 of the 50 United States had fatalities during wildland fire operations (figure 12). During the initial study period, 137 persons died in 33 States (15.2 fatalities per year). During the most recent period, 173 persons died in 41 States (21.6 fatalities per year).

Fatalities During Wildland Fire Operations, 1990 to 2006

310 Total

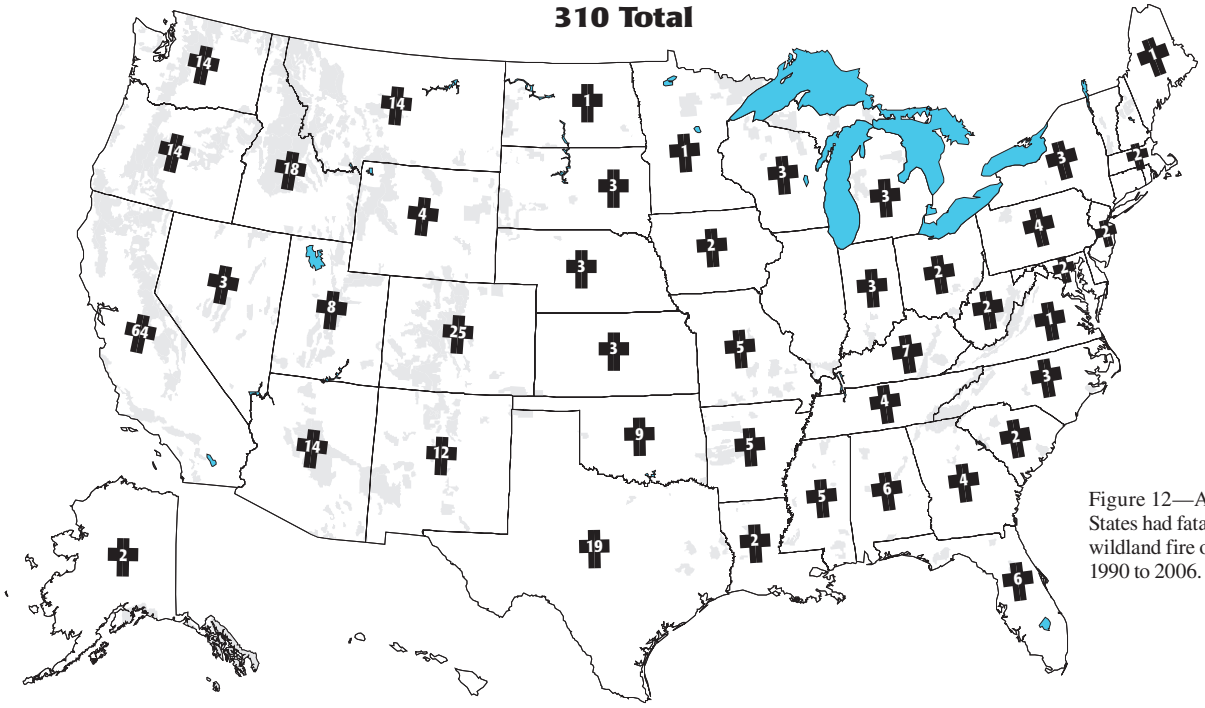


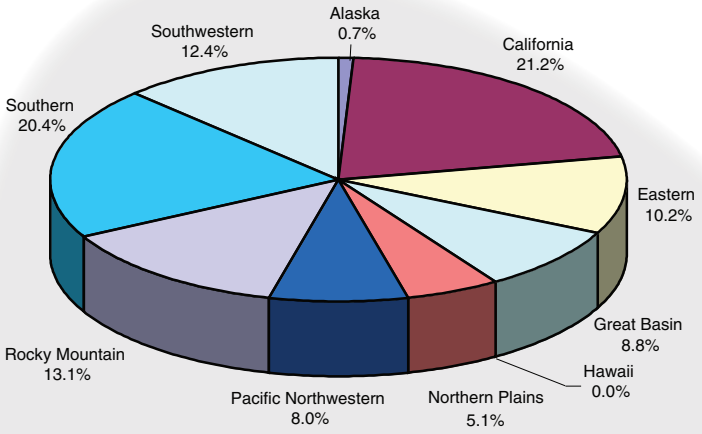
Figure 12—All but seven States had fatalities during wildland fire operations from 1990 to 2006.

Sections of the Country

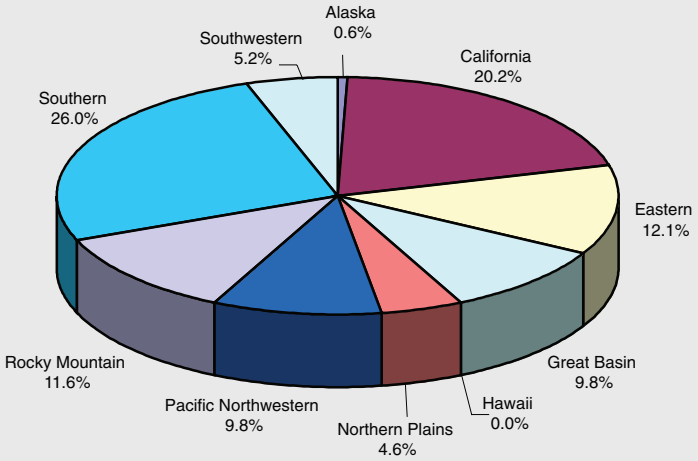
The "Safety Gram" identifies fires by State. The following groups of States were used to provide an overview of fatalities for different sections of the country (figure 13).

- Hawaii—(There were no fatalities in this State during the entire period.)
- Alaska
- California
- Pacific Northwestern States—Oregon, Washington
- Rocky Mountain States—Colorado, Kansas, Nebraska, South Dakota, Wyoming
- Northern Plains States—Montana, North Dakota
- Great Basin States—Idaho, Nevada, Utah
- Southwestern States—Arizona, New Mexico
- Southern States—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia
- Eastern States—Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin

Fatalities by Section of the Country From 1990 to 1998



Fatalities by Section of the Country From 1999 to 2006



Fatalities by Section of the Country From 1990 to 2006

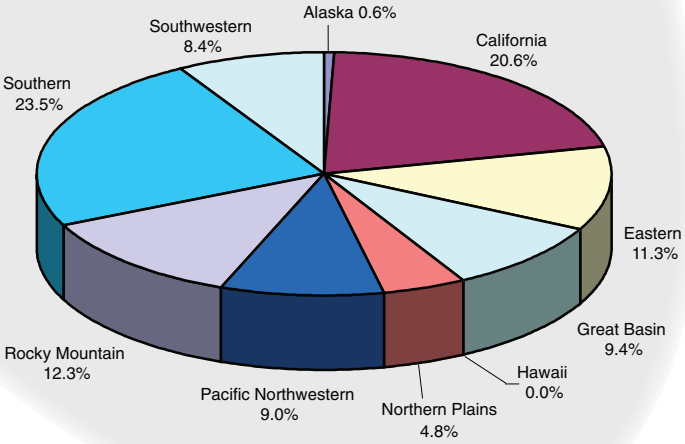


Figure 13—One in five fatalities during wildland fire operations from 1990 to 2006 was in California.

California was the State with the largest number of fatalities, 64 (3.8 fatalities per year). Fatalities in California increased from 29 during the initial period (3.2 fatalities per year) to 35 in the most recent period (4.4 fatalities per year), a 36-percent increase in the annual average. The California incident with the largest number of fatalities was the October 2006 Esperanza Fire that killed five Federal firefighters during a burnover.

Other States with large numbers of fatalities were: Colorado (25 fatalities, including 14 from the 1994 South Canyon Fire and 5 in the 2002 Grayback Forestry vehicle rollover), Texas (19 fatalities, including 11 during the most recent period); Idaho (18 fatalities, including 11 during the most recent period—four in a single aircraft crash). Washington, Oregon, Montana, and Arizona had 14 fatalities each. New Mexico had 12 fatalities. Other States had no more than 10 fatalities during the entire period.

Fatalities in the Southern States increased from 28 during the initial period (3.1 fatalities per year) to 45 during the most recent period (5.6 fatalities per year), an 81-percent increase in the annual average. Within this section of the country, seven States (Mississippi, Florida, Tennessee, North Carolina, Texas, Arkansas, and Kentucky) had a large increase in fatalities from the initial period (14, 1.6 per year) to the most recent period (35, 4.4 per year). The large increase in fatalities in the Southern States might be driven in part by drought conditions responsible for large increases in the number of fires and the acres burned.

In the Pacific Northwestern States, fatalities increased from 11 (1.2 fatalities per year) during the initial period to 17 (2.1 fatalities per year) during the most recent period. The large increase in this area was due to eight fatalities in the First Strike Environmental vehicle accident.

The Eastern States had the third largest percentage increase in fatalities, from 14 during the initial period (1.6 fatalities per year) to 21 during the most recent period (2.6 fatalities per year), a 69-percent increase in the annual average. This increase is not due to any single event, but to a combination of events across the region.

Overall, fatalities in the Great Basin States increased from 12 during the initial period (1.3 fatalities per year) to 17 during the most recent period (2.1 fatalities per year). Idaho had 7 fatalities during the initial period (0.8 fatalities per year) and 11 fatalities during the most recent period (1.4 fatalities per year).

The Southwestern States had a meaningful drop in fatalities: from 17 fatalities during the initial period (1.9 fatalities per year) to 9 fatalities during the most recent period (1.1 fatalities per year), a decrease of 40 percent in the annual average. The initial period included six fatalities on the Dude Fire in 1990.

The Northern Plains and Rocky Mountain States experienced moderate increases in fatalities during the most recent period. In the Northern Plains States, fatalities were up 14 percent, from 7 (0.8 fatalities per year) to 8 (1.0 fatality per year). In the Rocky Mountain States, fatalities were up 11 percent, from 18 (2.0 per year) to 20 (2.5 per year).

The greatest benefit of retrospective studies is that they allow us to see trends that have developed, or have continued, over a long period (17 years, in this case). Instead of making a short-term, knee-jerk reaction to perceived problems, fire managers can rely on retrospective studies to identify the problems that have recurred, their causal factors, and the mitigation measures needed to resolve them.

Overall, fatalities increased during the most recent period compared to the initial period. The 137 fatalities during the initial period represent an average of 15.2 fatalities per year. The 173 fatalities during the most recent period represent an average of 21.6 fatalities per year, a 42-percent increase in the annual average. Although burnover fatalities dropped, increases in other causes of death contributed to the overall increase in fatalities. While the average number of fires per year decreased about 5 percent during the most recent period, the average number of acres burned each year increased by 91 percent.

Aircraft Accidents

Aircraft accidents are the leading cause of fatalities during wildland fire operations. Aircraft accidents accounted for a total of 72 fatalities, (4.2 fatalities per year), about 23 percent of all fatalities. Fatalities increased from 33 (3.7 fatalities per year) during the initial period to 39 (4.9 fatalities per year) during the most recent period. The increase may be related to the number of acres burned during the period. Several fixed-wing, multiengine airtankers crashed during this period, resulting in a temporary shutdown of fixed-wing, multiengine airtanker operations and later a reduction in the number of fixed-wing, multiengine airtankers being used. This reduction led to an increase in the use of SEATs and Type 1 helitankers. Four SEAT crashes with fatalities occurred during the most recent period.

Vehicle Accidents

Vehicle accidents (figure 14) also were a leading cause of death, killing 71 persons (23 percent of the total fatalities), an average of 4.2 fatalities per year. Vehicle accident fatalities increased from 25 during the initial period (2.8 fatalities per year) to 46 during the most recent period (5.8 fatalities per year), a 107-percent increase in the annual average. Most vehicle accident fatalities involved a single individual. Many of the victims were driving to an incident or were returning home after being demobilized.

Because the time of accidents is not reported in the "Safety Gram," it is not possible to evaluate the effect of darkness and/or fatigue. Rollovers were a recurring factor. Several reports documented firefighters being thrown out of their fire apparatus and being run over by the vehicle.

Volunteer firefighters suffered the most vehicle accident fatalities (40), 56 percent of the total. This percentage may be attributed to the large number of volunteer vehicles that respond to wildland fires across the country.

Figure 14—Pay attention to speed, seat belts, and fatigue to avoid being injured or killed in a vehicle accident.

Heart Attacks

Heart attacks continue to be a leading cause of death among wildland firefighters (22 percent of the total fatalities). The number of heart attacks increased from 29 during the initial period (3.2 fatalities per year) to 39 during the most recent period (4.9 fatalities per year), a 51-percent increase in the annual average.

Among Federal and State firefighters, heart attacks increased from 7 during the initial period (0.8 fatalities per year) to 12 during the most recent period (1.5 fatalities per year), an 88-percent increase in the annual average. From 1998 to 2004, four Federal, three State, and two volunteer firefighters died from heart attacks while taking the Work Capacity Test or training to do so. No one died during 2005 or 2006, the period during which Federal firefighters were required to undergo improved health screening before taking the Work Capacity Test. The brochure, "Work Capacity Testing for Wildland Firefighters: Promoting Wildland Firefighter Safety" (figure 15), is available at *http://www.fs.fed.us/fire/safety/wct/2002/brochure_2002.pdf.*

Burnovers

The NWCG defines a burnover as "…a situation where personnel or equipment is caught in an advancing flame front." Burnovers (figure 16) are the most visible cause of death for wildland firefighters, but they caused only 64 (21 percent, or an average of 3.8 fatalities per year) of the total (310) fatalities. Four burnovers were responsible for nearly half (29) of the 64 fatalities:

- Dude Fire in Arizona (1990)—6 fatalities
- South Canyon Fire in Colorado (1994)—14 fatalities
- Thirtymile Fire in Washington (2001)—4 fatalities
- Esperanza Fire in California (2006)—5 fatalities

The first three major burnover fatality events (Dude, South Canyon, and Thirtymile Fires) led to significant changes in the way wildland fire suppression efforts are undertaken. If we remove these three events and the 2006 Esperanza burnover from consideration (for a total of 29 fatalities), the average number of burnover fatalities drops to a base level of 2.1 burnover fatalities per year.

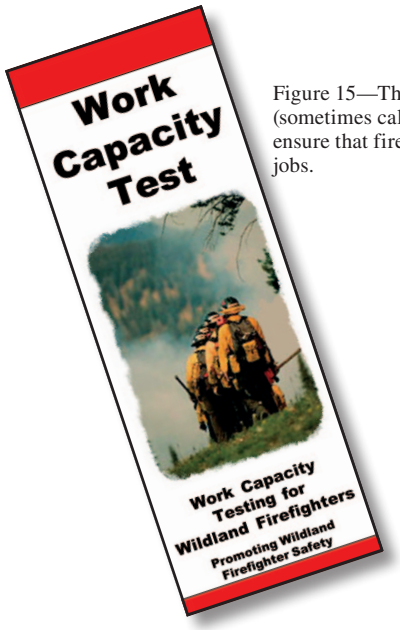


Figure 15—The Work Capacity Test (sometimes called the pack test) helps ensure that firefighters are fit for their jobs.

Figure 16—Burnovers continue to be one of the major causes of death during wildland fire operations.

To get a better sense of trends that might be lost by consolidating data, the analysis of burnover fatalities was broken into timeframes that differ from the study periods used elsewhere in this report (figure 17):

- 1990 to 1994—From the Dude Fire (1990) through calendar year 1994 when the South Canyon Fire occurred.
- 1995 to 2001—After the South Canyon Fire, its reviews, and subsequent changes in fire operations. This timeframe includes the four fatalities on the Thirtymile Fire.
- 2002 to 2006—The "Post-Thirtymile" era that includes the five fatalities on the Esperanza Fire.

Burnovers killed 33 firefighters from 1990 to 1994, an average of 6.6 per year. More than half of those fatalities were on the Dude (6 fatalities) and South Canyon Fires (14 fatalities). Many of those killed during this timeframe were Federal and State firefighters who were suppressing fires that were viewed as direct or indirect threats to private homes and other structures (figure 18).

After the South Canyon Fire, several reviews, special studies, and conferences focused the attention of wildland firefighters across the United States on the need for safer work practices on the fireline.

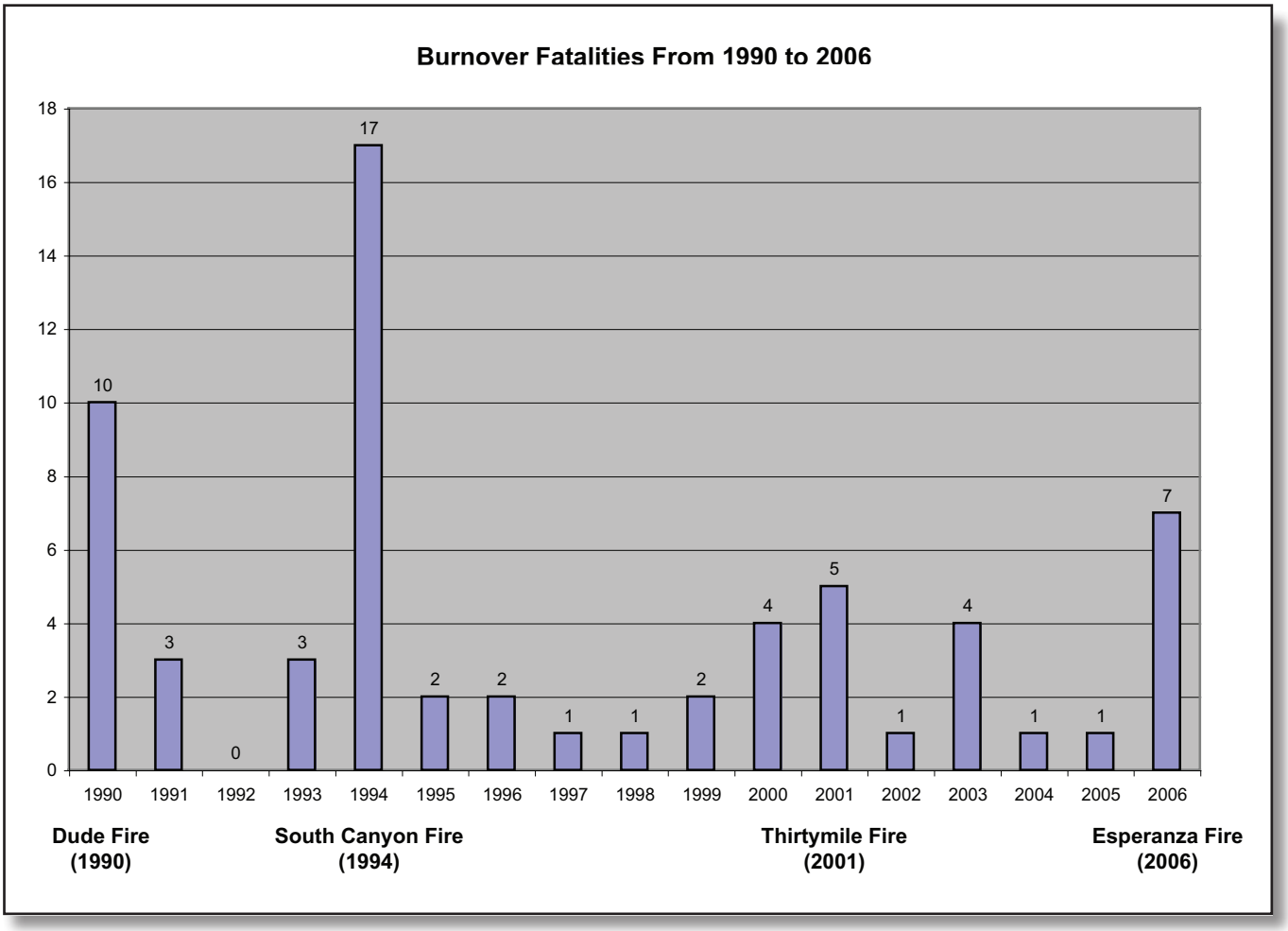


Figure 17—Burnovers can be grouped based on the changes that occurred after the most serious burnovers: the Dude Fire (1990), the South Canyon Fire (1994), and the Thirtymile Fire (2001).

Figure 18—Protecting homes in the wildland-urban interface has increased the risk to firefighters. This wildland-urban interface is on Long Island, NY.

From 1995 to 2001, 17 firefighters died in burnovers, an average of 2.4 per year. Both 1996 (6.0 million acres burned) and 2000 (7.4 million acres burned) were significant fire years. In 2001, the Thirtymile Fire killed four firefighters and led to a new round of reviews and policy changes.

From 2002 until 2006, an additional 14 firefighters were killed by burnovers, an average of 2.8 per year. During October 2006, five Federal firefighters were killed by a burnover on the Esperanza fire in California.

Entrapments

Although this report documents and analyzes fatalities that occurred during wildland fire operations, close call events that are not as well documented may lead to future fatalities. The "Safety Gram" does document entrapments.

The NWCG defines an entrapment as "…a situation where personnel are unexpectedly caught in a fire behavior-related, life-threatening position where planned escape routes or safety zones are absent, inadequate, or have been compromised. An entrapment may or may not include the deployment of a fire shelter for its intended purpose. These situations may or may not result in injury. They include near misses."

Entrapments were reviewed during the same timeframes as burnover fatalities: 1990–1994; 1995–2001; and 2002–2006. While the number of burnover fatalities decreased after fires with multiple fatalities from burnovers, such as South Canyon (14 fatalities, 1994) or Thirtymile (4 fatalities, 2001), the number of entrapments did not drop. The "Safety Gram" and "Wildland Firefighter Entrapments: 1976–1999" (figure 19), recorded a total of 875 entrapments from 1990 to 2006 (figure 20):

- 1990 to 1994—218 entrapments (43.6 per year)
- 1995 to 2001—414 entrapments (59.1 per year)
- 2002 to 2006—243 entrapments (48.6 per year)

While many of these events did not result in fatalities, they are a harsh reminder of the fine line between a close call and death. They merit our attention.

Figure 19—This report is available online at:
http://www.fs.fed.us/t-d/pubs/htmlpubs/htm00512853/
Username: t-d, Password: t-d
—Cover photo by Mark Erickson, Silver City, NM.

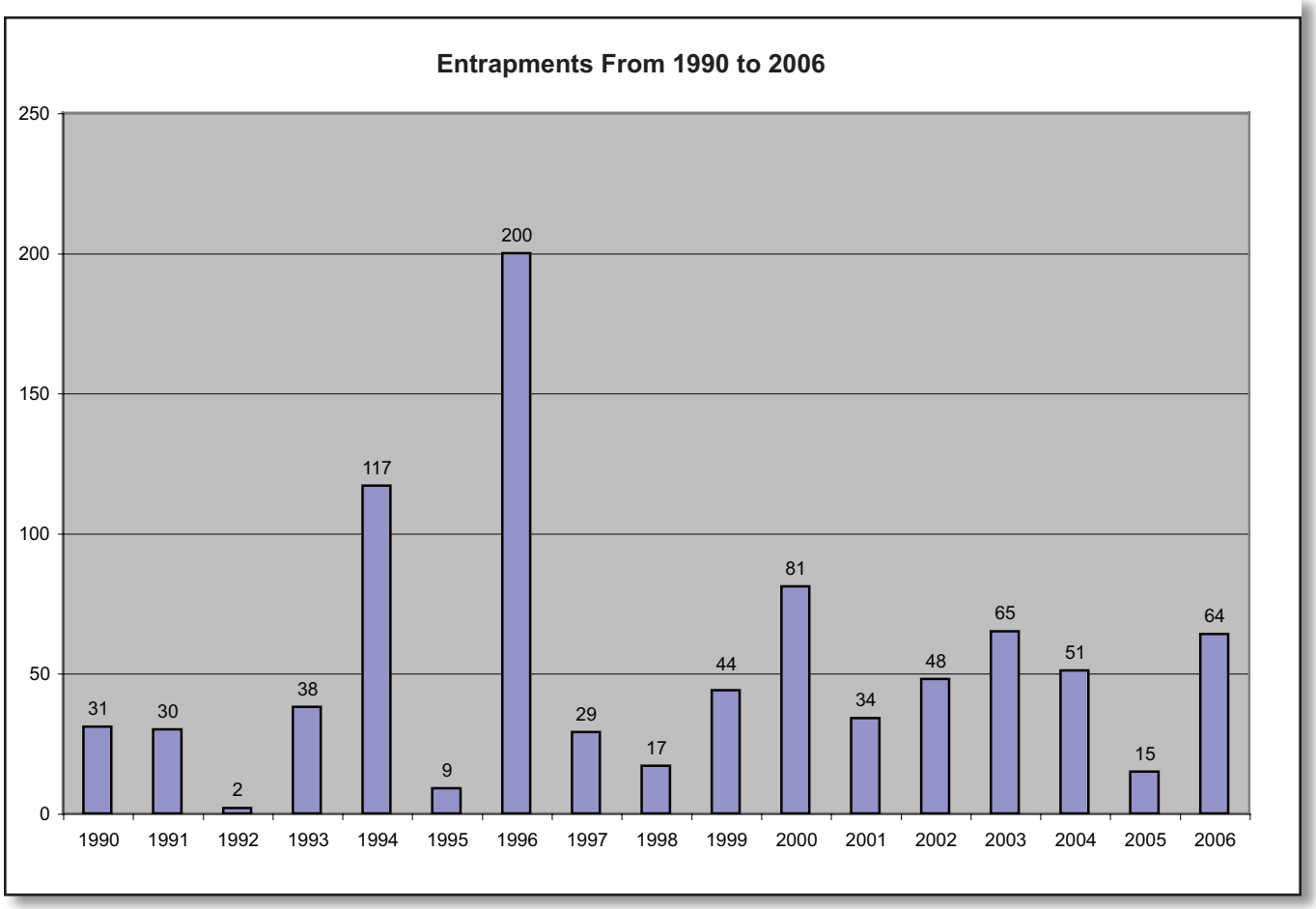


Figure 20—The number of entrapments from 1990 to 2006.

Falling Trees/Snags, Other Medical, and Miscellaneous Causes

Falling trees/snags and rolling rocks killed 11 firefighters: 5 during the initial period (0.6 per year) and 6 during the most recent period (0.8 per year).

Fatalities from other medical and miscellaneous causes increased from 6 during the initial period (0.7 per year, including 3 from other medical causes and 3 from miscellaneous causes) to 17 during the most recent period (2.1 per year, 6 from other medical causes and 11 from miscellaneous causes). Other medical causes included brain aneurysms, undefined sickness, and heat stress.

The miscellaneous causes included being struck by lightning, electrocution, drowning, and even a murder in a staging area. While the 23 fatalities from other medical and miscellaneous causes include only 7 percent of the total deaths, targeted actions (figure 21), such as training in lightning awareness and powerline dangers, can be taken to reduce the number of fatalities, especially those with nonmedical causes.

Figure 21—Following safe practices at all times can help reduce fire fatalities. Riding outside an engine is not a safe practice.

Common Denominators for Wildland Firefighter Fatalities

In the mid-1970s, fire researcher Carl Wilson identified four common denominators of fire behavior that caused fatalities and near-misses on wildland fires. These four common denominators have been cited for decades in fire safety training, in the "Fireline Handbook" (PMS No. 410–1), and in the "Incident Response Pocket Guide" (PMS No. 461).

Based on my analysis of 310 fire fatalities during wildland fire operations from 1990 to 2006, I believe that it is time to consider some 21st-century common denominators to help reduce wildland firefighter fatalities.

21st-Century Common Denominators for Wildland Firefighter Fatalities

As the major causes of firefighter fatalities shift, additional factors need to be considered:

1. Firefighters are most likely to die in an aircraft accident. Before every flight, fire managers must ask, "Is this flight essential?" and "Is everyone onboard essential to the mission?"
2. Firefighters are nearly as likely to die in a vehicle accident as in an aircraft accident. Driving too fast for the conditions, failing to wear seat belts, rushing to a fire, and driving home while exhausted from firefighting kill firefighters.
3. Firefighters can reduce their risk of dying from heart attacks on the job by staying fit, maintaining their body weight, and having regular medical checkups.
4. Unexpected events such as falling snags, rolling rocks, downed power lines, and lightning strikes cause more than 8 percent of fatalities during wildland fire fighting operations. Firefighters and fire managers can reduce fatalities by learning to expect these unexpected events.

More than 20 percent of fatalities during wildland firefighting operations continue to occur in burnovers. Carl Wilson's original common denominators are just as important in the 21st century as they were in the 20th.

There are four major common denominators of fire behavior on fatal and near-fatal fires. Such fires often occur:

1. On relatively small fires or deceptively quiet areas of large fires.
2. In relatively light fuels, such as grass, herbs, and light brush.
3. When there is an unexpected shift in wind direction or wind speed.
4. When fire responds to topographic conditions and runs uphill. Alignment of topography and wind during the burning period should always be considered a trigger point to re-evaluate strategy and tactics.

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About the Author

Dick Mangan founded Blackbull Wildfire Services after retiring from MTDC in 2000. Mangan came to MTDC in 1989 as the Fire and Aviation Program Leader. He served as an advisor to the National Wildfire Coordinating Group's Safety and Health and Fire Equipment Working Teams and was chair of the National Fire Protection Association's Technical Committee on Wildland Fire Protective Clothing and Equipment (NFPA 1977) from 1995 to 2000. In the wildland fire suppression world, Mangan is qualified as an operations section chief, safety officer, and planning section chief. He has been involved in suppression operations across the United States and has been chief investigator, team member, and technical expert on wildland fire entrapment and fatality investigations. He has written and spoken widely on fire safety and equipment issues not only in the United States, but also in Australia, Spain, and Siberia. He is a member of the International Association of Wildland Fire, the National Fire Protection Association, and the National Association of Fire Investigators. In April 2001, he was awarded the GEICO Insurance Public Service Award for Fire Safety. He served on the board of the International Association of Wildland Fire from 2001 to 2006 and was president from 2004 to 2006.

Fire season 2001

Library Card

Mangan, Richard. 2007. Wildland firefighter fatalities in the United States: 1990–2006. NWCG PMS 841. Boise, ID: National Wildfire Coordinating Group, Safety and Health Working Team, National Interagency Fire Center. 28 p.

This report updates the 1999 report, "Wildland Fire Fatalities in the United States: 1990–1998" (9951–2808–MTDC). From 1990 to 2006, 310 persons died during wildland fire operations. The number of fatalities each year increased 26 percent from the initial period (1990 to 1998, 15.2 fatalities per year) to the most recent period (1999 to 2006, 21.6 fatalities per year). Burnovers were the leading cause of death during the initial period. During the most recent period, the leading causes of death were aircraft accidents, vehicle accidents, and heart attacks. Mangan proposes four new "21st-Century Common Denominators of Wildland Firefighter Fatalities" to supplement the original four "Common Denominators of Fire Behavior on Tragedy Fires" identified during the 1970s by fire researcher Carl Wilson.

Keywords: accident prevention, accidents, aircraft, burnovers, common denominators, contractors, deaths, entrapments, fatalities, fire fighters, fire fighting, firefighting, fire shelters, fitness, heart attacks, safety at work, vehicles, volunteers, wildfires, wildland fires

The NWCG "SafetyGram" and "Historical Wildland Firefighter Fatality" reports are available on the Internet at:

http://www.nwcg.gov/teams/shwt/safetygram2.htm

Electronic copies of MTDC's documents, including "Wildland Firefighter Fatalities in the United States: 1990–2006" (0751–2814–MTDC), are available on the Internet at:

http://www.fs.fed.us/t-d

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:

http://fsweb.mtdc.wo.fs.fed.us/search/